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TWO-STAGE CHANNEL INVESTIGATION

Initial investigation into the effect of a two-stage channel on flood risk along the lower River Crane

Zoological Society of London

04 February 2026

100119541 / 9.1 / DG / 001

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This document has 32 pages including the cover.

Document history

Document title: Initial investigation into the effect of a two-stage channel on flood risk along the lower River Crane

Document reference: 100119541 / 9.1 / DG / 001

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
1.0	For Information	MH	AC	SM	MH	14/11/2025
2.0	Final Report	MH	AC	SM	MH	04/02/2026

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1. Introduction

Background

The Zoological Society of London (ZSL) has developed a new vision for the re-naturalisation and enhancement of the lower River Crane (ZSL, 2023[1]). The vision document was prepared on behalf of London Borough of Richmond of Thames and the Crane Valley Partnership and was funded by Thames Water. Whilst this vision has multiple aims, a key goal is to create an in-channel environment that is more conducive to the passage of fish along the river.

The channel of the lower River Crane has been heavily modified, principally to accelerate the conveyance of flood flows. It has been realigned (often out of the natural valley bottom), straightened, widened, deepened and lined with concrete (Figure 1-1). Most of the channel has a uniform vertical banked and flat bedded profile. There are many reasons why this artificial channel form adversely impacts fish passage, but one particular problem is insufficient water depth during periods of low flows. Fish would be more likely to swim through the lower River Crane during periods of lower flow if the depth of water were increased.

A practical way of increasing water depth at low flows is to create a "two-stage" channel, as illustrated by the project carried out on the River Medina (Figure 1-2). This can be created by constructing berms that narrow the lower part of the channel and raise water levels during low flows (lower stage). The middle and upper section of the channel would remain at full width (upper stage).

Whilst narrowing the low flow part of the channel in the lower River Crane would benefit fish movement it could also reduce the capacity of the river, reducing the capacity of the channel to convey flood flows, which in turn could increase the risk of flooding to sensitive receptors such as properties, roads or footpaths.

A balance between improving fish passage and managing flood risk needs to be struck.

Study reach

The study reach is the lower River Crane from Mereway Weir to downstream of Chertsey Bridge, located in west London, to the north of Twickenham (Figure 1-3). Mereway Weir is located at NGR TQ 149 732.

Purpose of report

This is an initial investigation into the effect of a two-stage channel on flood risk along the lower River Crane.

This study specifically utilises the 1% AEP + 54% Climate Change (CC) allowance[2] flood event to investigate the flood risk impacts of installing a two-stage channel. The two-stage channel has been

[1] Lower Crane Re-Naturalisation and Enhancement: A New Vision, November 2023. (Lower Crane Enhancement Plan)

[2] The flood event with a 1% chance of being equalled or exceeded in any one year, accounting for climate change.

sized specifically to convey the Q95[3] low flow percentile at a depth of 200 mm (a water depth within which fish can comfortably function).

[3] The Q95 flow is a commonly used low flow statistic. It is the flow that is exceeded 95% of the time.

Figure 1-1 – Typical view of the lower River Crane

Two-stage channel creation

The creation of a two-stage channel system is an in-channel practice that is used to **improve or restore uniform trapezoidal channels to a more natural form**. The design of a smaller main channel/ditch acts as a low-flow channel and vegetated benches on one/both sides are created to flood during higher flows.

These are difficult to create in concrete, impounded channels if breaking out is not an option. However, through using some of the techniques highlighted in this document such as the addition of vegetated berms, coir/rocks rolls and gravel additions, a more natural river form can be created.

Benefits of restoring a more natural channel form include improved filtration of run-off, reduced sediments, more natural flows and enhanced the ecological function.

Extracted from ZSL (2023) - Lower Crane Re-Naturalisation and Enhancement: A New Vision.

Figure 1-2 – Example of two stage channel on River Medina

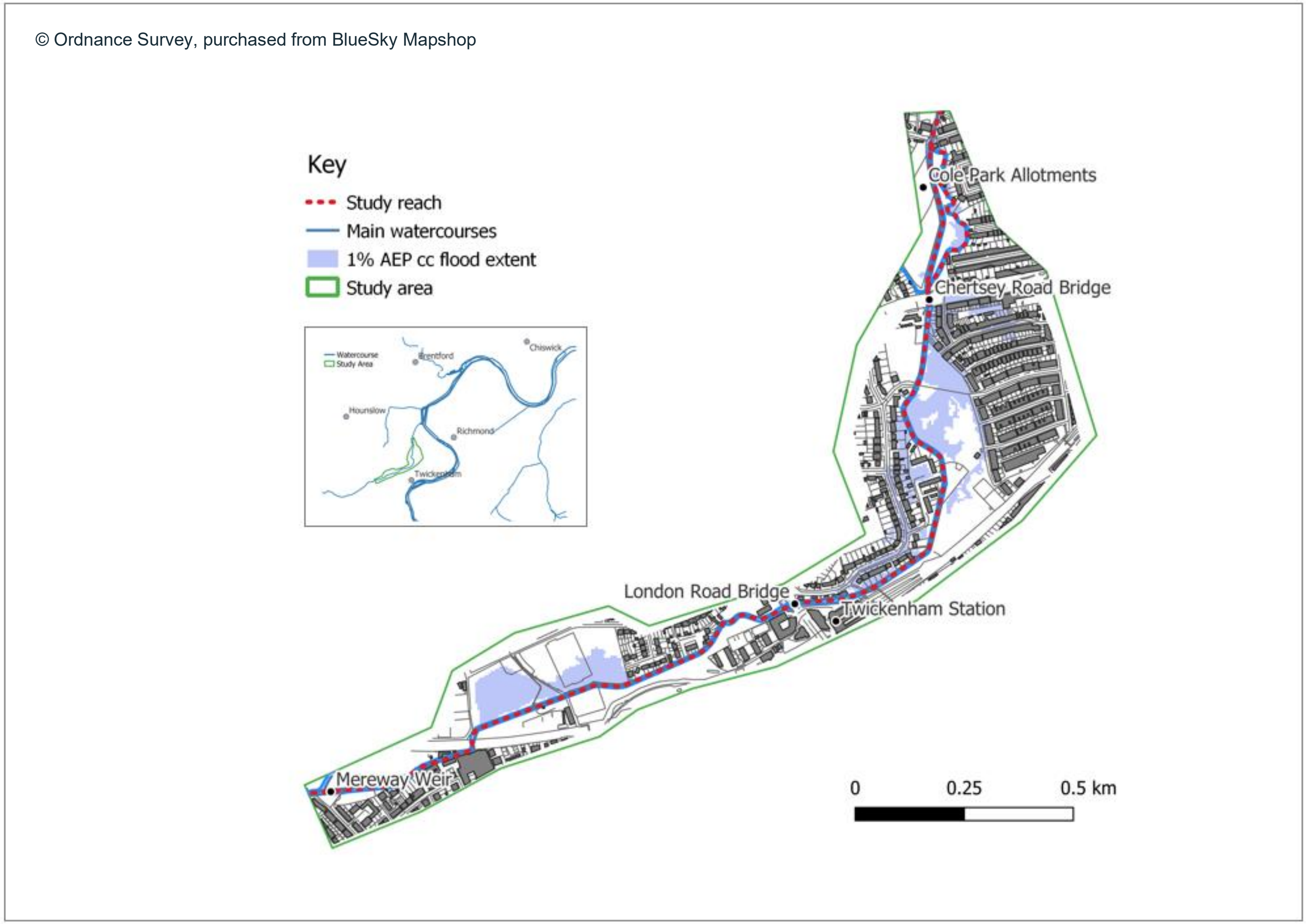

Figure 1-3 – Lower River Crane study area

2. Approach

This is an initial investigation to determine how a two-stage channel, or changes to the shape of the river channel, affects flood levels and resulting flood risk along the lower River Crane using a recently developed hydraulic model.

The hydraulic model used for the River Crane is a linked 1D-2D Flood Modeller – TUFLOW model developed by AECOM in 2024.

The initial investigation was limited to a single design flood: the 1% AEP event with a 54% uplift on peak flows to allow for climate change (1% AEP+54% CC).

