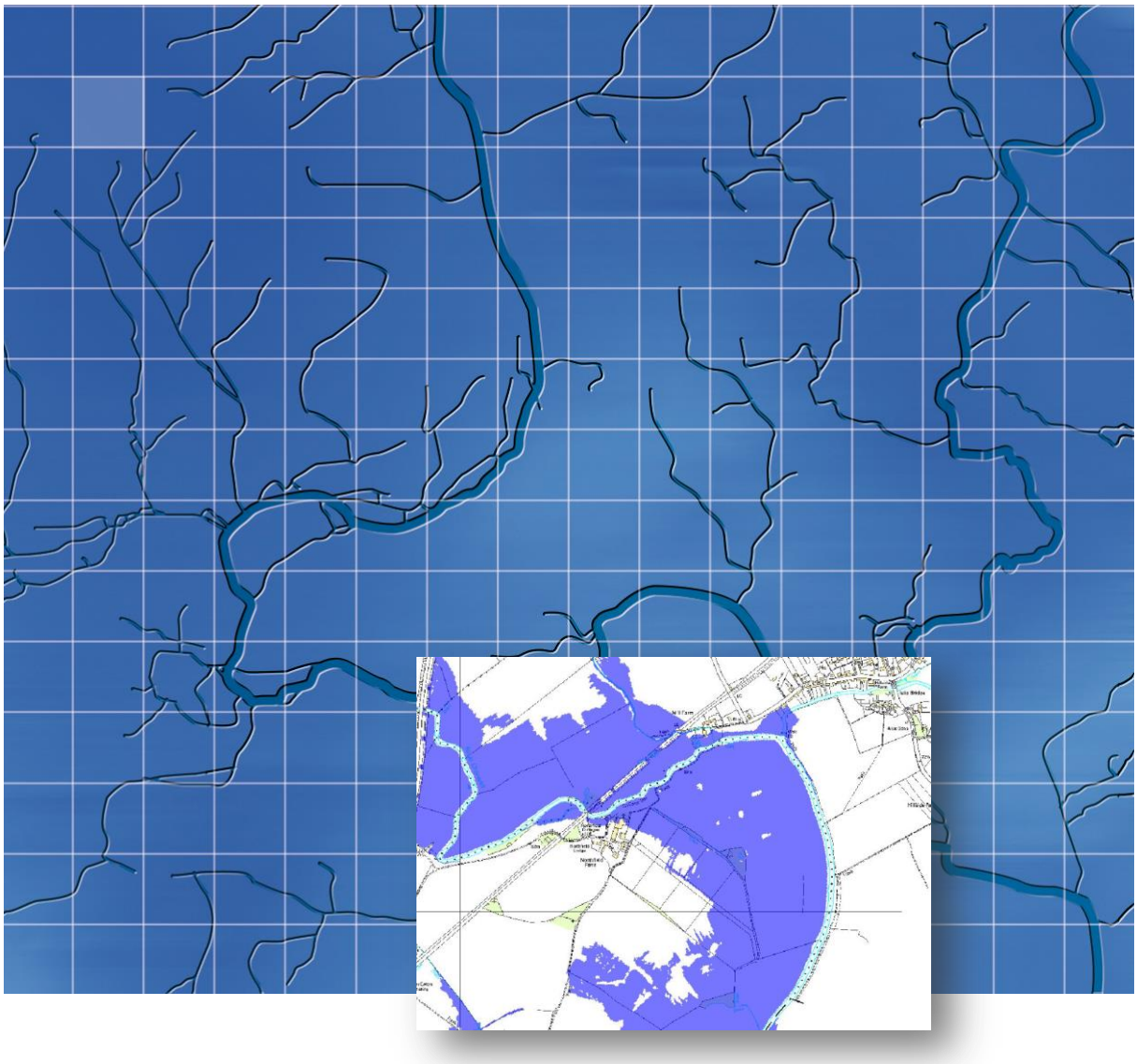
Network Rail and Chiltern Railways

October 2014

EWR-P1-Level 3 FRA: Wolvercote to Islip Embankment Works



Wallingford HydroSolutions Limited

Network Rail and Chiltern Railways

EWR P1 - Level 3 FRA: Wolvercote to Islip Embankment Works

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For and on behalf of Wallingford HydroSolutions Ltd.

