

**EMM BROOK
WOOSEHILL FISH PASSAGE IMPROVEMENTS**

FINAL REPORT

**Prepared for
South East Rivers Trust**

**Prepared by
cbec eco-engineering UK Ltd**

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1. INTRODUCTION

This report describes the development of a river restoration design for a reach of the Emm Brook, South of Wokingham, Berkshire, commissioned by South East Rivers Trust (SERT). The brook is a tributary of the River Loddon, itself part of the wider River Thames catchment.

Location details of the study site are provided below, with extents also shown in Figure 1-1.

- Restoration Reach: OS NGR SU 79910 68889 to SU 79824 69269.

The ultimate aim of the project was to develop a design to re-instate a historic channel located to the east of the current course of the Emm Brook, bypassing the existing channel and an associated weir structure at the downstream end of the site.

The primary objective of the work was to improve fish passage at the site, whilst wider benefits included improvements to geomorphological and wider ecological diversity, channel – floodplain reconnection, enhanced amenity value and reduced flashiness/ possible reductions to flood risk.

This project follows on from an initial feasibility and preliminary design study undertaken by SERT, funded by the Environment Agency (EA).

1.1 APPROACH

A number of assessments, both desk- and field-based, were carried out to guide the development of a site appropriate, sustainable final design.

Following provision of information relating to previous studies across the site, a desk-based review of this data was undertaken to assess gaps in the existing datasets, and collate all relevant information (i.e. utilities, etc). This data was used to develop an understanding of the current physical condition of the site, to allow for consideration of key design criteria and constraints.

An initial site visit was undertaken by experienced geomorphologist Dr Hamish Moir, following which, through discussions with SERT at the beginning of the design process allowed the team to understand the aspirations for the site as well as any further constraints or structures to be considered as part of the design.

A topographic survey and 2D hydraulic modelling were then conducted, informing the identification of a suitable design for the site through an iterative design-modelling process (whereby the initial design is refined through an iterative process of examining model output). A Level 1 (i.e. qualitative) Flood Risk Assessment (FRA) was also undertaken to assist SERT with the consenting process.

The final restoration design was developed using a process-based restoration approach, working with the river to reinstate or reproduce natural river process as much as site constraints permit. This provides a longer term and sustainable restoration design.

2. REVIEW OF EXISTING DATA

This section provides an overview of key features of the study site of the Emm Brook, derived from a baseline data review, setting the context for the design development discussed in the following sections of the report.

2.1 HISTORIC MODIFICATIONS

Analysis of historic OS maps¹ suggests that there has been little change in channel planform through the restoration site since the late 19th Century. However, there are indicators which provide evidence that, originally, this section of the water body flowed to the east of the current day alignment. These include evidence of a historic channel to the east of the current channel (visible on online aerial imagery and OS mapping and observed in the field), and a Corn Mill located immediately downstream of the site, present on the OS 6-inch map published in 1900, suggesting that the previous sinuous course was diverted in order to provide a water supply to the Mill.

2.2 GEOLOGY

An assessment of site geology² has confirmed a band of alluvium (consisting of clay, sand and gravels) runs through the site in the general alignment of the brook. This was corroborated by information provided by SERT which states that previous cores taken throughout the historic channel confirmed the site is underlain by London Clay with a drift geology of very slowly permeable clay soils. This presence of alluvium suggests that prior to realignment, the water course was likely to have displayed some sinuosity (as is evident within the historic channel planform), with a degree of lateral channel migration (i.e. bank erosion and bar development) expected to occur over extended periods of time.

2.3 AMENITY VALUE

In addition to fish passage improvements, this commission aims to assist SERT's wider work at the site improving site visibility and accessibility, including the local footpath network. Issues currently experienced include regular waterlogging of the footpath in places, and overgrown bramble/ scrub vegetation and the incised nature of the channel with steep banks limiting visibility.

2.4 UTILITIES REVIEW

As part of the desk-based review, an assessment of known services/ utilities at the site (as determined during the previous options appraisal phase of works) was undertaken. This identifies the following services crossing both the existing and historical channels at the Emm Brook site:

- **Thames Water** – There are two foul sewer pipes within the site boundaries. One crosses the existing channel approximately 50 m upstream of the upstream footbridge crossing located at SU 79872 69056. The pipe is visible protruding from the river bed with the remaining pipe crossing the site underground from Arthur Road in the East towards Morrisons supermarket in the West. The second sewer pipe deviates from a pipe running behind the houses of Brookside, where it crosses the historic channel approximately 50 m upstream of the footpath crossing (SU 79849 69227). As the pipe is cast iron, Thames Water have confirmed to SERT that they have no issue with the historic channel being reinstated and have advised

¹ Available online at: <http://maps.nls.uk/geo/explore/#> [Accessed 12 February 2019]

² Available online at: <http://mapapps.bgs.ac.uk/geologyofbritain/home.html> [Accessed 12 February 2019]

that the concrete abutments could be trimmed/ set back by up to 1m if required, to improve conveyance at this location. See **Section 2.6** for photographs.

- **South East Water** – A freshwater pipe crosses both channels through the centre of the site. It enters the site from the park entrance at Brookside where it turns 90 degrees and crosses the site from East to West. It crosses the historic channel approximately 75 m downstream of the pond (SU 79919 69102) and the existing channel approximately 100 m downstream of the upstream footbridge (SU 79872 69056).
- **Scottish and Southern Electricity** – A high voltage cable enters the site from Brookside and crosses the site North East to South West. The cable crosses the historic channel immediately downstream of the pond (SU 79919 69102), below the gabion retention structure. The cable crosses the existing channel underneath the upstream foot bridge (SU 79872 69056), suspended above the water. It runs alongside the footpath South West where it leaves the site. A lower voltage cable enters the site downstream and follows the footpath behind the houses on Brookside in a South West direction where it crosses the historic channel at the footpath crossing (SU 79849 69227).

2.5 PREVIOUS SURVEY DATA

The project team were provided with 2D drawing file containing data relating to a previous topographic survey at the site. This was assessed and used to inform the topographic survey undertaken as part of this commission (see **Section 3**).

2.6 SITE PHOTOGRAPHS

A series of high-resolution, georeferenced photographs were taken during both the initial site visit and topographic survey. These can be provided separate to this report. Photos of key features of the site are provided overleaf.



Figure 2-1 Upstream footbridge (near proposed tie-in location)



Figure 2-2 Upstream foul sewer pipe crossing by tie-in location



Figure 2-3 Wildlife pond located in historic channel



Figure 2-4 Footpath crossing historic channel



Figure 2-5 Second foul sewer pipe and abutments, in historic channel

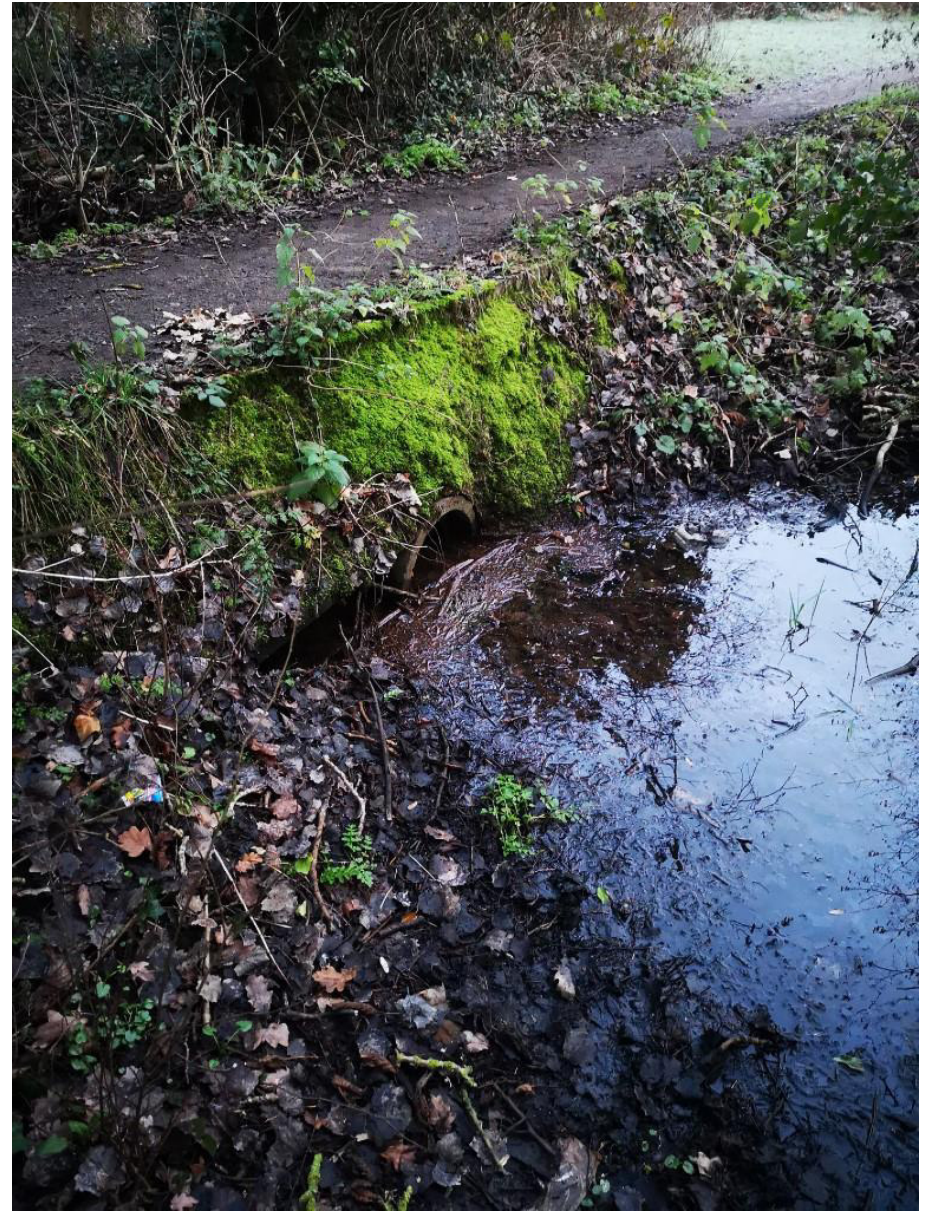


Figure 2-6 Footpath crossing historic channel towards downstream end of site



Figure 2-7 Bridge upstream of weir pool at downstream end of site



Figure 2-8 Weir, weir pool and small culvert outflow (view upstream)

3. TOPOGRAPHIC SURVEY

A detailed topographic survey was conducted in order to inform detailed design development and subsequent 2D hydraulic modelling. The survey was undertaken on 29th January and 1st February 2019, during normal/ low flow conditions (based on visual assessment given no gauge data is available for the site). GNSS Lecia Base Station equipment and RTK GPS Leica GS14 was used to capture accessible and open areas of the study reach. In areas where tree canopy and/ or other obstacles restricted RTK-GPS utility, survey data was collected using a Trimble S6 Total Station.

The survey extents coincided with a relatively straight section of the Emm Brook beyond the hydraulic influence of the weir (i.e. impoundment effects). The upstream extent extended ~430 m upstream of the weir (SU 79910 68889) and the downstream extent extended ~ 50 m downstream of the weir (SU 79875 69282). The survey also included floodplain upstream and downstream and where possible due to vegetation cover a ~330 m section of historic channel from the offtake (SU 79890 69018) feeding back into the downstream weir pool (SU 79834 69271).