The investigation was carried out in three steps:

1. Determine existing flood depths and extents on the lower River Crane associated with the 1% AEP+54% CC event using a 'Baseline' (existing conditions) model setup of the study reach, developed by truncating the AECOM (2024) hydraulic model.
2. Use a short section of the AECOM (2024) hydraulic model to determine the dimensions (width and depth) of a low flow channel in the lower River Crane that conveys the Q95 low flow percentile to a depth of 200mm.
3. Use two modified version of the 'Baseline' hydraulic model setup to determine flood depths and extents on the lower River Crane associated with the 1% AEP+54% CC event with a low flow channel of dimensions determined in step 2 above. These model setups investigated two configurations of a 'Two-Stage Channel':
    a. One in which existing weirs in the Lower River Crane are retained; and,
    b. Another in which the existing weirs on the lower River Crane are notched. The notch would be sized to convey the same flow rate as the low flow channel.

3. Methodology

Step 1: Determine existing flood depths and extents on the lower River Crane

Baseline model build

Firstly, a ‘Baseline’ model setup was built. This is a digital representation of the lower River Crane and its floodplain as they are at present. This setup was created by truncating the AECOM (2024) hydraulic model of the River Crane at the upstream end of its 2D domain (at Staines Road, A315) to create a setup of just the middle and lower River Crane together with the lower Duke of Northumberland River (as shown in Figure 3-1). The 2D domain remained unchanged.

Although this truncated model contains more of the River Crane than required for this study, the upstream end of the 2D domain was a suitable place to truncate the model and avoided unnecessary modifications to the 2D domain and 1D-2D interface. On balance, simulating a much longer model extent beyond the study area was more time efficient than unnecessarily modifying the 2D domain.

Model boundaries

To simulate the 1% AEP+54% CC event for this study:

- the inflow time-series at the upstream end of the truncated model (the upstream boundary) was the extracted 1% AEP+54% CC hydrograph from the AECOM (2024) model from the appropriate cross section.
- Water levels at the confluences of the River Crane and Duke of Northumberland River with the River Thames (the downstream boundaries) were taken as a spring tide time-series for the River Thames. This was the same condition used in the AECOM (2024) model.

Model simulation (verification)

Flood depths and extents for the lower River Crane associated with the 1% AEP+54% CC event were extracted from the supplied ‘Product 6’ model results from the AECOM (2024) study.

The truncated Baseline setup was then run for the same 1% AEP+54% CC event and the outputs of the two scenarios compared. There were anomalies between the outputs, with a median difference in water level of 0.04 m. These differences are most likely attributed to use of alternative versions of Flood Modeller software.

The differences are not considered to compromise the findings of this initial investigation because all findings are based on a like-for-like comparison to results generated by the Baseline setup (rather than results generated by the original AECOM (2024) model).

Step 2: Estimate the dimensions (width and depth) of a low flow channel on the lower River Crane

Q95 flow

The Q95 low flow percentile used in the study was determined in close consultation with the Crane Valley Partnership and Environment Agency. It was taken as the Q95 low flow percentile at Marsh Farm Gauging Station for the period 2018-2023 plus half of the average abstraction at Mogden Wastewater Recycling Centre (WwRC):

Q95 low flow percentile at Marsh Farm GS for period 2018-2023	Half of surrendered licence rate at Mogden WwTW	Estimated Q95 low flow percentile in lower River Crane
0.0340 m³/s	0.0556 / 2 = **0.0278 m³/s**	**0.0618 m³/s**

Flow duration curves for Marsh Farm Gauging Station are shown in Figure 3-2.

Key aspects of this determination are as follows:

- Marsh Farm is an Environment Agency flow gauging station on the Lower Crane, just downstream of the Mereway Weir (NRFA, 2025).
- Analysis of the average daily flow record for Marsh Farm is limited to the period 2018-2023 because of a change to operational protocol at Mereway Weir that increased the proportion of flow passing into the lower River Crane in 2018 (rather than the Duke of Northumberland River).
- The abstraction at Mogden refers to the proposed surrender of an abstraction to support operation of the Mogden WwRC from the Duke of Northumberland River. An allocation of half this additional water resource to the lower River Crane assumes the resource would be split evenly between the lower River Crane and Duke of Northumberland watercourses.
- **Note that the additional water resource made available by the sacrifice of the Mogden WwRC abstraction licence generates a significant uplift on (almost doubles) the lower River Crane Q95 low flow percentile. Also be aware that this flow uplift is yet to be secured as a water resource for the lower River Crane.**

Low flow channel dimensions

A one-dimensional model of a short reach of the River Crane was created to estimate the width of a low flow channel that conveyed the Q95 flow. The selected reach (Figure 3-3) has a gradient and cross section representative of the lower River Crane. For consistency the Mannings *'n'* roughness value used in this short reach model was the same as that used in the AECOM (2024) model (0.02).

Various widths of the low flow channel were tested (at 250 mm increments). A 500 mm channel width conveyed the Q95 low flow percentile at closest to 200 mm depth, as illustrated in Figure 3-4.