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Position *Technical Director*

Date **1st October 2014**

This report has been produced in accordance with the WHS Quality Management system which is certified as meeting the requirements of ISO 9001:2008.

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Contents

1 Introduction

1.1 Background

Environmental Resources Management (ERM) and Wallingford HydroSolutions Ltd. (WHS) completed a Level 2 Flood Risk Assessment (FRA) in 2009 (including a revision in July 2010), together with a Technical Paper[1] outlining potential flood storage mitigation requirements for the proposed Chiltern Railways Bicester to Oxford improvement scheme in support of an application for an Order under the Transport and Works Act 1992 (TWA) by Chiltern Railways (CRCL). The TWA Order was granted by the Secretary of State for Transport in October 2012. This gives statutory powers to authorise the East West Rail Phase 1 (EWR P1) project, comprising the redevelopment and operation of the railway between Oxford and Bicester. The project seeks to introduce a new, fast service between London and Oxford.

The Level 2 FRA was conducted in accordance with Planning Policy Statement 25: Development and Flood Risk (PPS25), and its Practice Guide companion. The Level 2 FRA document highlighted a number of locations along the railway corridor where proposed developments lie within Flood Zones 2 or 3 and could potentially have impacts upon the incidence of local flooding. The report identified a number of assessment points (AP's) along the route of the EWR P1 that require further consideration in a Level 3 FRA. However, the proposed works to the embankments along the route was not included within this original Level 2 FRA study as the extent of embankment widening and cutting works was not clearly identified at the time. Subsequently, Atkins provided details on the locations of where embankment widening work is proposed and where this coincides with active flood zone areas an additional Level 3 FRA is required. The proposed works to the embankments between Wolvercote and Islip were not included within the original Level 2 FRA and this Level 3 FRA is required to assess and provide mitigation for the flood risk impacts of this work. The AP points within this section (i.e AP11 to AP16) have been considered in additional site specific FRAs.

1.2 Scope of Level 3 FRA

This document constitutes a Level 3 FRA for the proposed embankment widening works between Wolvercote to Islip, as required by Planning Condition 12 of deemed planning permission granted alongside the Order under the Transport and Works Act 1992.

This document also provides the information required by the National Planning Policy Framework (NPPF) and the associated requirements of PPS25.

As part of the improvement works, the existing railway embankment is to be strengthened to allow for a dual mainline track between Oxford and Bicester. This FRA document has been commissioned to address the flood risk issues that result from the proposed embankment widening work within active flood zone areas. The location of these works considered within this FRA is between Wolvercote and Islip and is shown in Figure 1. The purpose of this FRA is to quantify any adverse impacts on flood risk and provide sustainable and effective mitigation where required.

The scope and method of analysis for this FRA have been agreed in discussions with the Environment Agency (EA).

[1] WHS. 2010. Chiltern Railways Bicester to Oxford Improvements Level 2 Flood Risk Assessment