Where access allowed, data collected characterised the physical form/ hydraulic function of the site, including channel structures such as the Emm Brook weir, culverts and foot bridges throughout the survey extent as well as data on the floodplain. Again, where access was feasible given the heavily vegetated nature of parts of the site, the survey representatively characterised variation in the horizontal (i.e. channel bends) and vertical (i.e. relative topographic highs, riffle crests/ hydraulic controls, and lows, pool centres).

Where complex topography dictated, additional data were collected in a non-uniform gridded format, with greatest point density around areas of highest elevation variability (i.e. around the weir structure and adjacent sections of channel upstream and downstream). Such a point scatter approach was essential to capture the salient aspects of channel morphology in more complex topographic areas, so that subsequent model output sufficiently represented site and design conditions. All points were collected in the OSGB36 (15) coordinate system, following the latest ordnance surveyed guidelines.

The topographic data was post-processed and meshed with available LiDAR and previous survey data provided to cbec by SERT, to create a Digital Elevation Model (DEM) of the site (produced in AutoCAD Civil 3D). From this, a full topographic map was developed in ArcMap GIS software. The resulting existing conditions Digital Elevation Model (DEM) of the site is presented in Figure 3-1.

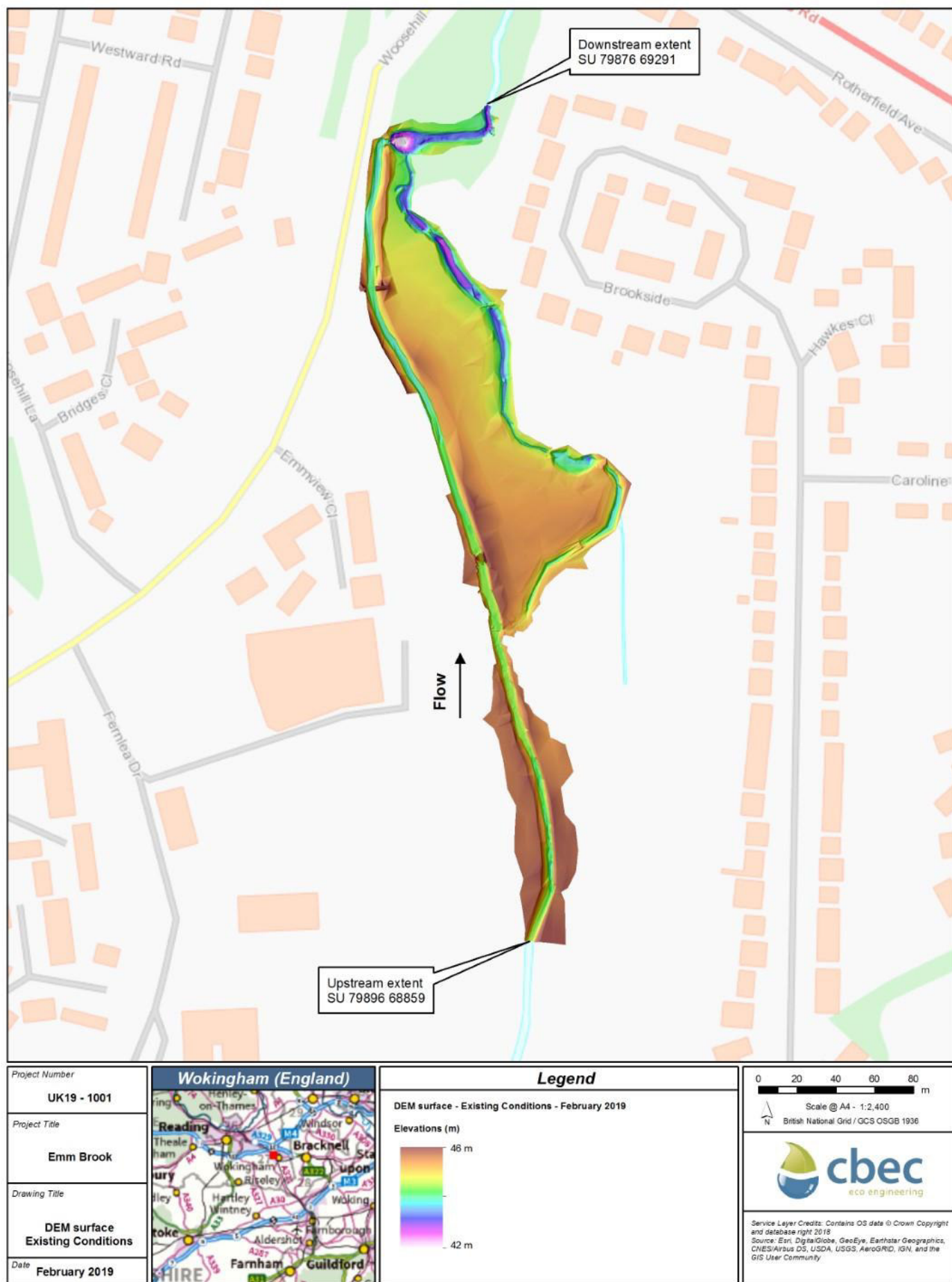


Figure 3-1 Existing Conditions DEM (based on topographic data and LiDAR)

4. DESIGN DEVELOPMENT

Following the development of an existing conditions surface and further discussions with SERT, an initial design surface was developed (again in AutoCAD Civil 3D). A summary of the key design features/ components incorporated at this initial stage of design is provided below. Following this, the design was modelled (see **Section 5**). Final design details are provided in **Section 6** and in the detailed design drawings provided separate to this report.

Channel design

The design channel was built with a simple geometry, allowing for natural adjustment and development of physical process and bedform diversity over time. Bed elevation has been based on the hard bed levels of the historic channel, with cross-sectional profile determined through an iterative process. The tie-in location for the design channel is situated immediately upstream of the oak tree, with the existing upstream channel bed regraded to reduce slope at the location of the channel diversion.

Flows and fish passage consideration

Under normal flow conditions, the reinstated historical channel was designed to take all flow. A provisional maximum flow for the channel was estimated by SERT at 1.5m³/s, however, it was advised that if the model results showed this to be unrealistic given imposed conditions, this could be adjusted as necessary. For fish passage, SERT recommended a maximum velocity of 1.3m/s with a minimum water depth of 250-300 mm.

Upstream flow control structure

The requirement and dimensions of an upstream flow control structure in the existing channel were to be determined following review of initial model output. During design discussions with SERT it was decided to utilise the foul sewer pipe as a weir control without further modification. This would ensure no increase in upstream flood risk, and no difficulties associated with modifying the existing pipe. See **Section 5.1** for further details.

Additional structures (i.e. culverts and footbridges)

It was agreed that all culverts in the existing channel would be removed as part of the design. The design channel was to include three footbridges, the dimensions for which were to be determined following review of initial model output, to ensure that the structures will not impact the functioning of the design channel.

Wildlife pond

A pond currently exists within the historic channel alignment. The geometry of this pond has been retained as part of the developed scheme, with the design channel tying into the upstream and downstream end of the feature. There was an acknowledgement that this will require to be dredged to remove some silt from the pond as part of the works.

Utilities

A key criterion of the design was to ensure that the scheme would not impact a high voltage electric cable which currently runs ~500 mm below hard bed level through the historic channel course. The bed elevations within the design channel are such that potential risk to this cable is minimised.

Large Wood

In-channel large wood structures currently existing throughout the site have been retained as part of the design.

5. HYDRAULIC MODELLING

This section details 2D hydraulic modelling results of the Emm Brook site under existing and restoration design conditions.

A fully 2D model was created of both channels and the functional floodplain. As discussed in **Section 3**, survey data of both channels was combined with 1m LiDAR data. Bridges were daylighted in the main channel, as the 100 year model results (15.48 m³/s peak) were just under the bridge soffits: 45.42 m and 45.03 m water levels for soffits at 45.5 m and 46.2 m respectively.

Main stem channel friction was set at $n = 0.03$ for the Western existing channel and $n = 0.025$ for the design channel, in accordance with baseline values in the UK CES roughness advisor software. Channel vegetated banks were provided with $n = 0.05$ except in the presence of large trees, which had $n = 0.1$. Elsewhere a constant floodplain friction of $n = 0.06$ was used in accordance with standard UK practice.

The model was run steady state because there was minimal floodplain storage present.

The model downstream boundary was normal depth, with a slope of 0.0024 (measured from survey data and LiDAR).

The design channel dimensions were arrived at through Manning equation analysis with design constraints of:

- A minimum depth of 0.25 m at the mean daily flow of 0.258 m³/s, with all of the flow going down the design channel.
- A maximum velocity of 1.3 m/s at flows up to 1.5 m³/s.
- No increase in flood risk within the design area, downstream, and upstream.

The appropriate toe to toe width of the channel, given the above constraints, was determined to be around 1.5 m. A DEM of the design, with excavated pond area, de-culverted sections, and following the original relict channel route, was constructed and merged with LiDAR to create the design model surface.

In areas where the design channel runs through two Alder trees (nominally to be retained) the trees were modelled as a direct restriction on channel width (i.e. modelled as solid pillars in the model mesh), with an associated increase in roughness.

Immediately downstream of the bifurcation between existing and design channel is a foul sewer pipe. This pipe causes a raised area in the bed of the existing channel. This high point in itself causes some existing impoundment at the bifurcation and acts like a weir flow control: with the lowered elevations in the design channel, this foul sewer pipe controls low flows to enter the design channel rather than down the existing channel. This foul sewer pipe extends into the design channel, although the design channel bed is lower than the pipe invert. This suspended feature is modelled as an obstruction (via its drag force) in the channel.

Immediately upstream of this pipe is a footbridge/ capped part of the design channel, which extends a footpath over the design channel. This is modelled as a cap on water levels, with weir overflow when levels reach the deck height.

5.1 MODEL RESULTS

Details of the flow split between the eastern design and western flood relief channels is shown in Figure 5-1. Flow is contained within the design channel while it is $< 0.46 \text{ m}^3/\text{s}$, above which point flow starts to enter the western flood bypass channel. If the Alder trees are removed, then flow is contained in the design channel $< 0.52 \text{ m}^3/\text{s}$, an increase that is unlikely to warrant removal of the trees. If a greater flow split is desired, then channel toe-toe could be increased, but this would drop channel depths at mean daily flow. Figure 5-2 shows the water levels in relation to the foul sewer pipe weir, suspended foul sewer pipe invert and footbridge soffit and deck for three flows between mean daily flow to $0.46 \text{ m}^3/\text{s}$ and $1.5 \text{ m}^3/\text{s}$. Channel bed levels are also shown. At $0.46 \text{ m}^3/\text{s}$ the levels upstream of the existing channel foul sewer just reach the pipe crest, and at $1.5 \text{ m}^3/\text{s}$, the levels in the design channel just reach the bridge soffit. This bridge acts under outlet control because of the low slope.

The model was run at the mean daily flow ($0.258 \text{ m}^3/\text{s}$) to determine whether depths in the design channel were above the minimum limit of 0.25 m , suitable for a range of fish species. Depths and velocities throughout the design channel are illustrated in Figure 5-3. Depths average 0.35 m , and there are only isolated locations where they drop slightly below 0.25 m . All velocities are below $1.3 \text{ m}^3/\text{s}$. The average channel velocity is $0.44 \text{ m}^3/\text{s}$. The model results confirm that fish passage is possible through the entire design channel at the mean flow. The channel depths at mean daily flow are mapped in Figure 5-4.