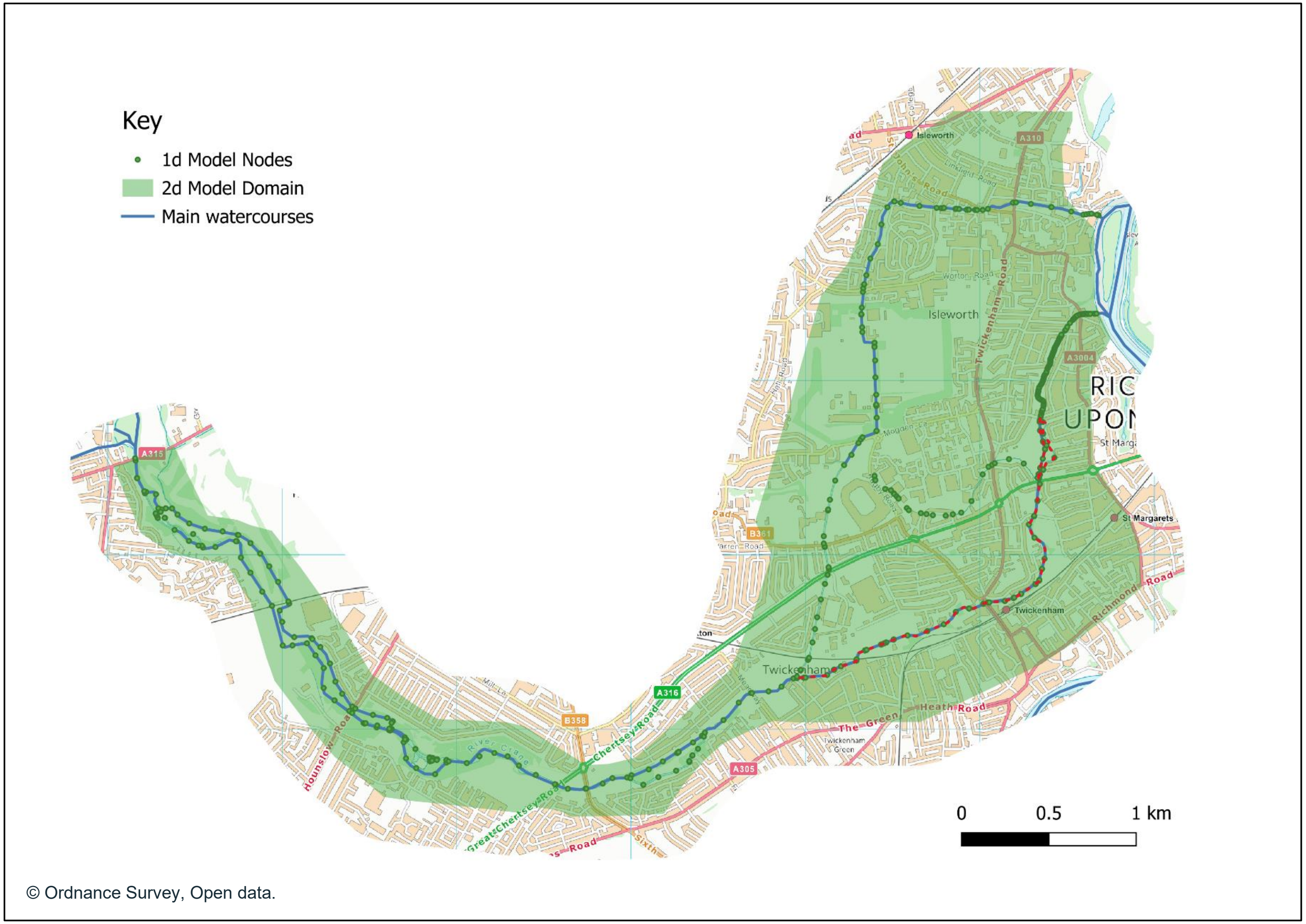

Figure 3-1 – Full extent of Baseline and Two-Stage channel model setups

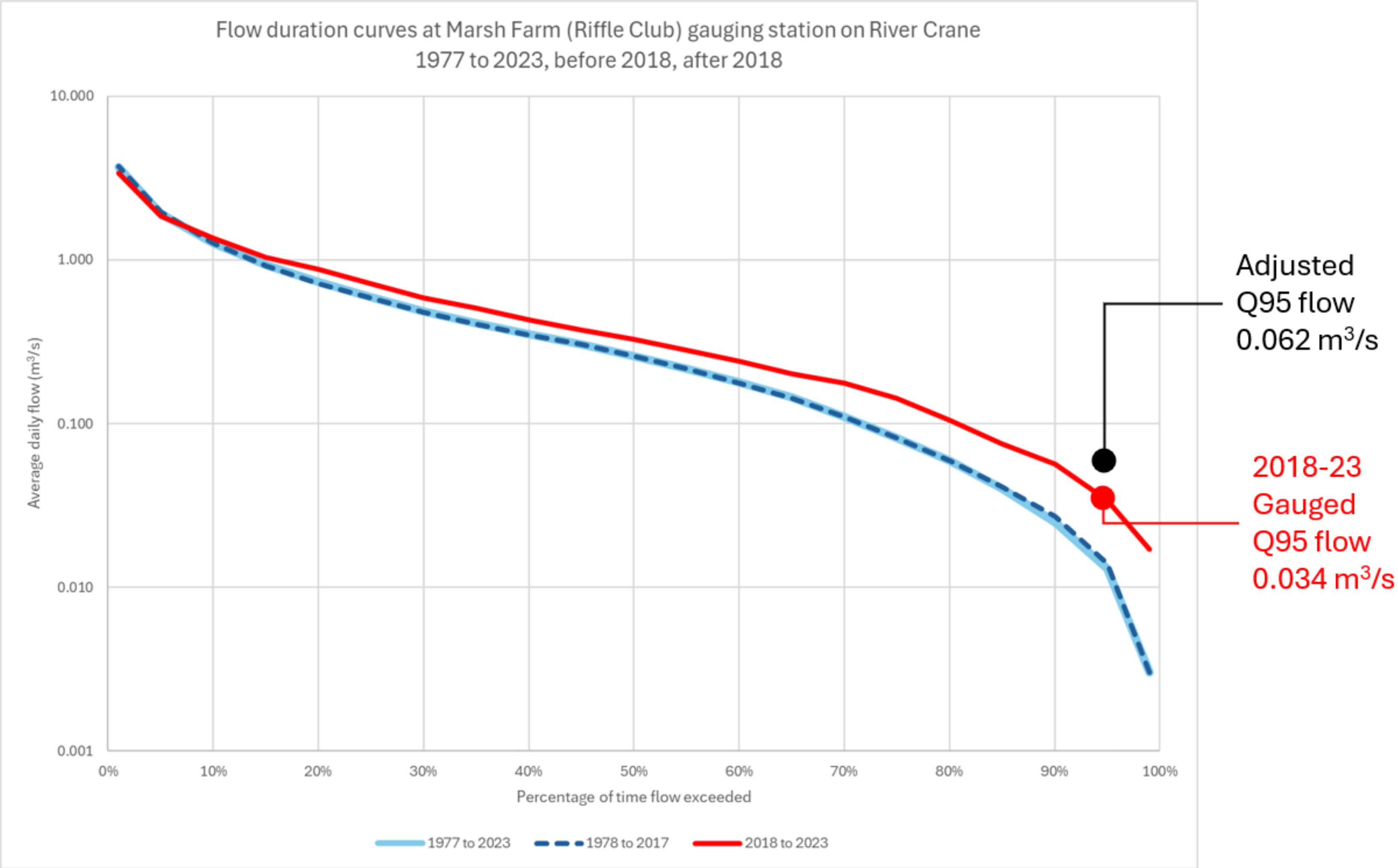

Figure 3-2 – Flow duration curves for Marsh Farm Gauging Station

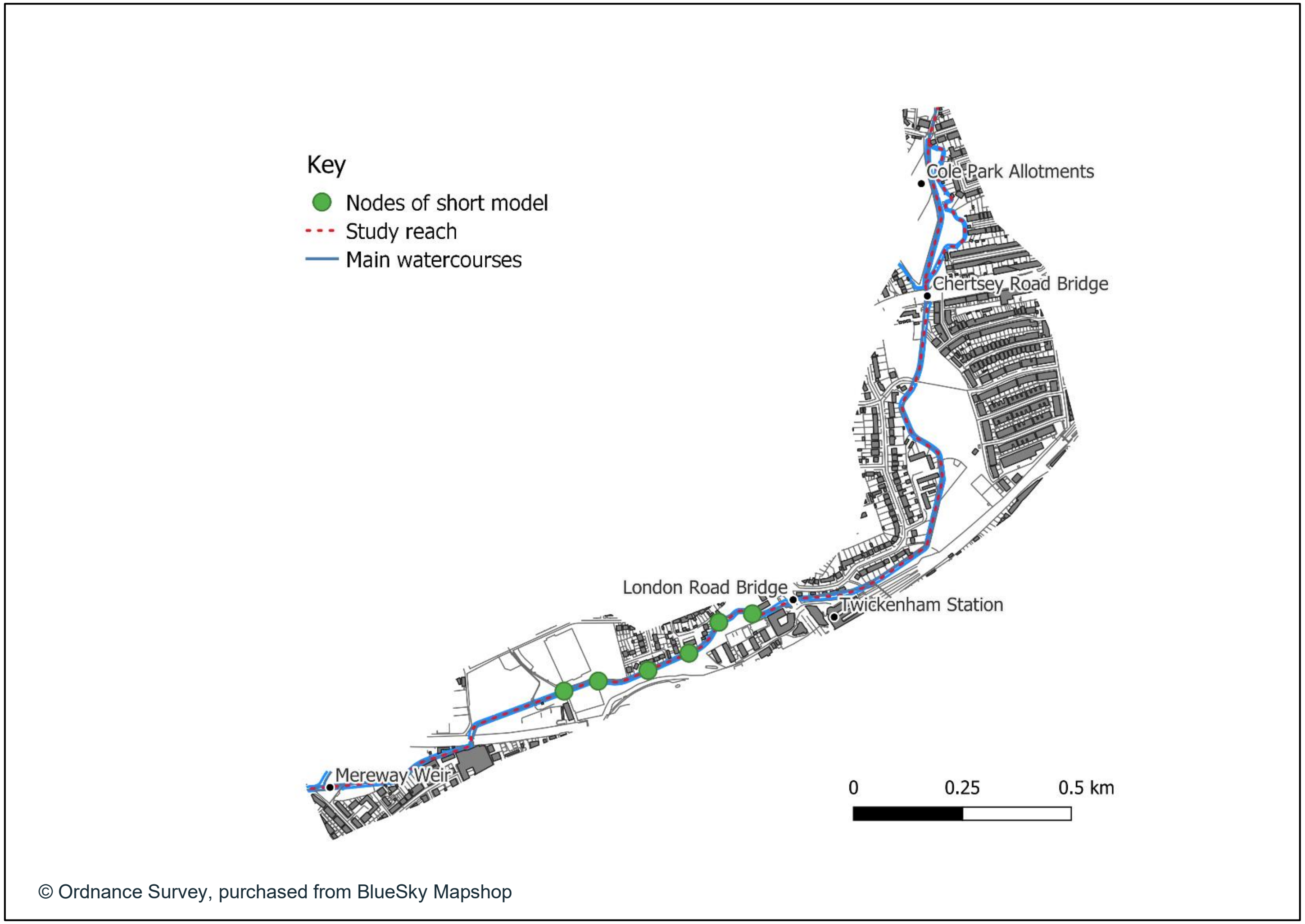

Figure 3-3 – Extent of short low flows model used to determine size of two-stage channel