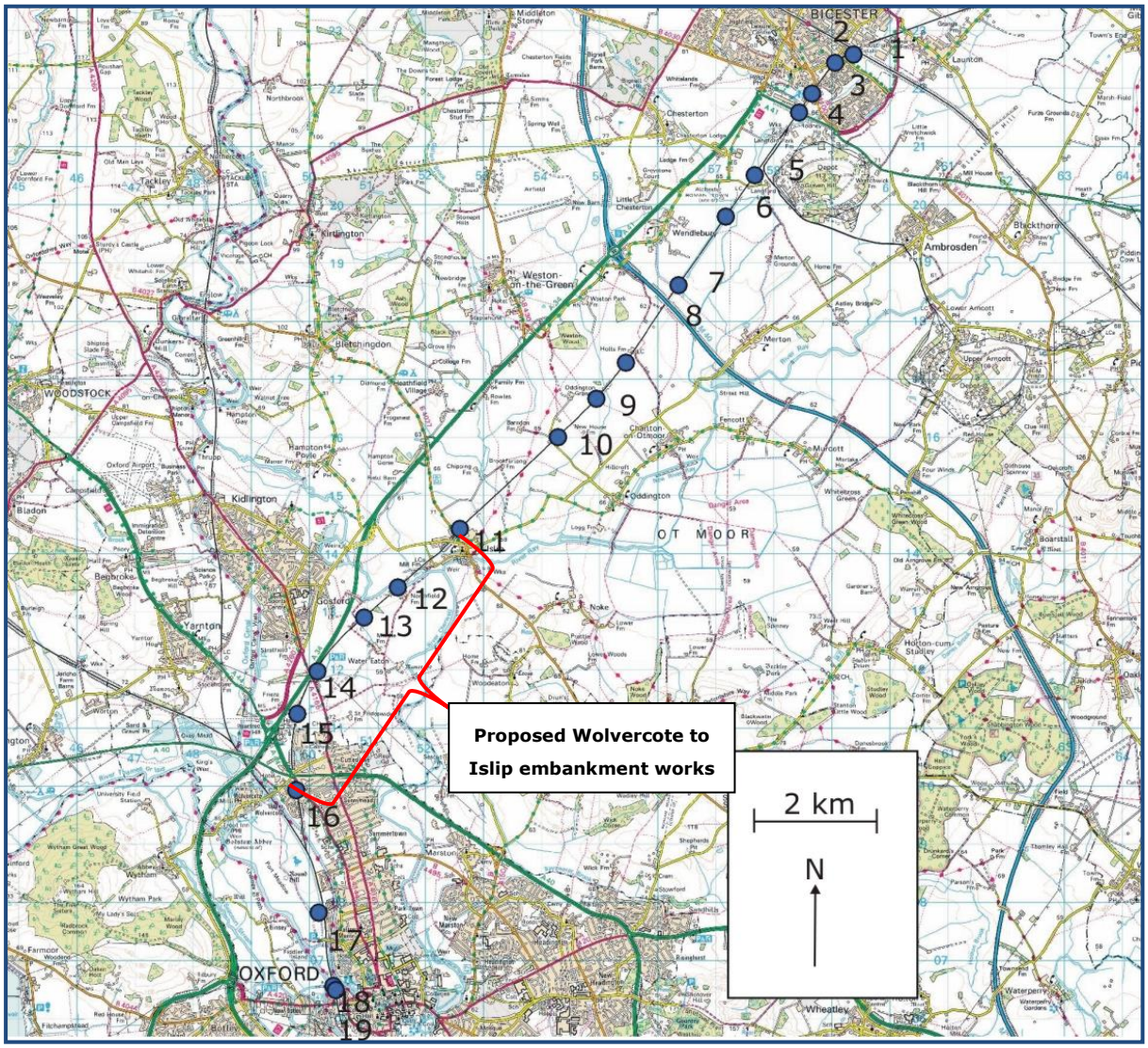

Figure 1 – Scheme Overview Showing Assessment Points.

2 Site Description

2.1 Overview

The proposed development area is located between Wolvercote to the south west and Islip to the north east. A location plan is provided as in Figure 2.

This site specific Level 3 FRA considers the proposed embankment works within the active floodplain between Wolvercote and Islip. Additionally, the OXD UB 45 Underbridge is going to be infilled as part of this work. This report will quantify flood impacts and ensure suitable mitigation is provided to ensure flood risk is effectively managed.