5.1.1. Flood extents and flood risk

Figure 5-5 shows the water depths at the 2 year peak flow. Flows are mostly within bank with 48% of the total flow routing through the design channel. It is likely that there is enough flow through the sinuous design channel at this 2 year peak to have a geomorphic effect on substrate and form pools and riffles (unlike the more flume-like existing channel).

Figure 5-6 and Figure 5-7 show a comparison of flood extents for both the 5 year and 10 year flood events. Particularly within the latter, flood extents within the upper half of the site are significantly reduced by the design.

100 year flood depths and inundations (at $10.48 \text{ m}^3/\text{s}$) are compared in Figure 5-8. The design has slightly more capacity than existing conditions (the design channel and pond is excavated) and so there is a marginal reduction in flood depths in the park, as shown in the difference map in Figure 5-9. No properties are affected for either condition.

The results suggest there is no increase in flood risk as a result of the design.

5.1.2. Bridge design soffits

At the 100 year flood, levels at the proposed bridge locations are 45.13 m at the upstream bridge and 44.81 m at the downstream bridge, although a factor of safety should be applied to these as there has been no sensitivity testing of the model. At the 2 year flood, levels at the upstream bridge are 44.57 m and at the downstream bridge are 44.26 m .

Recommended dimensions for the bridges based on the model results, are provided in the detailed drawings provided separate to this report.

A Level 1 (i.e. qualitative) Flood Risk Assessment is provided in **Appendix A**.

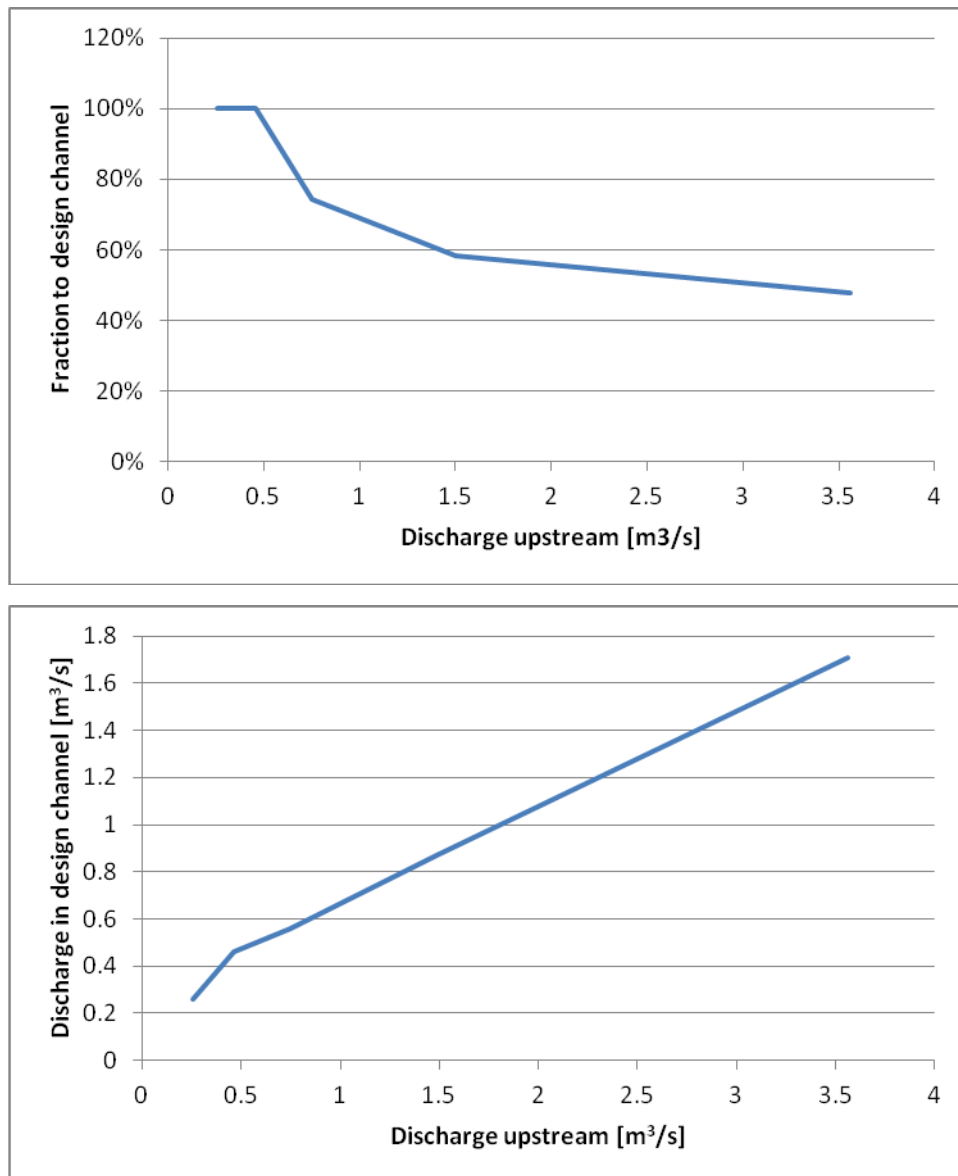


Figure 5-1 Flow split between eastern design channel and western flood relief channel under design conditions.

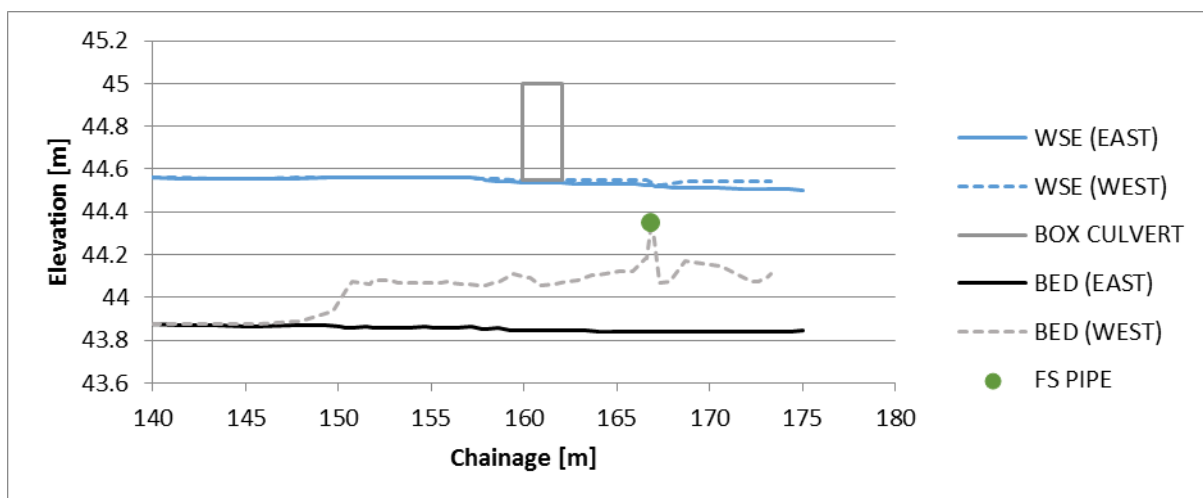
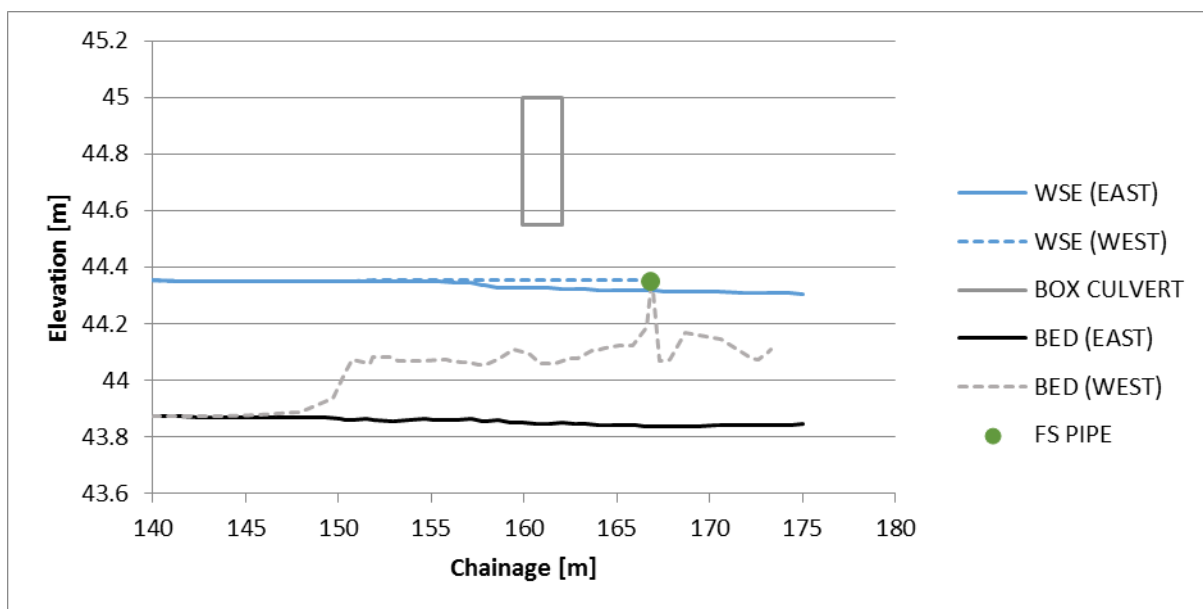
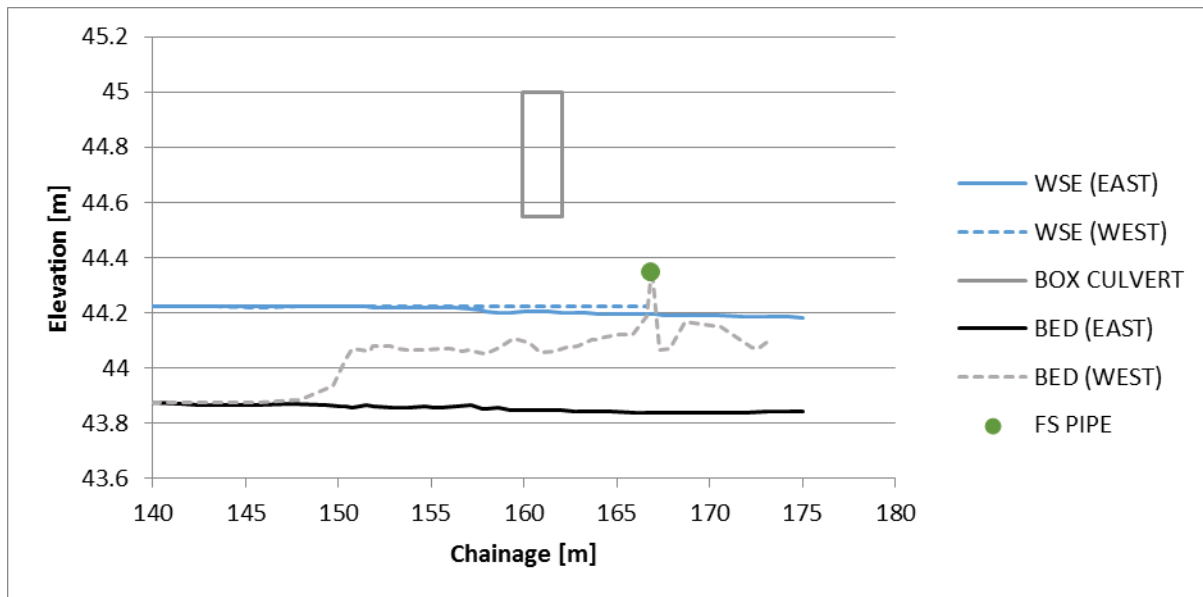


Figure 5-2 Water levels at the bifurcation at three flows: Mean daily flow (upper), 0.46 m³/s (middle) and 1.5m³/s (lower).