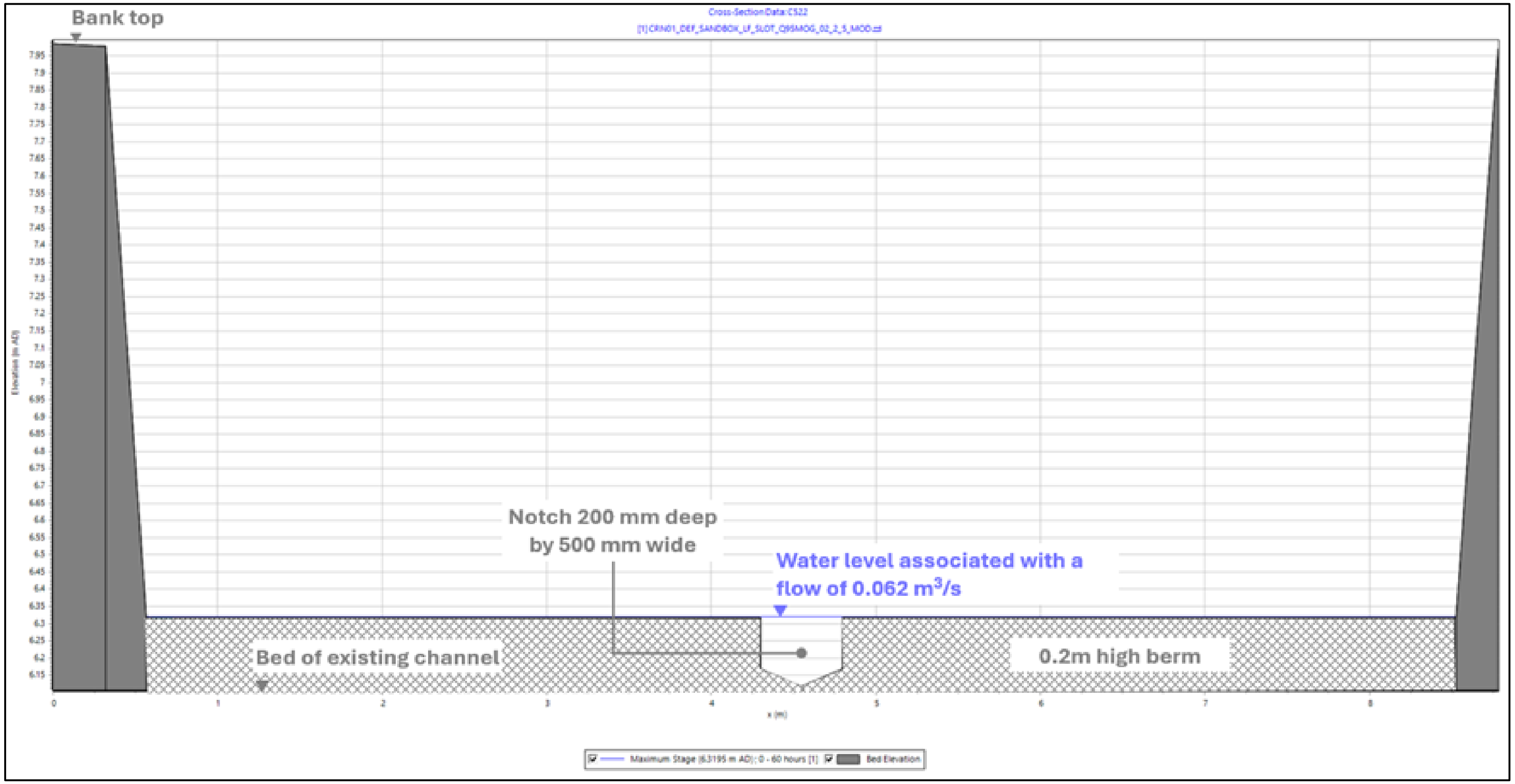

Figure 3-4 – Q95 low flow percentile water level in a 500 mm wide by 200 mm deep low flow channel in Cross Section C522

Step 3: Determine flood depths and extents on the lower River Crane with two-stage channel in place

Two-stage channel model build

The Baseline model setup, as described above, was modified to create two versions of a Two-Stage Channel setup for the study reach (Mereway Weir to downstream of Chertsey Bridge):

- Two-stage Channel (weirs retained)
- Two-stage Channel (weirs notched)

These additional setups are digital representations of the lower River Crane and its floodplain with two subtly different configurations of the berms and low flow channel in place.

The two-stage channel was created by universally modifying the geometry of 1D cross section river units along the reach between Mereway and downstream of Chertsey Road Bridge (shown as red dotted line in Figure 3-1). Two 200mm berms were added on the left and right side of the channel bed and a 500 mm wide low flow slot was placed in the centre, as shown in Figure 3-4. Note this two-stage channel has the effect of raising the bed of the watercourse across most of its cross section.

Schematics of the Baseline and the two additional two-stage channel model setups are presented in the figures below and described in the following.

1. In the Baseline setup (Figure 3-5), the River Crane is represented in its existing condition. The channel has not been reshaped into two stages, and the existing sequence of weirs along the reach is retained.
2. Figure 3-6 illustrates the first of the additional setups [Two-stage Channel (weirs retained)] in which the two-stage channel is represented but the existing sequence of weirs are kept as water retaining structures. This setup has been included in the study in recognition of the intended function of the weirs (to retain a depth of water in the lower Crane during low flows).
3. Figure 3-7 illustrates a further setup in which the two-stage channel is represented, and the existing sequence of weirs are notched [Two-stage Channel (weirs notched)]. The notch is sized to convey the same flow rate as the low flow channel. This setup has been included in the study to minimise the barrier effect of existing weirs to fish passage and in recognition that a two-stage channel should elevate water levels and hence negate the need for some or all of the existing weirs.

Note that there is no representation of a two-stage channel beneath bridges in either two-stage channel model setup. This to avoid compounding the throttling effect of bridges on flood flows.

Combined, the throttling effect of a bridge aperture with the loss of conveyance associated with a two-stage channel could create a pinch point in the hydraulic system that substantially increases water levels and flood risk.

Model simulations

The two two-stage channel model setups of the lower River Crane were run with the 1% AEP+54% CC as an upstream inflow and a Spring tide time-series for the River Thames at the downstream boundary. These model runs simulate the effect of the two-stage channel on flood depths and extents along the lower River Crane (with weirs retained in one setup and notched in the other).

The results of these simulations are discussed in the next section and compared to the results of the Baseline simulation to give an initial idea of how a two-stage channel could affect flood risk along the lower River Crane.