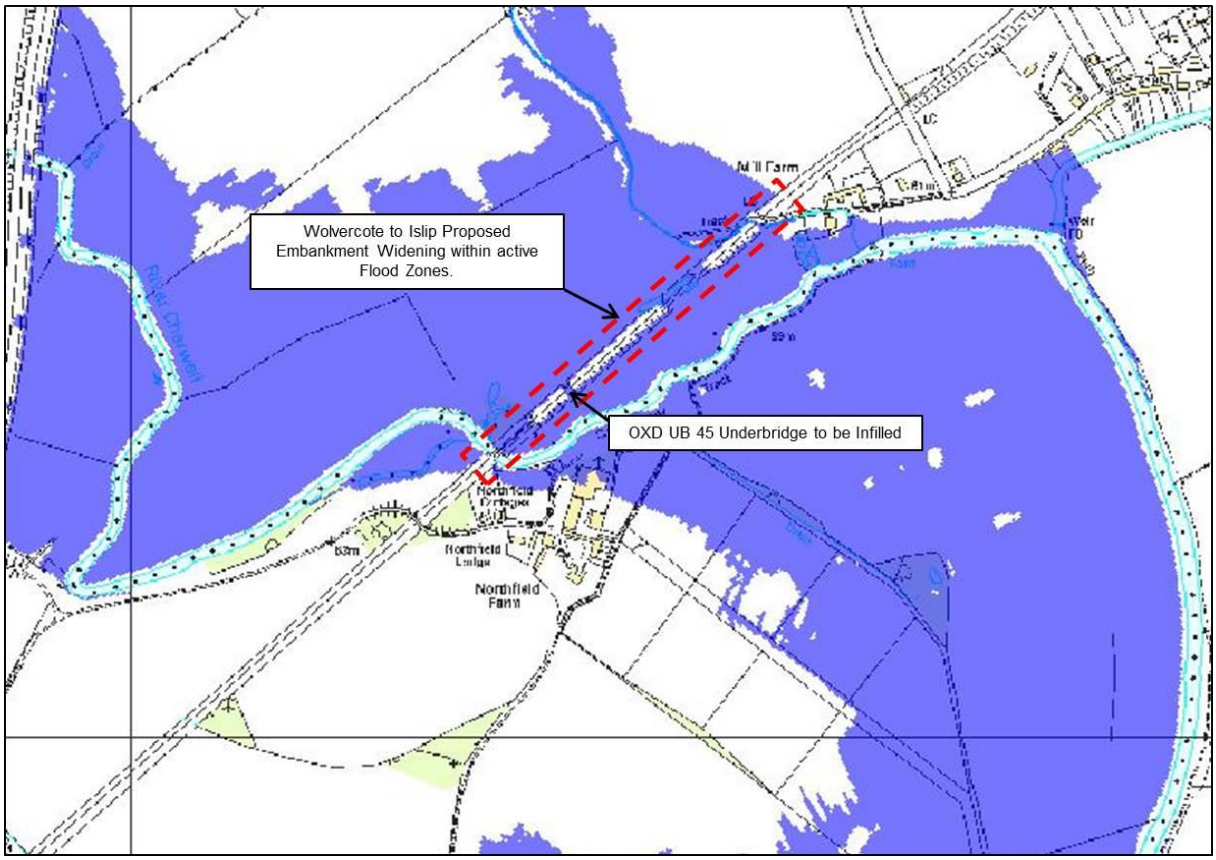

Figure 2 – Wolvercote to Islip Proposed Embankment Widening Work located within Active Flood Zones. (Flood zone extent is based on the WHS hydraulic modelling outputs from the AP13 Northfield Farm FRA[2]).

[2] WHS. 2014. EWR P1 Level 3 FRA: AP13 Northfield Farm. Submitted to the EA in June 2014 and approved as part of Cherwell District Council Planning Ref: 14/00077/DISC.