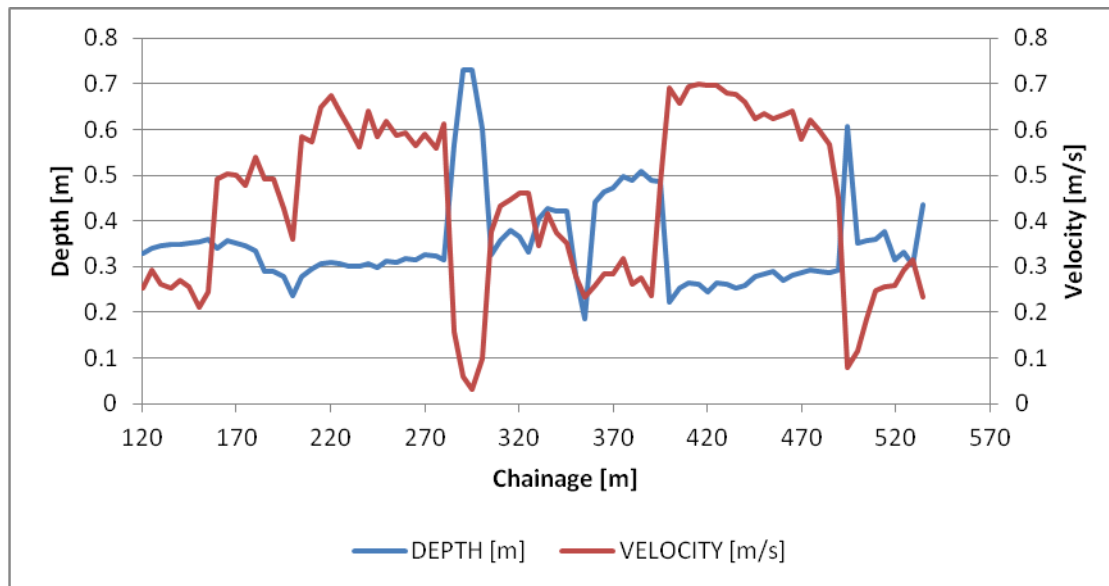


Figure 5-3 Velocity and depths through design channel at mean daily flow.

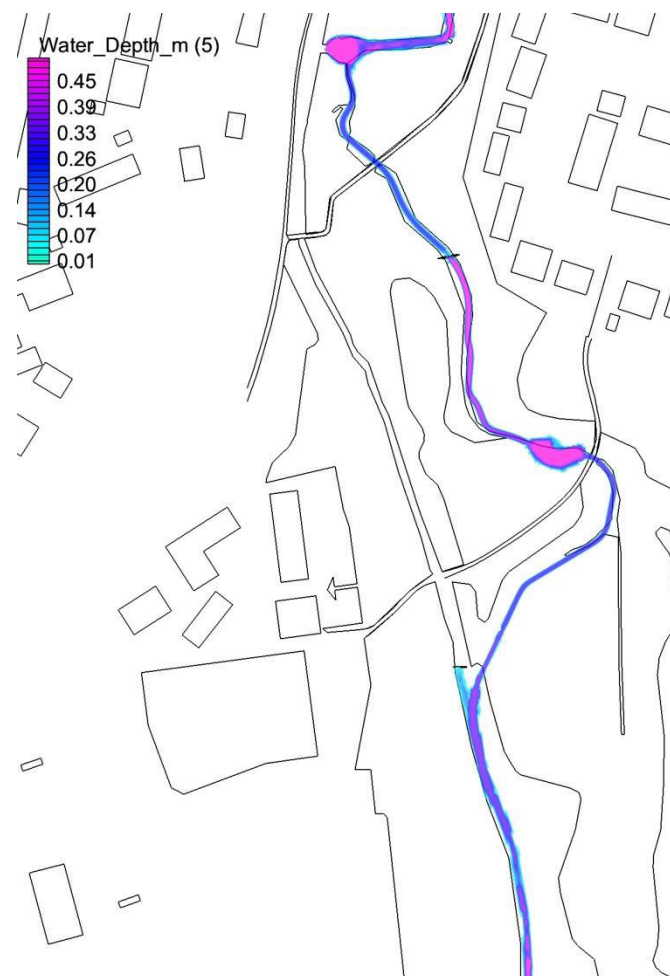


Figure 5-4 Water depths and design channel footprint at mean daily flow.

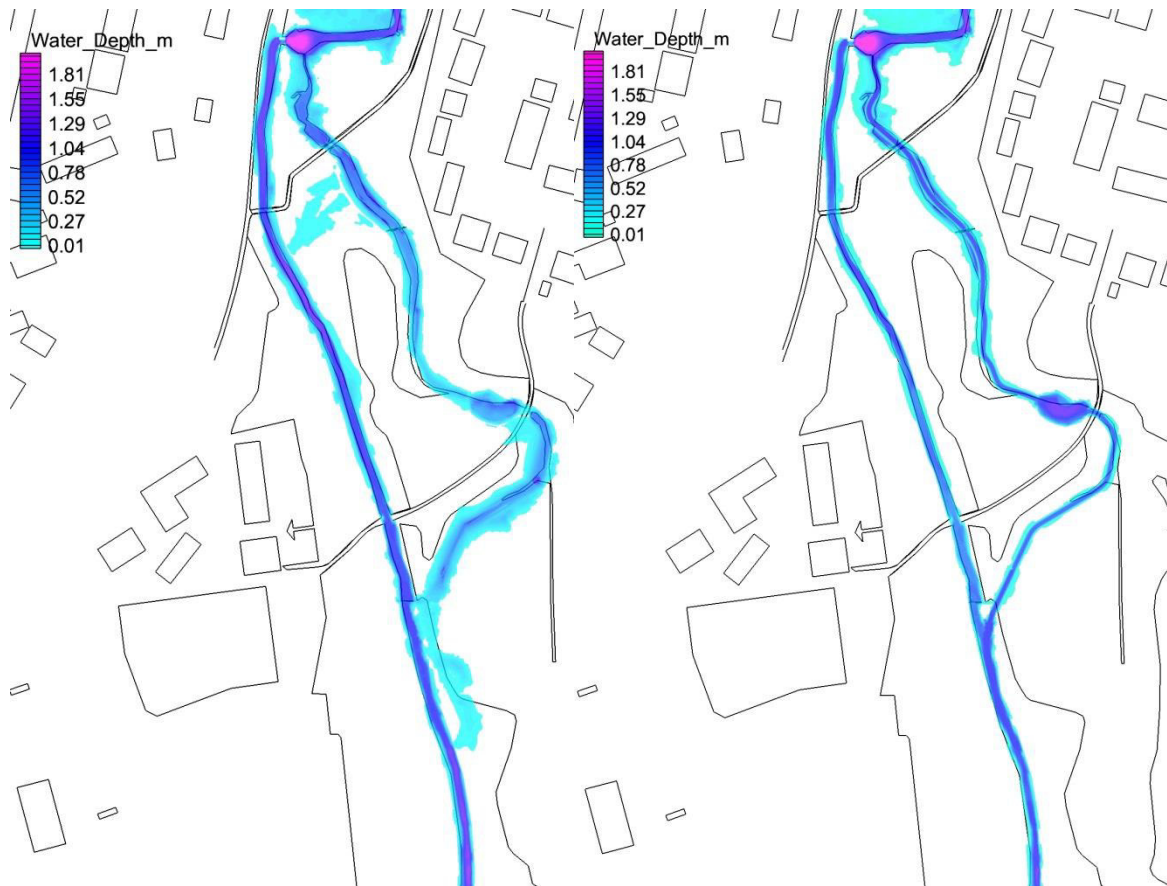


Figure 5-5 2 year flood inundation. Existing condition left; design condition right. Peak flow 3.56 m³/s.

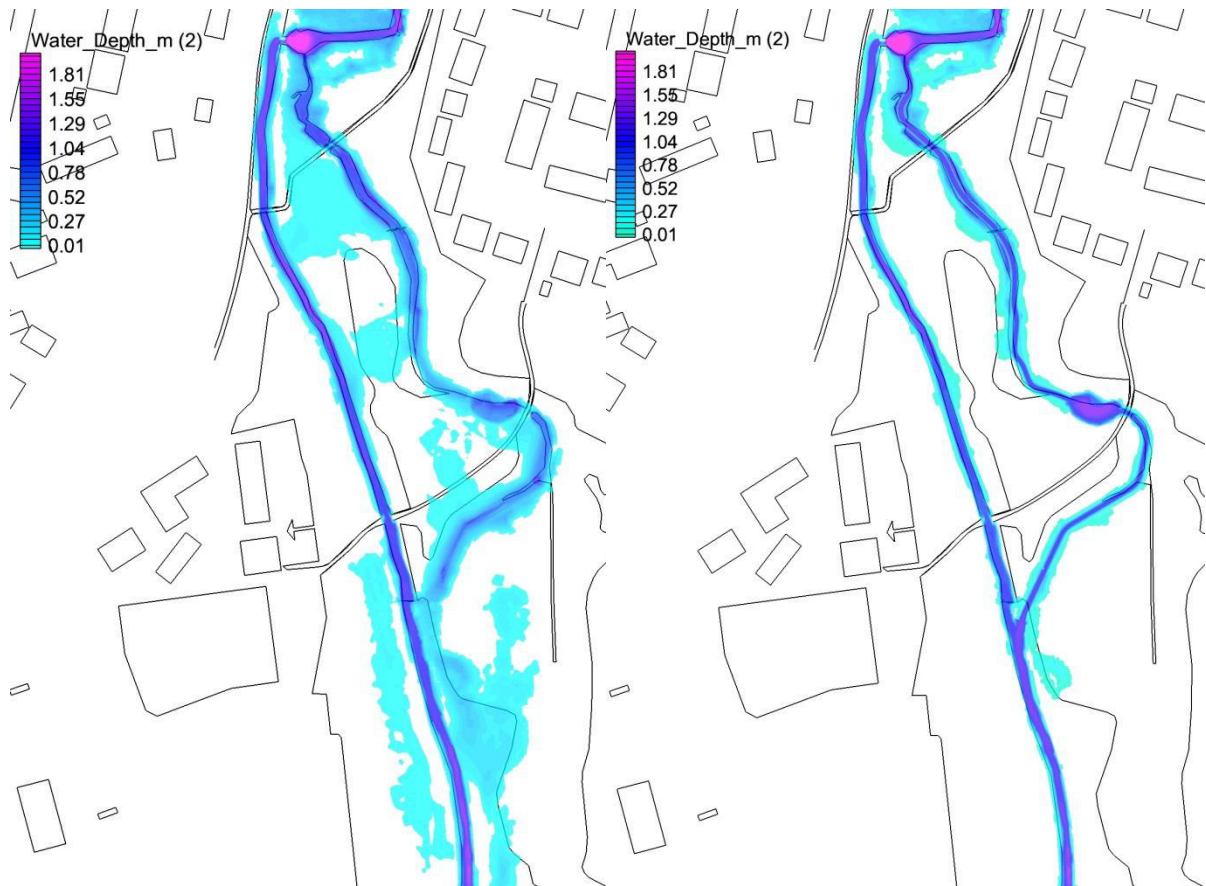


Figure 5-6 5 year flood inundation. Existing condition left; design condition right. Peak flow 5.36 m³/s.