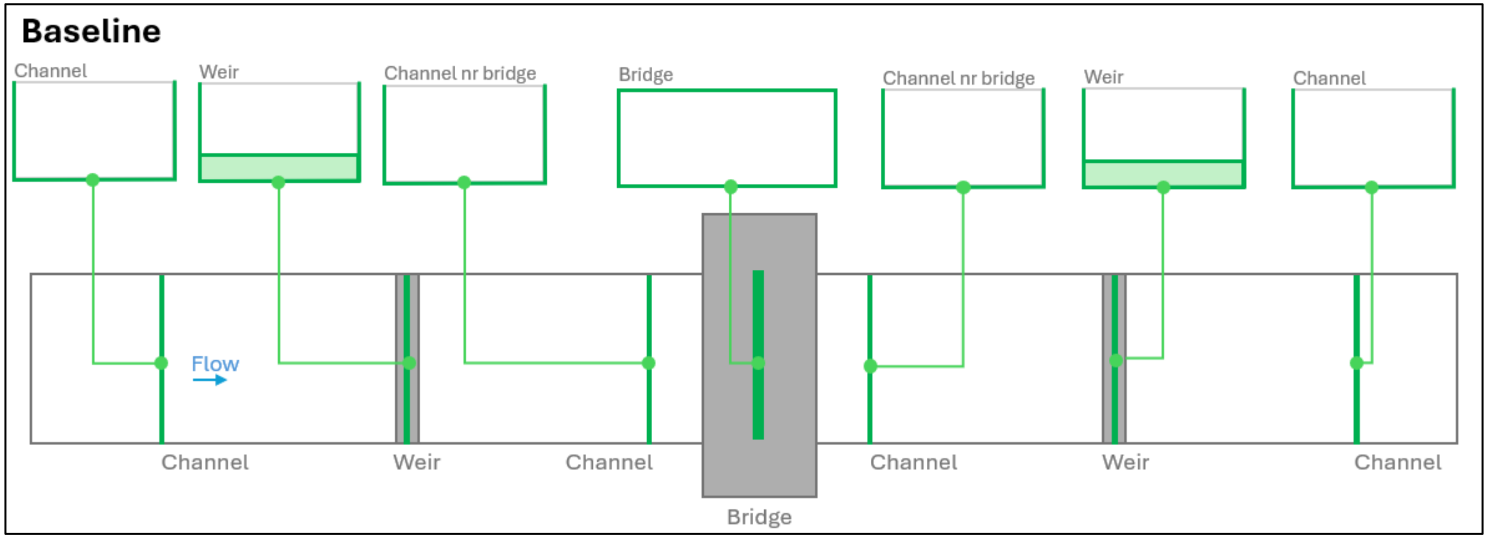

Figure 3-5 – Schematic representation of Baseline model setup for Study Reach

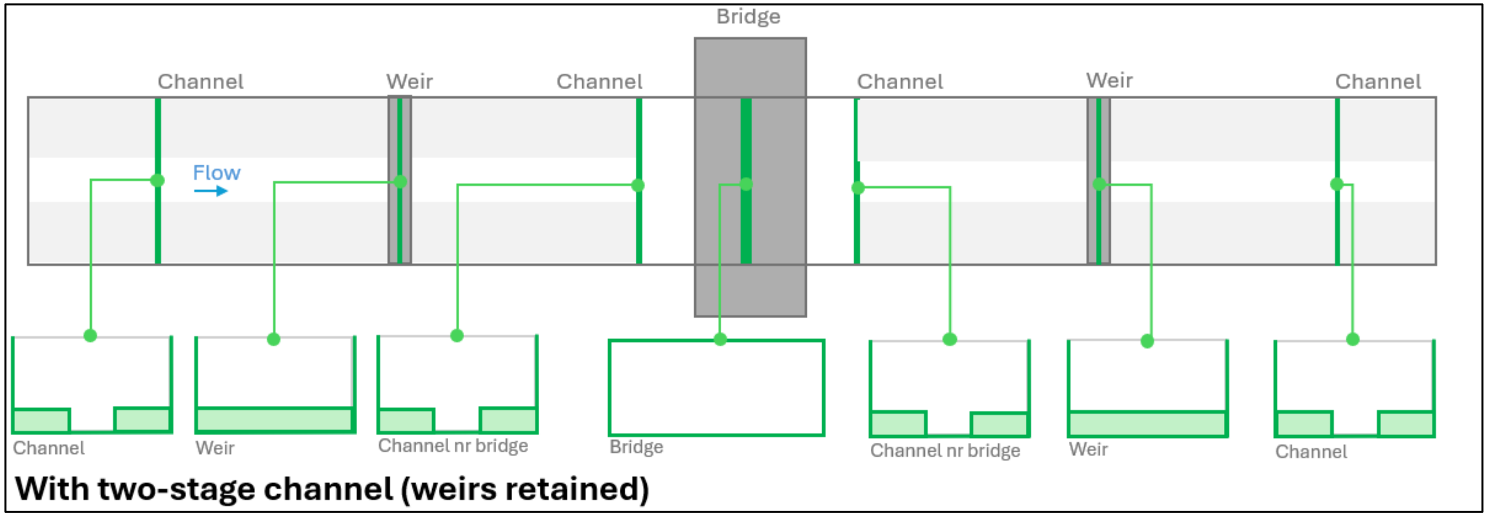

Figure 3-6 – Schematic representation of with two stage channel (weirs retained) model setup for Study Reach

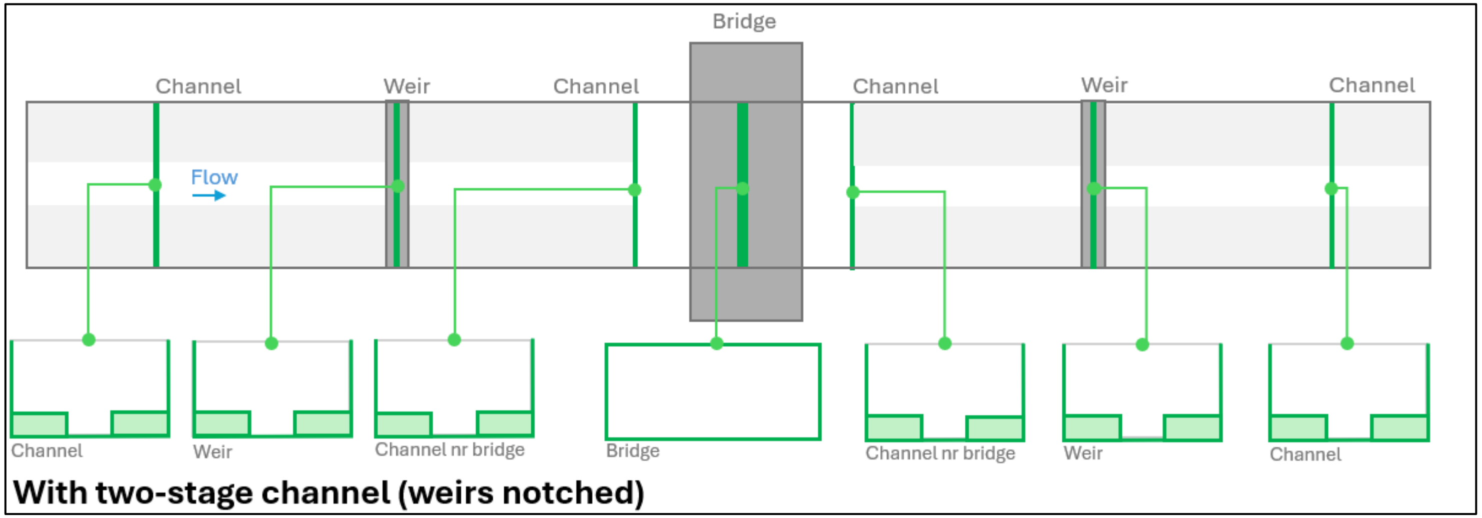

Figure 3-7 – Schematic representation of with two stage channel (weirs notched) model setup for Study Reach

4. Results

Overview

This section presents the results of the 1% AEP+54% CC simulations of the three model set-ups of the lower River Crane built for this study:

- **Baseline**: representing the lower Crane in its existing form
- **Two-stage Channel (weirs retained)**: representing the lower River Crane as a two-stage channel, with the existing sequence of weirs kept in place
- **Two-stage Channel (weirs notched)**: representing the lower River Crane as a two-stage channel, with the existing sequence of weirs notched to convey the same flow rate as the low flow section of the two-stage channel

Marsh Farm Gauging Sation Weir anomaly:

The way that the weir at Marsh Farm Gauging Station is represented in the Two-stage Channel (weirs notched) model setup has an anomalous effect on the water surface elevations and flood extents generated by the hydraulic model for the reach upstream of the gauging station to the Weir at Mereway Nature Park (see long section in Figure 4-1 for the locations of these features).

The weir at Marsh Farm Gauging Station is represented in the Baseline hydraulic model of the lower River Crane as a single model weir unit. In this initial high-level investigation, notching of this structure was represented simply by lowering the crest level of the whole weir unit to bed level. This approach had a pronounced effect on water levels in the reach upstream of the weir at Mereway Nature Park. This pronounced effect is very unlikely to be truly representative of the effect of just notching the weir in this short section of the river.

Whilst this representation of notching Marsh Farm Gauging Station Weir does generate some anomalous water surface elevations in the Two-stage Channel (weirs notched) model setup, it is a useful demonstration of the pronounced effect that an existing weir has on water surface elevations in the Lower River Crane. This helps understand the explanation of the results of the investigation given in the section below headed 'Interpretation'.

Description of model results

In the baseline simulation, peak water surface elevations in the 1%+54% AEP CC event are at or just in excess of bank full. Out of bank flooding is identified at five locations (see Table 4-1).

The Two-stage Channel (weirs retained) model setup generates a higher water elevation surface than the baseline (Figure 1-1). The range of the increase in water levels is modest up to 0.1m). The setup also generates changes in flood extent on the floodplain of the reach for instance marginal increases in flood extent in the lower part of the reach at Moormead Park, Roads off Winchester Road and North of Chertsey Road (Table 4-1). Whilst these changes are significant in that some affect residential areas, they are subtle in nature.

Ignoring the anomalous results immediately upstream of Marsh Farm Gauging Station (as a result of limitations of the model approach, see blue box above), the water surface elevations and flood extents generated by the Two-stage Channel (weirs notched) model setup are very similar to the those generated by the weirs retained setup. Again, surface water elevation increases are largely up to 0.1m and marginal changes to flood extent are reported in the floodplain of the reach, affecting green space and some residential areas.

Interpretation

The Baseline model set-up includes representations of a sequence of existing weirs along the lower River Crane. The hydraulic control exerted by these weirs is thought to strongly influence the findings of this study (as demonstrated by the anomalous results in the reach upstream of Marsh Farm Gauging Station presented in the blue box above). Of particular significance is that these weirs are a similar (or sometimes greater) height than the berms put into the two-stage channel model setups to create a low flow channel for fish passage.

In the baseline model setup these weirs create a stepped water elevation profile. The weirs are controlling upstream water level, creating a sequence of backwaters.