2.2 Description of the Proposed Works

In order to allow the dual tracking of the line between Oxford and Bicester, embankment widening/ strengthening works are required. This will be achieved through a number of construction methods. For the section between Wolvercote and Islip the preferred earthwork solution is the regrading of the existing embankments with regrading with a gabion toe wall only for those sections where land available within the LOD boundary is constrained.

The majority of the required embankment widening in this section will be achieved using conventional earthworks regrading. This approach will involve adding engineered fill to the outer margins of the embankment to form a wider section at cess level. Granular fill material will be used and, following soft strip, benches will be cut into the existing embankment to allow this additional fill to compacted into layers to create a widened embankment. The maximum slope gradient will be 1:2.5 with shallow slopes being used where stability assessment indicates this is required. This regrading solution will be adopted on one or both sides of the existing embankment depending on the permanent way alignment requirements and the availability of space within the TWA boundary. A typical section of the embankment works is shown in Figure 3.

Figure 3 – Typical Cross Section Representing the Regrade Earthwork Stabilisation Solution.

In some instances where there is limited space within the TWA boundary a regrade solution with a gabion toe solution will be required. A typical section showing the regrade solution on the left side with a regrade and gabion toe wall on the right side is shown in Figure 4.

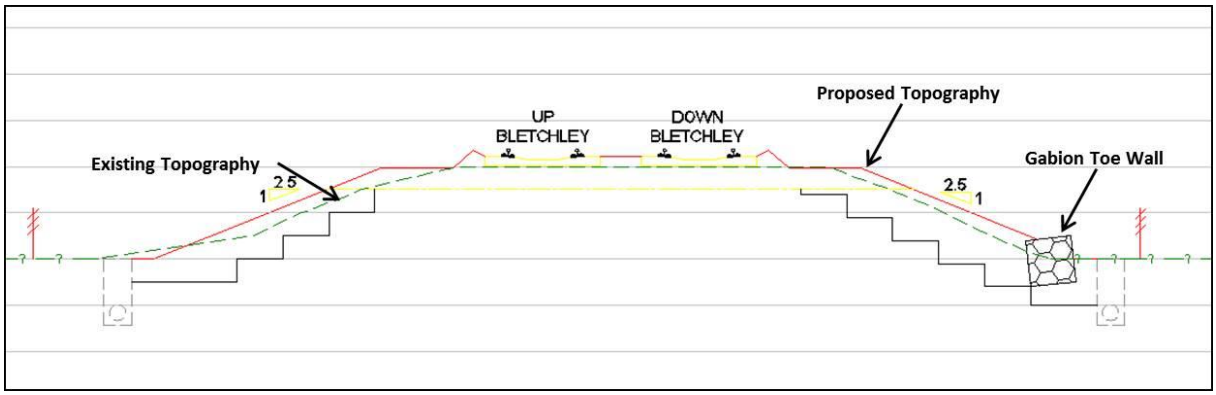

Figure 4 – Typical Cross Section Representing a Regrade Solution of the Left and Regrade and Gabion Toe Wall on the Right.

3 Flood Risk Impacts

3.1 Data Sources Used and Proposed Methodology

This section outlines the methodology used in undertaking the flood impact assessment for the proposed work between Wolvercote and Islip. This involves an assessment of the floodplain storage volume lost as a result of embankment widening and includes recommendations for mitigation measures to provide compensatory floodplain storage. The methodology, parameters and working assumptions, together with the results and recommendations for mitigation are all described in the following sections. An outline of the procedure used to calculate floodplain storage loss is presented below:

- Calculation of the predicted flood level adjacent to the proposed embankment widening using the best available data which is taken from the WHS AP13 Northfield Farm Model[2].
- Calculation of the subsequent flood storage volumes lost as a result of the embankment widening works. This uses detailed earthworks design sections provided by Atkins[3] to assess volumes of floodplain lost.
- Assessment of the potential for level for level storage within the current Limits of Deviation boundary (LOD).