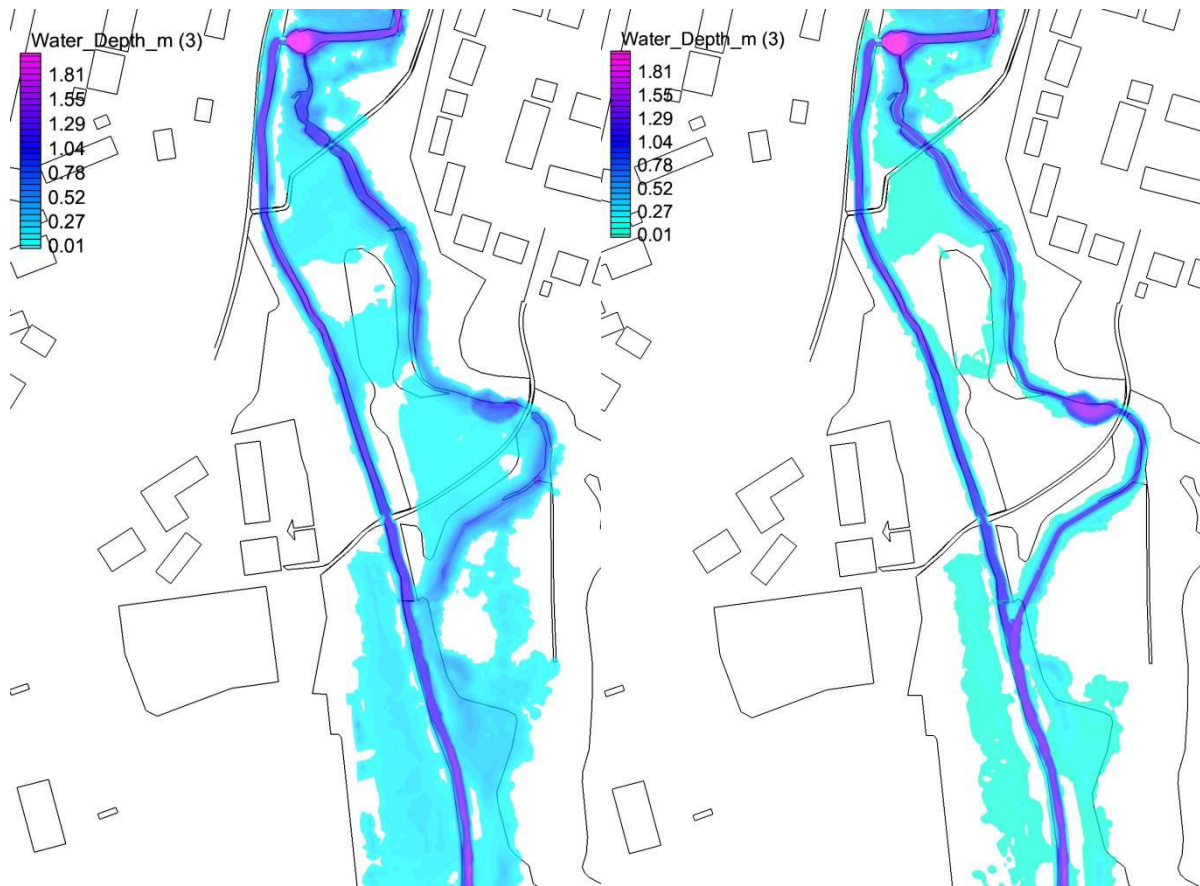


Figure 5-7 10 year flood inundation. Existing condition left; design condition right. Peak flow 6.91 m³/s.

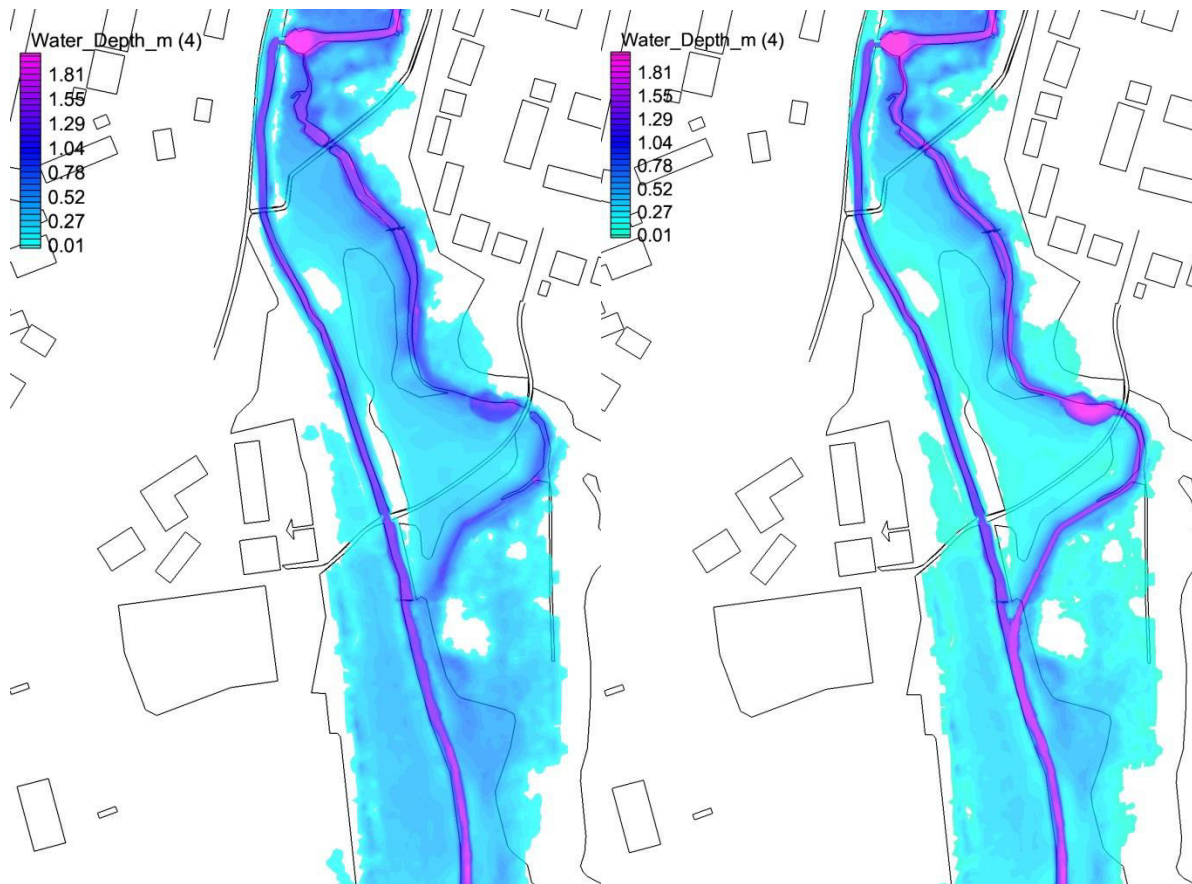


Figure 5-8 100 year flood inundation. Existing condition left; design condition right. Peak flow 10.48 m³/s.

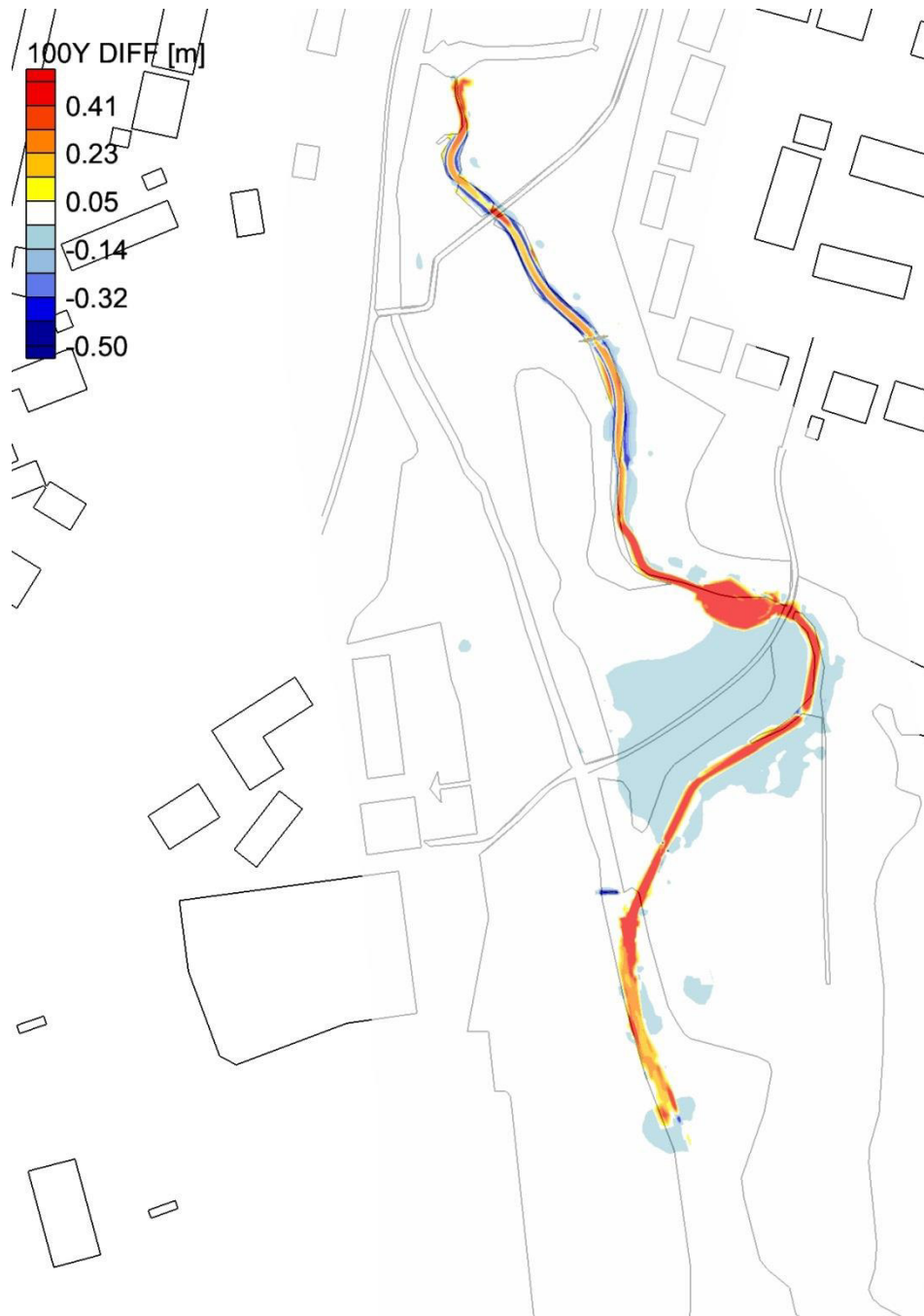


Figure 5-9 Difference in flood depths (design - existing), 100 year flood.

6. FINAL DESIGN AND RECOMMENDATIONS

Analysis of the desk and field-based data collected throughout this project has highlighted that the Emm Brook has been subject to detrimental impacts associated with historic anthropogenic modifications. The restoration of the channel to realign the brook through its historic course, will provide a more sustainable, diverse channel environment (both ecologically and physically).