In the two-stage channel (weirs retained) model setup 0.2m high berms are put into the channel, raising the bed across most of its cross section. However, the sequence of existing weirs is also included in this setup. The hydraulic effect of the berms appears to be substantially dampened by (or subsumed into) the backwaters already created by the existing sequence of weirs. It is thought that this is why we see a very subdued increase in water elevation generated by the two-stage channel up to 0.1m) compared to the height of the berms that extend across most of the channel cross section (0.2m). In turn this subdued increase in water levels generates modest changes in flood extent (Figure 4-1).

In the two-stage channel (weirs notched) model setup 0.2m berms are put into the channel and the weirs are notched to convey the same flow rate as the low flow channel that runs between the berms. Notching the weirs should reduce their backwater effect, even at flood flows – bringing the hydraulic effects of the berms into play. However, the weirs notched setup generates very similar changes in water surface elevation as the weirs retained setup when compared to the Baseline. This is due to two factors in the weirs notched setup; a) the remaining weir crest left after notching weirs across the study reach still have a substantial impounding influence on flows and b) raising bed levels via berm installation upstream of notched weirs increases water levels in the study reach. (Figure 4-2, Figure 4-3).

Table 4-1 - Summary of flood extents in flood hotspots

Location	Baseline	Two-stage channel (weirs retained)	Two-stage channel (weirs notched)
Craneford Way and Playing Fields	Out of bank flooding	Flood extent same as in baseline	Flood extent **less** than in baseline (**Marsh Farm GS anomaly**)
Cole Park Road	Out of bank flooding	Flood extent **marginally less** than in baseline	Flood extent **marginally less** than in baseline
Moormead Park	Out of bank flooding	Flood extent **marginally more** than in baseline	Flood extent **marginally more** than in baseline
Roads off Winchester Road	Out of bank flooding	Flood extent **marginally more** than in baseline	Flood extent **marginally more** than in baseline
North of Chertsey Road	Out of bank flooding	Flood extent **marginally more** than in baseline	Flood extent **marginally more** than in baseline

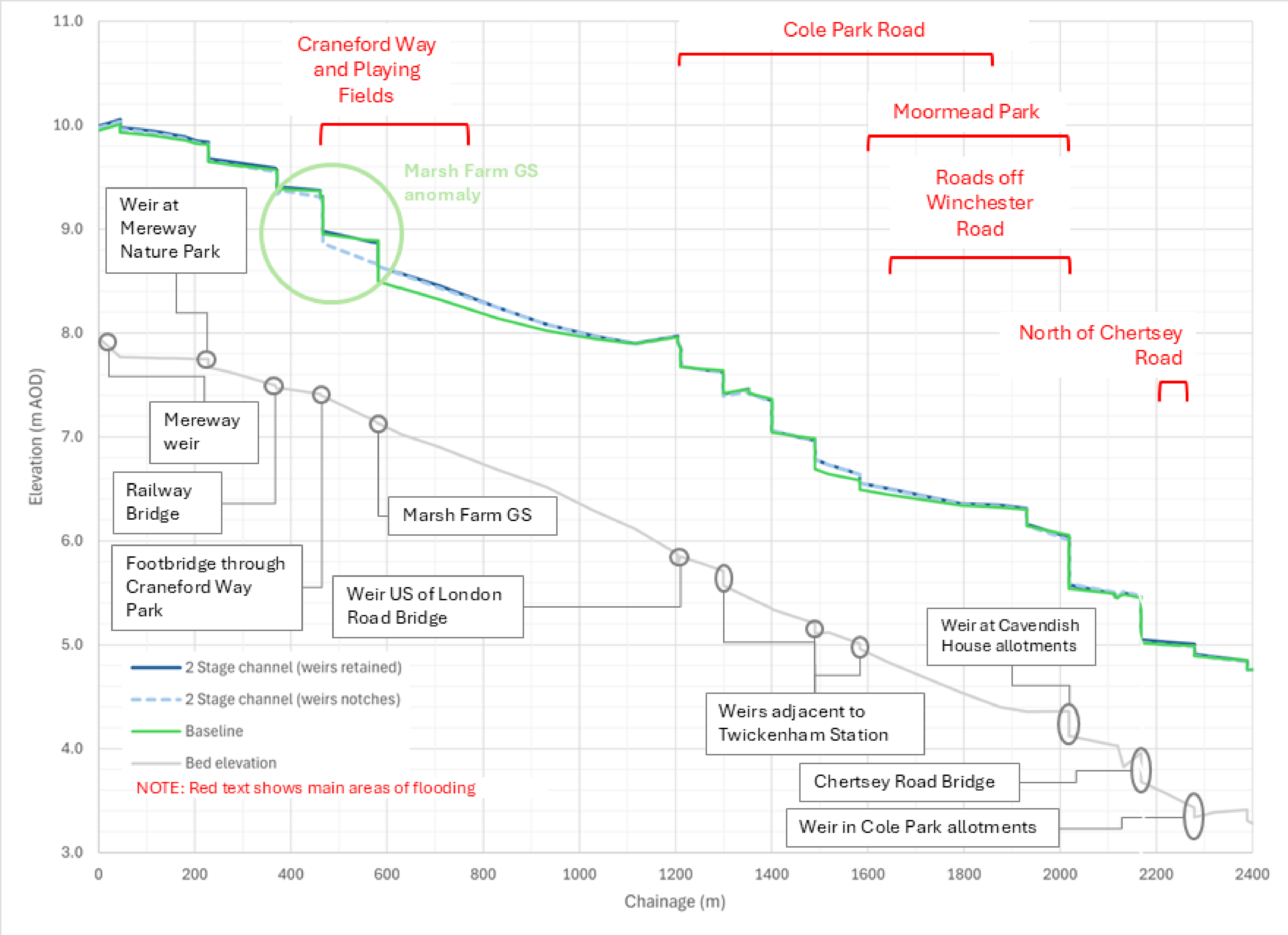

Figure 4-1 – 1% AEP+54% CC water surface elevations - Baseline v Two stage channel (weirs retained and weirs notched)