The approach used in this assessment has been discussed and agreed with the EA.

A number of data sources have been used in the current assessment, which include:

- Detailed earthworks cross sections[3] of the proposed works within the 1 in 100 year (plus an allowance for climate change) flood zone at 20m intervals.
- LiDAR data have been purchased through Geomatics Group. This has a 2m resolution, with a vertical accuracy of +/- 0.15 m;
- The Scheme Boundary, this boundary incorporates land within the Limits of Deviation (LOD) and those areas of the Limits of Land to be Acquired and Used (LLAU) where Chiltern Railways has the legal powers to install flood mitigation, without further land acquisition.
- Hydraulic modelling outputs from the WHS AP13 Northfield Farm Hydraulic Model are used to delineate the inundation area and obtain design flood levels for the 1 in 100 year (plus an allowance for climate change) event.

[3] Atkins. 2014. Provided detailed earthworks sections between Islip and the M40 in AutoCAD format.

3.2 Predicted Flood Level

As part of the AP13 Northfield Farm FRA an updated modelling study was undertaken by WHS to more accurately define flood extents and levels within the Lower Cherwell Floodplain. The AP13 modelling work benefits from updated hydrological inflows (produced by WHS to inform the Islip safe access & egress model[4]) and a more robust modelling methodology utilising a linked 1D – 2D model. This updated modelling predicts reduced flood extents over the original EA flood maps within the Lower Cherwell Floodplain as per Figure 5. This modelling shows that the railway embankment between Islip and the River Cherwell is located within an active flood zone and has been assessed in this FRA.