The model results, as detailed in **Section 5.1**, confirm the following:

- At the 2 year peak flow, flows are mostly within bank and are likely to be substantial enough to have a geomorphic effect on substrate, over time contributing to the formation of pools and riffles, improving in-channel habitat diversity.
- There is no increase in flood risk as a result of the design, and a marginal decrease in flood risk due to a slight increase in the capacity of the restoration design.
- No buildings are inundated at the 100 year peak flow.

6.1 FINAL DESIGN DETAILS

Details of the final design are summarised below. Supporting detailed design drawings are provided separate to this report, showing the planview, long and cross-section profiles, and further detail of key structures through the site.

6.1.1. Upstream Tie-in and Bed Regrading

At the upstream extent of the design scheme, the channel is regraded (from OS NGR SU 79901 68952, at 95 m chainage), to reduce the slope into the design channel.

The design channel ties into the existing channel approximately 20 m downstream of the old oak tree, at location SU 79886 69000.

6.1.2. Flow Control Structure in Existing Channel

A Thames Water owners foul sewer pipe currently crosses the existing channel at 166.4 m chainage and is exposed (with a crest height of **around 44.37 m AOD**), set within a concrete base. The pipe is utilised as a weir, preventing flows below 0.46 m³/s from entering the existing channel. Above this flow, flows split between east and west channels approximately 50/50.

6.1.3. Enhancement Features in Existing Channel

To improve biodiversity/ habitat and channel form in the existing channel as part of the restoration scheme, the design includes recommendations of planting measures for the stretch of channel between the foul sewer pipe crossing and the footbridge, in addition to the creation of a pond feature downstream of the footbridge crossing.

Recommended planting

Due to constraints associated with two veteran oak trees downstream of the foul sewer pipe crossing, enhancement measures in this section of channel consist of planting of native species to encourage and improve in-channel and marginal vegetation cover. Recommended in-channel options include the planting of plug plants or inclusion of seeded coir pallets the latter. Given that the existing channel will only be temporarily wetted, in order to minimise risk of failure to establish,

it is advised that these be installed during the wetter winter months. This will allow roots to establish into the ground prior to any prolonged dry period.

For bankside vegetation (above the bare soil bank line), a mix of wildflower is recommended.

Further details of the above planting measures, including species used, are provided in **Appendix B**.

Pond

Downstream of the footbridge, a pond feature has been incorporated into the design. This involves regrading the existing bed and excavating areas of floodplain (particularly on the river right), creating deeper sections of pond, surrounded by shallower, marginal areas which can be planted with similar measures as described previously. Access to the centre of the feature is proposed from the right hand floodplain.

The deepest sections of the pond have been set at an elevation ~900 mm lower than the surrounding bed in the hope of maximising water retention, however, it is important to note that this feature has not been included in design modelling, and so it is not possible to predict with any accuracy how often this feature will remain wetted.

The design of the pond is included within the detailed design drawings provided separate to this report.

6.1.4. Design Channel Dimensions and Features

Dimensions

The design channel has been set with a simple geometry, with the intention that over time, the channel is allowed to adjust naturally, creating a more physically diverse environment that is reflective of natural chalk stream habitat.

Alders

Two alder trees situated within the upper section of the design channel (located in close proximity but on opposite banks), impound flow in the design channel very slightly. In between the Alders velocities are slightly raised. Removing these trees slightly increases the flow to the design channel (from 0.46 m³/s to 0.52 m³/s before flow splits to the west). Through discussions with SERT, it has been agreed that these trees should be retained within the design given the riparian/ habitat benefits they offer to the site.

Pond

A wildlife pond currently situated in the historic channel, will be retained, and excavated, to create an online pond feature.

6.1.5. Design Channel Structures

Several structures are located throughout the design channel. Below is an overview of each.

Bridge crossing/ flow control structure in upper design channel

Within the upmost section of the design channel, it was requested by SERT that a bridge crossing/ flow control structure be installed, to attempt to limit flow down the design channel once flows increase above a certain discharge and provide a crossing to link the informal footpath on either side of the design channel. To achieve a combined crossing and some control on flow, whilst limiting the extent of hard engineering incorporated into the design, a flat structure has been incorporated, to

be installed flush to the banks/ floodplain. The structure is set with a soffit level of **44.55 m**, and a deck level of **45.0 m**. This allows for the natural channel bed and banks to be retained, and the soffit interacts with flows, providing some afflux **>1.5 m³/s**. This feature will be overtopped at flows > 1 in 2 year flood return interval.

Immediately downstream of this feature is the suspended foul sewer pipe. This pipe has a soffit level of **44.35 m AOD³**, which begins to interact with the water surface for flows 0.50 - 0.75 m³/s. Water surface elevation at the mean daily flow in this location is estimated at 44.18 m, so the pipe is free at normal flows. At higher flows, this submerged pipe, and the low slope of the channel means that the crossing structure is under outlet control (flows full) at higher flows, providing little control of discharge to the design channel. However, inundation around the design channel is either the same, or slightly reduced for the design case.

Footbridges (x 2)

There are two footbridges forming part of the design.

The upstream footbridge is located at SU 79934 69106. This is proposed to be a flat decked bridge.

The downstream footbridge is located at SU 79846 69225. Again, this is proposed to be a flat decked footbridge.

Dimensions of both bridges and details of water levels up to the 1 in 10 year flood return interval, are indicated on the cross section of this structure provided separate to this report. The 10 year water level at the upstream footbridge is 44.74 mAOD and the 10 year water level at the downstream footbridge is 44.46 mAOD.

It is important to note that the design of these structures has not been undertaken by a bridge engineer but follows best practice for their required function (i.e. pedestrian access).

Pipe crossing in lower design channel

A second foul sewer pipe crosses the design channel within the downstream section of the site (at location SU 79876 69188). This is set within two concrete abutments, which restrict flow slightly and cause some impoundment. The design has been developed with the abutments being retained in place (i.e. without the requirement for these to be set back). The soffit of the pipe is **44.16 m AOD**. Model results confirm that this pipe will interact with water at the 1 in 2 year flood return event and above but be proud of the water surface at mean daily flow.

³ Elevation determined from slope information provided by SERT.

6.2 CONSTRUCTION-RELATED CONSIDERATIONS

The design has been developed in such a way that, during construction, a degree of 'field fitting' can be used to achieve some variation in physical diversity throughout the new channel. The design has been produced using a consistent 'mean' cross-sectional profile throughout the length of the new channel alignment. This allows for an adjustment in channel toe to toe and top of bank width of up to 20% either side of the mean dimensions provided, to create a more diverse channel throughout the design extents.

It is recommended that a member of cbec's design/ geomorphology team be present on site at regular (i.e. weekly) intervals during the construction period to supervise the build, working with the contractor to ensure that the design is built to specification and that any deviations from the design dimensions fall within the acceptable limits as described.

As part of the enhancement features proposed in Section 6.1.3, any installation of seeded coir pallets is recommended to take place during winter months (ideally January/ February) to allow sufficient time for roots to establish/ take hold before any prolonged dry periods.

7. REFERENCES

British Geological Survey. 2019. *Geology of Britain*. [online] Available at:
<<http://mapapps.bgs.ac.uk/geologyofbritain/home.html> > [Accessed 12th February 2019].

National Library of Scotland. 2019. *Georeferenced Maps*. [online] Available at:
<<http://maps.nls.uk/geo/explore>> [Accessed 12th February 2019].

South East Rivers Trust. Date na. *Emm Brook Fish Passage Improvements Project and Site Details*.
Project Document.

APPENDIX A

LEVEL 1 FLOOD RISK ASSESSMENT

Date:	15 th March 2019
To:	Toby Hull, SERT
From:	Gordon Falconer, cbec eco engineering UK Ltd
Project:	Emm Brook - Woosehill Fish Passage Improvements
Subject:	Level 1 Flood Risk Assessment

1. INTRODUCTION

1.1 PURPOSE OF STUDY

cbec was contracted to produce detailed designs to improve fish passage on a reach of the Emm Brook, Wokingham. The study area can be seen in Figure 2.1.

As part of this study, a level 1 flood risk assessment (FRA) has been completed, assessing any flood risk concerns raised by the proposed scheme in accordance with National Planning Policy Framework (NPPF), Flood Risk and Coastal Change.

1.2 SCOPE OF STUDY

The assessment is a risk-based assessment of potential flooding from all possible sources, including fluvial flooding from adjacent watercourses, groundwater and surface water runoff. The assessment also identifies and examines the residual flood risk to the site and any neighbouring properties. The aim of this report is primarily to consider flood risk and satisfy requirements under NPPF.

Data and information have been obtained from the following sources:

- Environment Agency, (EA)
- Wokingham Borough Council, (WBC)
- WBC Local Flood Risk Management Strategy,
- Thames River Basin Management Plan (RBMP).

2. BACKGROUND INFORMATION

2.1 DEVELOPMENT SITE

The study site on the Emm Brook is a straightened stretch located South of Wokingham, Berkshire, as shown in Figure 2.1 below:

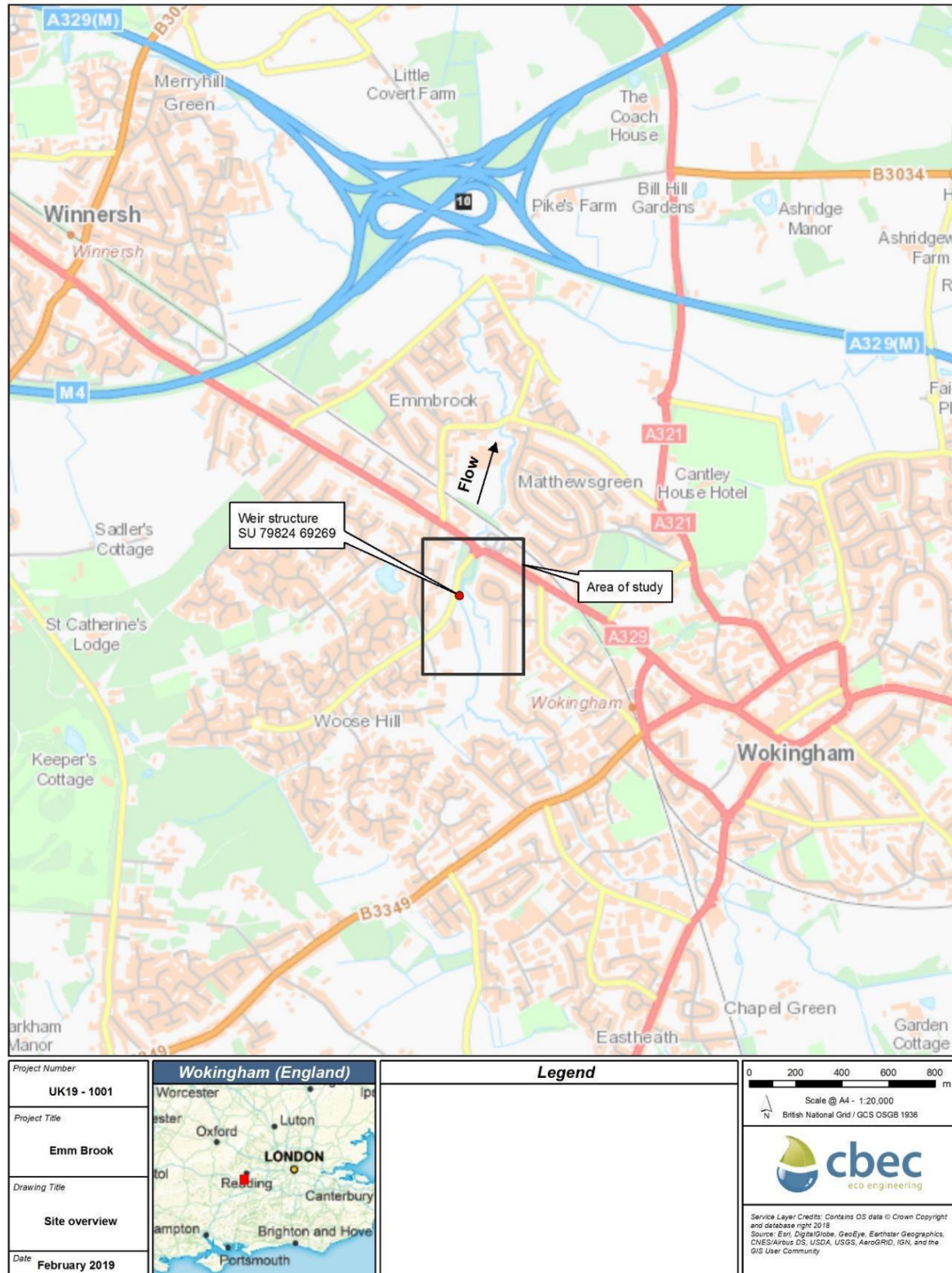


Figure 2.1 Development site location

The brook is a tributary of the River Loddon, itself part of the wider River Thames catchment.