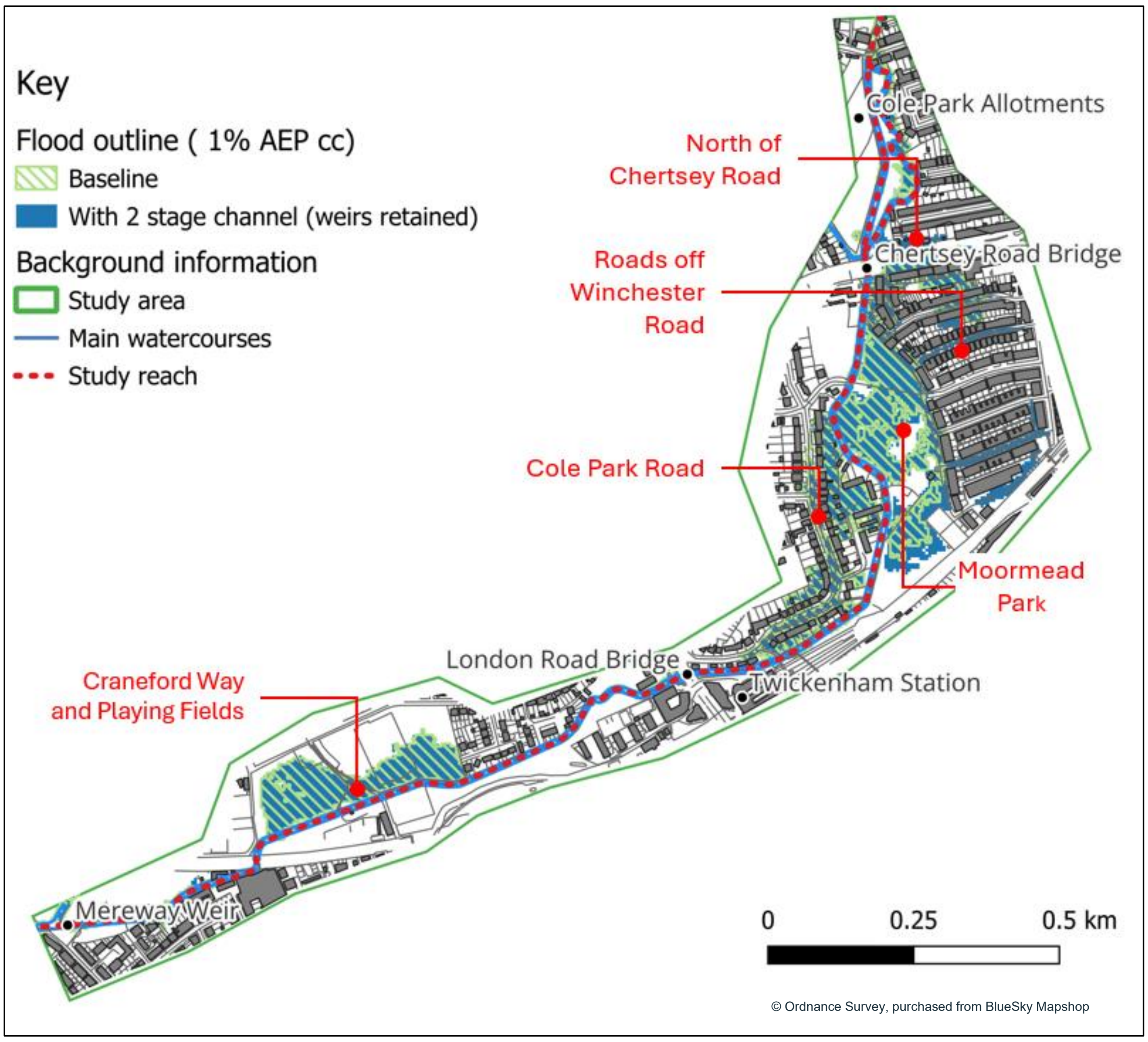

Figure 4-2 – 1% AEP+54% CC flood outlines - Baseline v Two-stage channel (weirs retained)

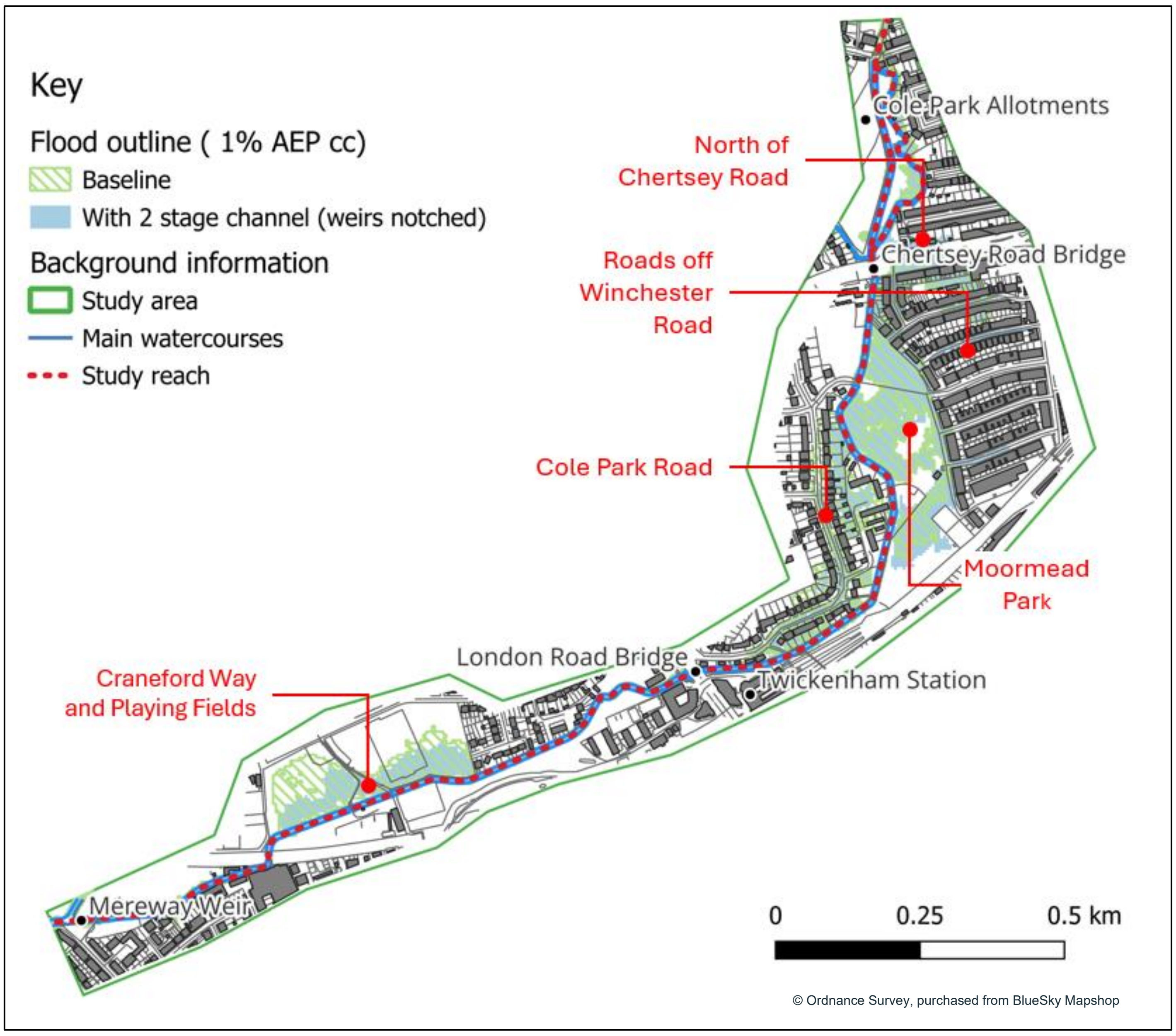

Figure 4-3 – 1% AEP+54% CC flood outlines - Baseline v Two-stage channel (weirs notched)

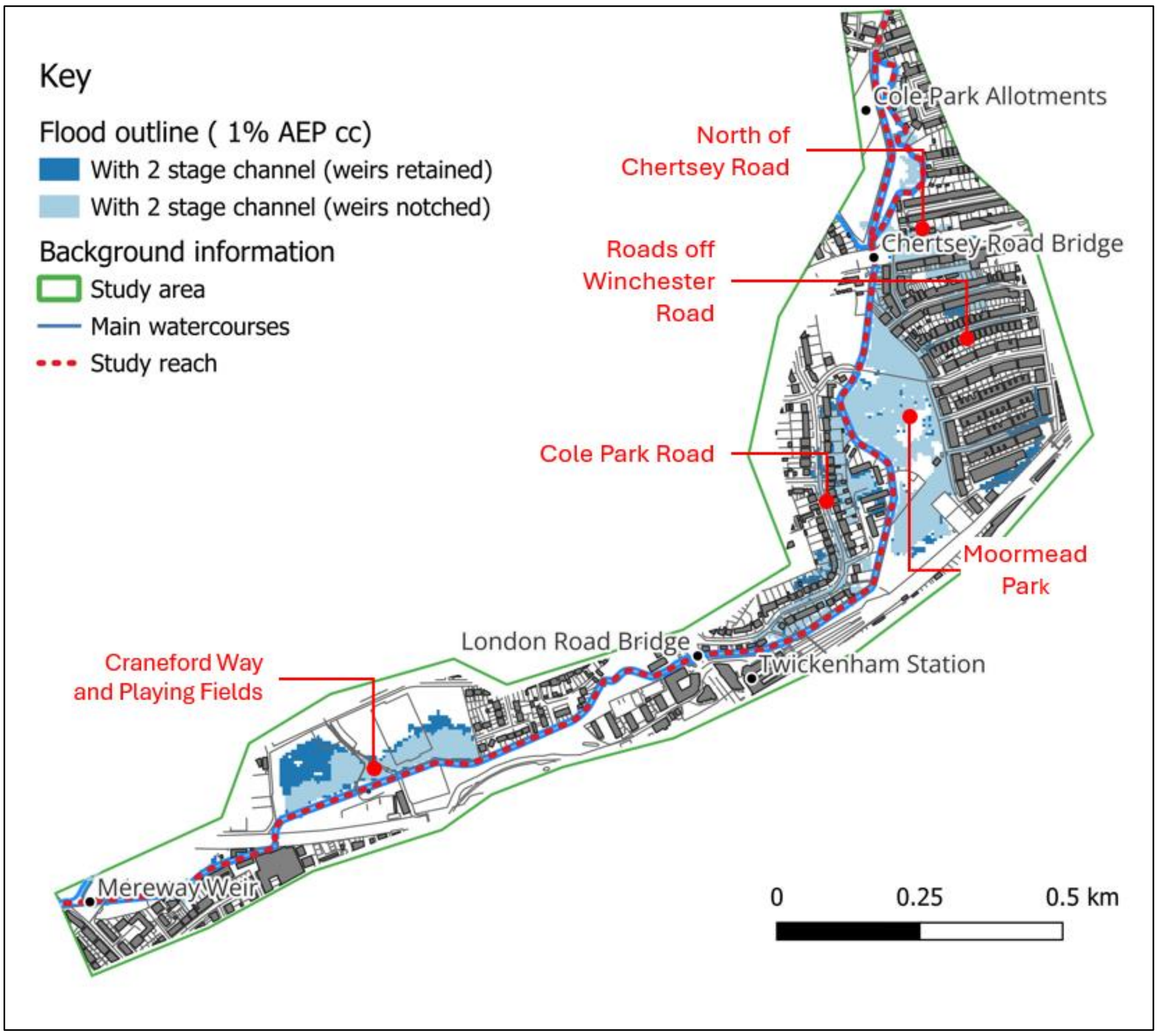

Figure 4-4 – 1% AEP+54% CC flood outlines - Two-stage channel (weirs retained v notched)