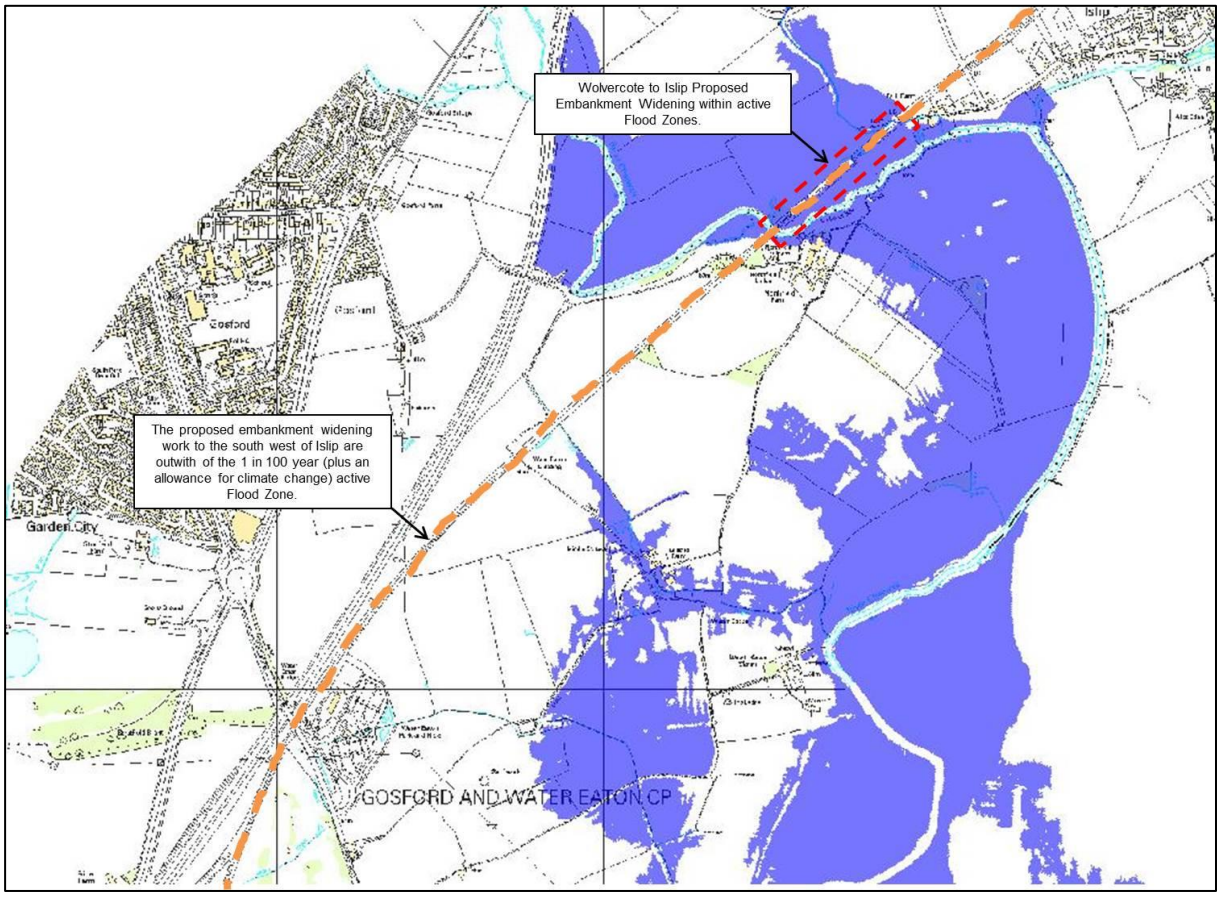

Figure 5 – Proposed Embankment Widening Work Located within Active Flood Zones. (Flood zone extent is based on the WHS hydraulic modelling outputs from the AP13 Northfield Farm FRA).

The WHS hydraulic model confirms that maximum 1 in 100 year plus climate change predicted flood levels are different on either side of the embankment. This is as a result of pooling behind the railway embankment on the northern side as this existing embankment forms a barrier to conveyance. This leads to a ponding effect upstream of the embankment resulting in elevated levels when compared to downstream. Figure 6 summarises the predicted flood levels on either side of the embankment that have been used in this study.

[4] WHS. 2013. Islip Hydrology Report.