Location details of the study site are provided below;

- Restoration Reach: OS NGR SU 79910 68889 to SU 79824 69269.

2.2 STUDY OBJECTIVES

The aim of the project was to develop a design to re-instate a historic channel located to the east of the current course of the Emm Brook, bypassing the existing channel and an associated weir structure at the downstream end of the site. The objective of the work was to improve fish passage at the site whilst also increasing physical diversity within the new design channel (compared to that of the existing channel).

3. STATUTORY CONSULTATION

3.1 ENVIRONMENT AGENCY (EA)

The Environment Agency were approached regarding any known local flood risk or historic flooding records in the area. The EA provided links to their flood models for the greater area. As these models are created using LiDAR, they mimic the results shown in the EA flood model shown in Figure 4.1.

Full correspondence with the EA is reported in Appendix A of this Flood Risk Assessment.

3.2 WOKINGHAM BOROUGH COUNCIL

Wokingham Borough Council were approached regarding any known local flood risk or historic flooding records in the area. At the time this document was created there had been no response received from Wokingham Borough Council. The document will be updated accordingly if any response is received.

4. PLANNING POLICY

4.1 WOKINGHAM BOROUGH COUNCIL LOCAL FLOOD RISK MANAGEMENT STRATEGY

The Wokingham LFRMP was prepared and submitted in February 2015. It discusses historic flooding on the Emm Brook as well as the wider catchment. Although there are no records of flooding at the study site there are historical events both upstream and downstream. Recurrent flooding issues have been recorded (October 2000, January 2003, July 2007 and during the winter of 2013/14) at the following locations;

- Sylvester close
- Emm Brook School
- Properties within the residential area downstream of Barkham Road
- Finchampstead Road, adjacent to Tesco

As the design is not intended to increase flood risk to key infrastructure and upstream/ downstream areas, it achieves the objectives of the LFRMP.

4.2 THAMES RIVER BASIN MANAGEMENT PLAN (RBMP)

The Thames River Basin District Management Plan (RBMP) was prepared and submitted in December 2015. There is no direct reference to Emm Brook, however, the aim of the management plan is to improve the environment, where possible. As this study looks at reinstating an historic channel for the purposes of habitat improvement and improved fish passage, it aligns with the objectives of the RBMP.

4.3 NPPF SEQUENTIAL TEST

NPPF provides guidance to both the controlling authorities and prospective developers for responsible, sustainable development on the functional floodplain. The NPPF provides a Sequential Test, which will help ensure that development can be safely and sustainably delivered, and developers do not waste their time promoting proposals which are inappropriate on flood risk grounds. According to the information available, other forms of flooding should be treated consistently with river flooding in mapping probability and assessing vulnerability to apply the sequential approach across all flood zones.

The proposed development lies within Flood Zone 3b, functional floodplain. However due to the nature of the development (i.e. channel reinstatement), the development cannot be placed in an area of lower flood risk, thus this satisfies the requirements of the Sequential Test.

4.4 SOURCES OF FLOODING

4.4.1. Fluvial

The EA flood maps (Figure 4.1) show that the proposed development is located within Flood Zone 3b, the functional floodplain. The primary source of flooding to these sites is fluvial, deriving from the Emm Brook.

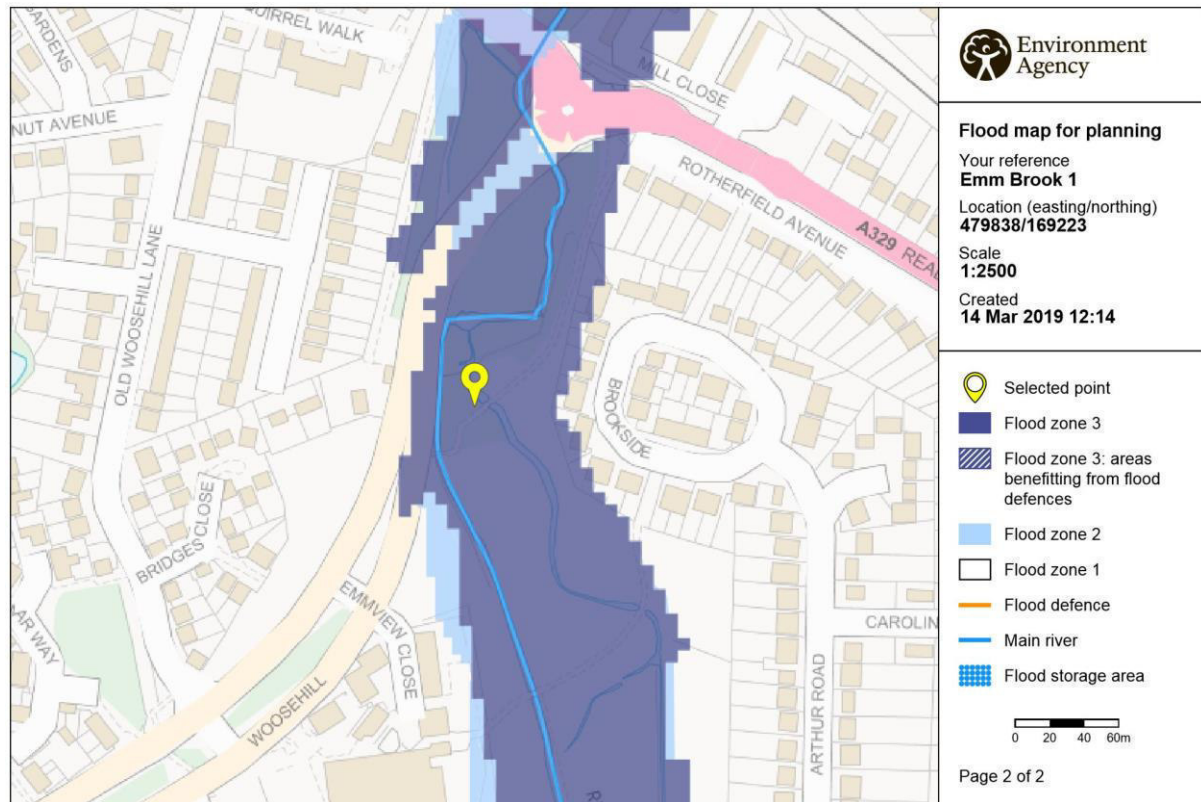


Figure 4.1 Fluvial flood map

4.4.2. Historic flooding

The Statutory Consultation highlighted several historic flooding incidents throughout the Emm Brook catchment. The issues raised were not located at the proposed weir removal however, as flooding events have occurred both upstream and downstream, flood risk is likely to be a main concern at the site.

4.4.3. Surface water flood risk to the scheme

The nature of the proposed works means that there is no risk posed by surface water flooding to the scheme.

4.4.4. Surface water flood risk from the scheme

The nature of the proposed works will not affect surface water flood risk.

4.5 GROUNDWATER

4.5.1. Groundwater flood risk to the scheme

The nature of the proposed works will not be affected by flood risk from groundwater flooding.

4.5.2. Groundwater flood risk from the scheme

As the proposed scheme will not add any hardstanding areas or impact any potential groundwater sources or flow paths, there will be no increase in groundwater flood risk caused by the scheme.

4.6 STRUCTURES

The proposed works do not pose any threat of increased flood risk to local structures.

4.7 SEWERAGE INFRASTRUCTURE

Two foul sewer pipes are located within the site boundaries. One crosses the existing channel approximately 50 m upstream of the upstream footbridge crossing located at SU 79872 69056 and is not envisaged to be impacted by the works. The second crosses the historic channel approximately 50 m upstream of the footpath crossing at SU 79849 69227. As the pipe is cast iron, Thames Water have confirmed that they have no issue with the historic channel being reinstated, and have advised that the concrete abutments could be trimmed/ set back by up to 1m if required, to improve conveyance at this location.

5. MITIGATION OPTIONS

There are no proposed mitigation options.

6. CONCLUSIONS

The proposed scheme aims to improve fish passage within this reach of the Emm Brook as well as improve physical condition of the channel and amenity value of the site. These aims are beneficial to the environmental and therefore satisfy any requirements set out in local and national policies.

As the site is in an urban environment, flood risk is a key consideration for any works in the channel. It is therefore recommended that a more comprehensive flood risk assessment is carried out, taking into consideration results from both existing and design conditions models.

APPENDIX A
STATUTORY CONSULTATION



Gordon Falconer <[REDACTED]>

RE: THM_118521 - Emm Brook - data request

3 messages

Enquiries_THM <enquiries_THM@environment-agency.gov.uk>

4 March 2019 at 12:16

To: Gordon Falconer <G.Falconer@cbecoeng.co.uk>, Toby Hull <toby@southeastriverstrust.org>

Dear Gordon

We have received your request for flood risk information from Isabel Southworth.

We have carried out flood risk modelling for the Emm Brook as part of the Lower Loddon Model. We can supply the model report, the model output and the model input referred respectively as Product 5 ,6 & 7.

The Emm Brook is too big an area to provide historic flood maps but you can visit the website for information on flood zones and historic flood events for the area.

Flood Map for Planning

Flood Zone 2 - <https://data.gov.uk/dataset/flood-map-for-planning-rivers-and-sea-flood-zone-2>

Flood Zone 3 - <https://data.gov.uk/dataset/flood-map-for-planning-rivers-and-sea-flood-zone-3>

Historic Flood Events - <https://data.gov.uk/dataset/historic-flood-map1>

Please let us know if you would like the hydraulic model in GIS format.

Kind regards

Julia Hewitt

Customers and Engagement Officer

Thames Area

From: Gordon Falconer [<mailto:G.Falconer@cbecoeng.co.uk>]**Sent:** 18 February 2019 13:09**To:** Southworth, Isabel <Isabel.Southworth@environment-agency.gov.uk>**Subject:** Emm Brook - data request

Hi Isabel,

I was given your contact details by Toby Hull of South East Rivers Trust with regards to a project on the Emm Brook.