5. Conclusions and Recommendations

Conclusions

1. The initial investigations undertaken in this study suggest that a modest increase in water levels and flood extent could occur as the result of the construction of a two-stage channel along the lower River Crane. The two-stage channel investigated comprised two 0.2 m berms and a 0.5 m wide low flow channel, as illustrated in Figure 3-4. Water levels in the channel increased within a relatively modest range of up to 0.1m. Marginal changes to flood extent were also reported in the floodplain of the reach, affecting green space and, most notably, some residential areas (e.g. Cole Park Road and roads off Winchester Road).
2. Two different two-stage model setups were tested in this initial investigation: one with existing weirs along the reach retained, and a second with those weirs notched. For reasons suggested in the interpretation section of chapter 4 of this report, both setups had very similar effects on water levels and flood extents, when compared to the results generated by the baseline setup.
3. The results of this study are likely sensitive to the way that the existing sequence of weirs have been represented in the baseline model setup. The results of this initial modelling exercise suggests that the weirs have a controlling influence on water levels in the lower River Crane that is of a similar scale to that of the proposed two-stage channel. Understanding the subtle balance between the hydraulic effects of the existing weirs and proposed two-stage channel is key to properly understanding the flood risk effects of the two-stage channel.
4. The modest increase in water levels and flood extents associated with a two-stage channel indicated by this initial investigation suggest it may be possible to design a two-stage channel (in combination with measures to mitigate adverse flood risk effects) that has minimal effect on flood risk.
5. The model setups used in this initial investigation did not include a representation of a two-stage channel beneath any of the bridge structures along the lower River Crane. This avoided accentuating the 'pinch point' effect commonly associated with bridges and the resulting potential increase in upstream water levels and flood risk.
6. This initial investigation solely considered flow hydraulics. It did not consider how a two-stage channel (and absence of a two-stage channel beneath bridges) would affect and respond to the movement of sediment along the lower River Crane. Sediment may accumulate, particularly in pools under bridges as well as in the notch. Reductions in conveyance associated with this deposition could elevate water levels.
7. This is an initial exploratory investigation based around an existing hydraulic model setup of the lower River Crane. The schematisation of this existing model would need refining before any results could be used to inform design. Further information on the dimensions and form of key hydraulic controls would also be required.

8. A large component (almost 50%) of the estimated Q95 low flow percentile used to determine the shape of the low flow channel in this initial investigation is an additional water resource coming from the surrender of the abstraction at Mogden WwRC. This resource would need to be secured for the Crane and realised by an adjustment to the operating rules of the Mereway Weir.

Recommendations

1. The low flow channel required to convey a Q95 low flow percentile at a 0.2 m depth, as simulated in the hydraulic models used in this study, is very narrow (0.5m). It is unlikely to be a feasible configuration for the lower Crane, for reasons of sediment management and fish passage. It is suggested that alternative low flow channel cross sections are considered.
2. Further investigation into anomalies picked up in model validation (a median difference of 0.04m in surface water elevations generated by the baseline model for this study compared to the AECOM (2024)) is recommended.
3. Further investigation is required to moderate the flood risk increases resulting from a two-stage channel identified in this investigation. Mitigation could include reducing both the cross sectional and spatial scale of the two-stage channel (e.g. reducing berm size or not constructing a two-stage channel along the full length of the lower River Crane), increasing the conveyance capacity of the channel at critical locations or provision of additional floodplain storage.
4. This initial investigation relied on a single downstream boundary to hydraulic model setups (Spring tide time series for the River Thames). Consultation with specialists at the Environment Agency would be sensible to determine whether alternatives scenarios warrant consideration – for instance high fluvial flows in the Thames when the Greenwich tidal barrier is closed.
5. Further investigation into the configuration of the two-stage channel around bridges is required, to understand both hydraulic effects and sediment management.
6. Wider consideration of how a two-stage channel could affect accumulation of sediment within the reach is required.
7. Visual and potentially topographic survey of weirs and flow control structures along the reach is required to properly understand their effect on channel hydraulics.
8. Changes to model schematisation is required to fully capture the effect of structures on the hydraulics of the reach, in particular upgrading from spill units to weir units as a more robust representation of weir structures across the hydraulic model.
9. Investigate the practicalities of notching the weirs on the lower River Crane. There may be constraints on doing this, for instance for reasons of heritage or amenity.
10. Further investigation into securing the additional water resource associated with the sacrifice of the Mogden WwRC abstraction for the lower River Crane is essential prior to any substantive design that sets the conveyance capacity of the low flow channel.

6. References

AECOM, 2004. River Crane Model Update. Report for Environment Agency delivered under the HNL and Thames Modelling Package - NGSA Modelling and Mapping Framework,
Bristol: AECOM.

Environment Agency, 2025. Guidance - Flood risk assessments: applying for planning permission. [online] Available at: <Flood risk assessments: applying for planning permission - GOV.UK>
[Accessed 13 October 2025].

Floodmodeller.com, 2025. Floodmodeller. [online] Available at: < Flood Modeller | One solution for flood modelling > [Accessed 12 Oct. 2025].

Environment Agency, 2025. Guidance - Flood risk assessments: applying for planning permission. [online] Available at: <Flood risk assessments: applying for planning permission - GOV.UK>
[Accessed 13 October 2025].

NRFA, 2025. Station 39094 - Crane at Marsh Farm. [online] Available at: < NRFA station data for 39094 - Crane at Marsh Farm >
[Accessed 13 October 2025].

ZSL, 2023. Lower Crane Re-Naturalisation and Enhancement: A New Vision.
[internet] Available at: < https://www.cranevalley.org.uk/wp-content/uploads/2024/02/Lower-Crane-Re-Naturalisation-and-Enhancement-Plan.pdf >
[Accessed 12 Oct 2025].

7. Glossary

Term	Meaning
1% AEP CC flood event	Short hand for the flood event with a 1% chance of being equalled or exceeded in any one year, accounting for climate change. In this study the climate change allowance is a 54% uplift on the peak of the flood. AEP stands for Annual Exceedance Probability. The probability of a flood event is sometimes also expressed in terms of the average number of years between occurrences of that event, so the 1% event can also be called the 100-year event.
Mannings n	A co-efficient that represents the resistance to a flow exerted by the channel boundary (its bed and banks). The more uneven the channel boundary, the more resistant it is to flow and the greater the Mannings n co-efficient.
Lower River Crane	For the purpose of this study the lower River Crane is defined as the reach downstream of Mereway Weir
Study Reach	For the purpose of this study the Study Reach is defined as the reach of the Lower Crane between Mereway Weir and 370 m downstream of Chertsey Bridge
Q95	A common measure of low flow. Q95 is the flow that is exceeded 95% of the time. When derived from a measured flow record (e.g. a timeseries of average daily flows) the Q95 is determined by ranking the entire record from smallest to largest value and then extracting the 5th percentile (i.e. the value that is exceeded by 95% of the record.
ZSL	Zoological Society of London
Linked 1D-2D hydraulic model	1D (one-dimensional) hydraulic models simulate river flows along a single axis. Whilst this approach provides a reliable representation of flow in most UK river channels, it is an over-simplification of flow over wide areas of floodplain where water movement along 2 axes (x and y directions) strongly influence flood depth and extent. Two-dimensional (2D) ‘grid’ models provide this more complete representation of floodplain flows. Linked 1D-2D models provide a reliable representation of flows in channels, on floodplains and the interaction between the two.
Soffit	The underside of a bridge or culvert arch or beam. The elevation of the soffit is an important influence of the rate at which water can pass through a structure.
Invert	The base of a channel or structure. The invert level of a channel is the elevation of the lowest point in the cross section

Flood receptors	Something that is affected by flooding (e.g. a property, a road or a park). Receptors are often differentiated as high sensitivity (those that are substantially and adversely affected by flooding e.g. houses) and low sensitivity (those that are resilient to flooding e.g. park land).

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