I am carrying out a Flood Risk Assessment for the restoration project on the Emm Brook, Wokingham, with works taking place between approximately **SU 79877 69295 and SU 79900 68822**.

As part of a Flood Risk Assessment for the ongoing project, I have some questions that it would be very useful to get your input to:

- Does the EA hold any records on historic flood events along the Emm Brook or any other incidents related to flooding, whether fluvial or surface water/other source in nature?
- Is the EA aware of any other schemes in the Emm Brook catchment that may be of relevance to this study/ assessment?
- Any other information the EA may hold that is relevant to considering the flood risk to/ from the Emm Brook and surrounding area.

I appreciate any help with this matter.

Kind regards,

Gordon Falconer

Gordon Falconer, MSc.
Technical Specialist

Central Scotland Office: +44 (0) 1259 726625, Mobile: +44 (0) 7493 811007,
Central Scotland Office: cbec eco-engineering UK Ltd, Alloa Business Centre, Whins Road,
Alloa, FK10 3SA

g.falconer@cbecoeng.co.uk
www.cbecoeng.co.uk

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Gordon Falconer <G.Falconer@cbecoeng.co.uk>
To: Enquiries_THM <enquiries_THM@environment-agency.gov.uk>
Cc: Toby Hull <toby@southeastriverstrust.org>

5 March 2019 at 09:24

Hi Julia,

If you would be able to provide the model files referred to as products 5, 6 and 7 that would be brilliant, thanks.

Kind regards,

Gordon.

Gordon Falconer, MSc.
Technical Specialist

Central Scotland Office: +44 (0) 1259 726625, Mobile: +44 (0) 7493 811007,
Central Scotland Office: cbec eco-engineering UK Ltd, Alloa Business Centre, Whins Road,
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Enquiries_THM <enquiries_THM@environment-agency.gov.uk>
To: Gordon Falconer <G.Falconer@cbecoeng.co.uk>

5 March 2019 at 11:27

Hi Gordon

Thank you for your email.

Please find the model files for the Lower Loddon 2009 in the Sharefile link below.

<https://ea.sharefile.com/d-s021aa193f5446e18>

Please note this link will expire in 30 days.

Please refer to the tables below for the permitted use of the supplied information. You must check the supporting information to determine if the conditions on use are suitable for your purposes. If they aren't, this information is not provided with a licence for use, and the data is provided for read right only.

Name	Product 5
Description	Lower Loddon Model Report
Licence	Open Government Licence
Information Warnings	<i>Any mapping of features provided as a background in this product is © Ordnance Survey. It is provided to give context to this product. The Open Government Licence does not apply.</i>
Attribution	Contains Environment Agency information © Environment Agency and/or database rights. Contains Ordnance Survey data © Crown copyright 2017 Ordnance Survey 100024198.

Name	Product 6
Description	Model Output Data for the Lower Loddon 2009
Name	Product 7
Description	Calibrated and Verified Model Input Data for the Lower Loddon 2009
Licence	Environment Agency Conditional Licence
Conditions	1. You may use the Information for your internal or personal purposes

	and may only sublicense others to use it if you do so under a written licence which includes the terms of these conditions and the agreement and in particular may not allow any period of use longer than the period licensed to you. 2. Notwithstanding the fact that the standard wording of the Environment Agency Conditional Licence indicates that it is perpetual, this Licence has a limited duration of 5 years at the end of which it will terminate automatically without notice. 3. We have restricted use of the Information as a result of legal restrictions placed upon us to protect the rights or confidentiality of others. In this instance it is because of third party data. If you contact us in writing (this includes email) we will, as far as confidentiality rules allow, provide you with details including, if available, how you might seek permission from a third party to extend your use rights. 4.1 The Information may contain some data that we believe is within the definition of "personal data" under the Data Protection Act 1998 but we consider that we will not be in breach of the Act if we disclose it to you with conditions set out in this condition and the conditions above. This personal data comprises names of individuals or commentary relating to property that may be owned by an individual or commentary relating to the activities of an individual. 4.2 Under the Act a person who holds and uses or passes to others personal data is responsible for any compliance with the Act and so we have no option but to warn you that this means you have responsibility to check that you are compliant with the Act in respect of this personal data. 5. The location of public water supply abstraction sources must not be published to a resolution more detailed than 1km². Information about the operation of flood assets should not be published.. 6.1 Where we have supplied model data which may include model inputs or outputs you agree to supply to the Environment Agency copies of any assessments/studies and related outputs, modifications or derivatives created pursuant to the supply to you of the Information, all of which are hereinafter referred to as "the Data". 6.2 You agree, in the public interest to grant to the Environment Agency a perpetual royalty free non-exclusive licence to use the Data or any part thereof for its internal purposes or to use it in any way as part of Environment Agency derivative products which it supplies free of charge to others such as incorporation into the Environment Agency's Open Data mapping products.
Information Warnings	Please be aware that model data is not raw, factual or measured but comprises of estimations or modelled results based on the data available to us.
Attribution	Contains Environment Agency information © Environment Agency and/or database rights.

Did you know that many of our datasets are available online? Simply visit environment.data.gov.uk

We respond to requests for recorded information that we hold under the Freedom of Information Act 2000 (FOIA) and the associated Environmental Information Regulations 2004 (EIR).

-

Please get in touch if you have any further queries or contact us within two months if you would like us to review the information we have sent.

Kind regards

[Julia Hewitt](#)

[Customers and Engagement Officer](#)

**Customers and Engagement
Environment Planning and Engagement
Environment Agency
Thames Area
Red Kite House, Howbery Park, Wallingford, OX10 8BD**

Telephone: 020302 59673

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APPENDIX B

PLANTING INFORMATION

Bank seeding	Species	Common Name	% of total
--------------	---------	-------------	------------

20% native wildflower seed and 80% British wild grasses.

Grasses

Agrostis capillaris	Common Bent	10
Alopecurus pratensis	Meadow Foxtail	4
Anthoxanthum odoratum	Sweet Vernal-grass	3
Cynosurus cristatus	Crested Dogstail	32
Festuca rubra	Slender-creeping Red-fescue	25
Schedonorus pratensis	Meadow Fescue	7

Wildflowers

Angelica sylvestris	Wild Angelica	0.5
Centaurea nigra	Common Knapweed	2
Eleocharis palustris	Common Spike-rush	1
Filipendula ulmaria	Meadowsweet	2
Galium mollugo	Hedge Bedstraw	1
Galium verum	Ladies Bedstraw	1
Geum rivale	Water Avens	0.5
Leucanthemum vulgare	Oxeye Daisy	1
Lychnis flos-cuculi	Ragged Robin	1
Lythrum salicaria	Purple Loosestrife	0.5
Plantago lanceolata	Ribwort Plantain	1
Prunella vulgaris	Selfheal	1
Ranunculus acris	Meadow Buttercup	2
Rhinanthus minor	Yellow Rattle	2
Rumex acetosa	Common Sorrel	0.5
Silene dioica	Red Campion	1
Stachys officinalis	Betony	1

Sowing rate: 4 g per square metre, 40 kg per hectare, 16 kg per acre.

Sow onto a well tilled subsoil. N.B. No topsoil as this will encourage grasses to dominate the wildflowers.

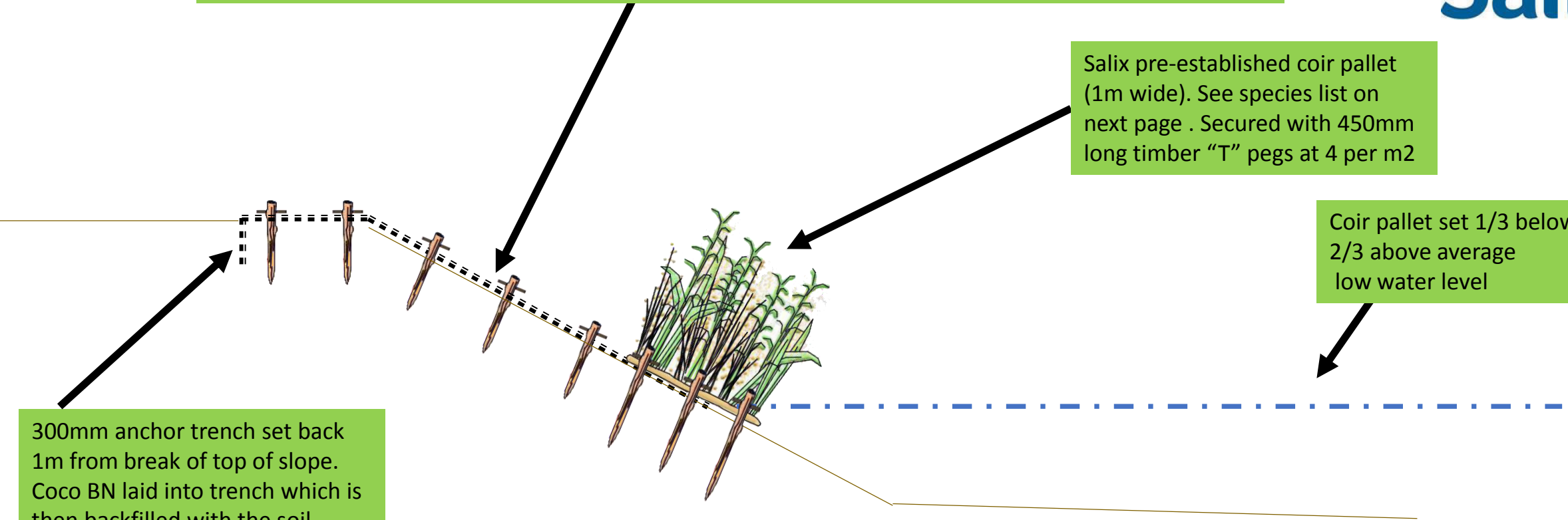
If risk of wash off of seed then apply a biodegradable erosion control blanket, such as C125BN by Salix Ltd.

Coco Net 800 laid over well prepared (tilthed then gently rolled to leave an even surface) and wildflower seeded subsoil. Secured with 300mm long timber "T" pegs at 4 per m2

Salix pre-established coir pallet (1m wide). See species list on next page . Secured with 450mm long timber "T" pegs at 4 per m2

Coir pallet set 1/3 below and 2/3 above average low water level

300mm anchor trench set back 1m from break of top of slope. Coco BN laid into trench which is then backfilled with the soil taken out to make trench



PROJECT NAME	Emm Brook		
CLIENT			
SCALE	N.T.S.		
DRAWN BY	D Holland		
CHECKED BY	NA		
DATE			

This sketch does not represent a detailed design and is a product application suggestion only. Detailed design responsibility to be by others

Planting Species in Coir Pallets



Species in Coir Pallets

Iris pseudacorus (Yellow Flag Iris)
Carex acutiformis (Lesser Pond Sedge)
Phalaris arundinacea (Reed Canary Grass)
Caltha palustris (Marsh Marigold)
Juncus effusus (Soft Rush)
Myosotis scorpioides (Water Forget Me Not)
Lythrum salicaria (Purple Loosestrife)
Ranunculus flammula (Lesser Spearwort)
Alisma plantago-aquatica (Water Plantain)
Mentha aquatica (Water mint)
Glyceria maxima (Sweet Reed Grass)
Apium nodiflorum (Fools Watercress)
Lycopus europaeus (Gypsywort)



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