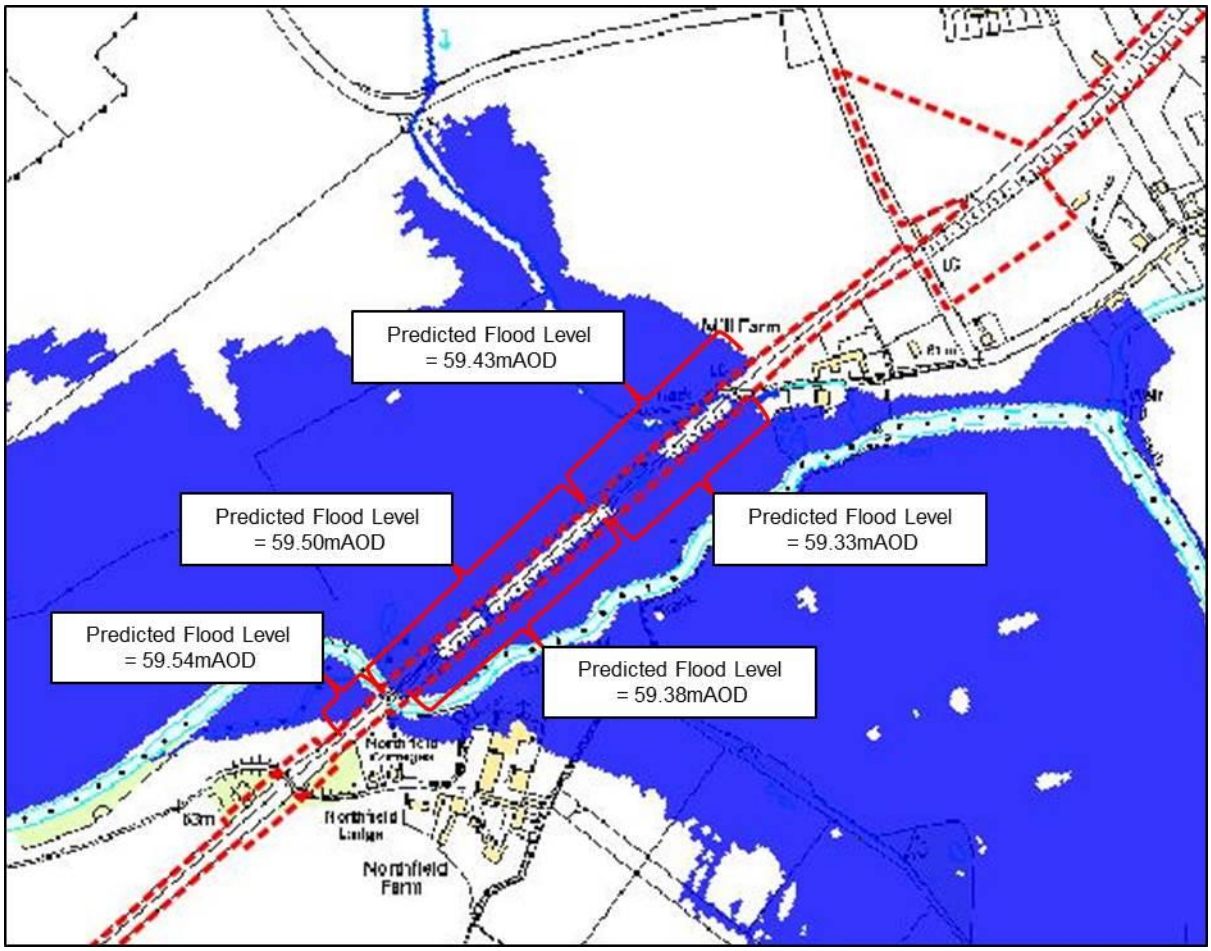

Figure 6 - 1 in 100 Year (plus an allowance for climate change) Predicted Flood Levels in the Lower Cherwell Floodplain.

3.3 Floodplain Storage Loss Analysis

The volume of floodplain storage lost as a result of the embankment widening work has been calculated to inform the design of any compensatory floodplain storage provision that is required to ensure flood risk is effectively managed. The loss of floodplain storage volume has been calculated with the aid of AutoCAD design software. The method adopted is outlined below:

- Atkins has provided detailed earthworks sections[3] at 20 metre intervals along the proposed works area. For each cross section, the area of floodplain lost has been determined by plotting the predicted flood level onto the embankment design sections and calculating the area of floodplain lost. The area lost has been calculated at 0.2m vertical bandings. See Figure 7 for a typical earthworks cross section of the embankment widening work and Figure 8 for details of how the cross-sectional area lost under the predicted 1 in 100 year (plus an allowance for climate change) flood level has been calculated.

- This process is repeated for all earthworks sections that lie within the 1 in 100 year (plus an allowance for climate change) flood inundation area along the length of the proposed works.

- The final stage is to calculate the total volume lost. This is achieved by multiplying the measured cross-sectional area within each depth band by the associated chainage (i.e. 20m centres) over the total length to give the total storage volume lost at each banding level as well as overall volume.

Table 1 provides a summary of the volume of floodplain storage predicted to be lost as a result of the proposed works at 200mm level bandings at each cross section within the Lower Cherwell Floodplain with a total volume of 417m^3 being lost.

As part of the embankment widening work between Wolvercote to Islip the OXD UB 45 Underbridge is also going to be infilled. A separate Flood Risk Assessment[5] has been completed to assess the flood risk impacts of the closure of this structure demonstrating that there is no significant increase in flood risk. Based on the earthwork cross sections and width of this structure an additional volume of 48m^3 has been calculated and is included within the total storage volume lost which is 417m^3.

[5] EWR – P1 – Level 3 FRA OXD UB 45 Underbridge. (WHS. September 2013)

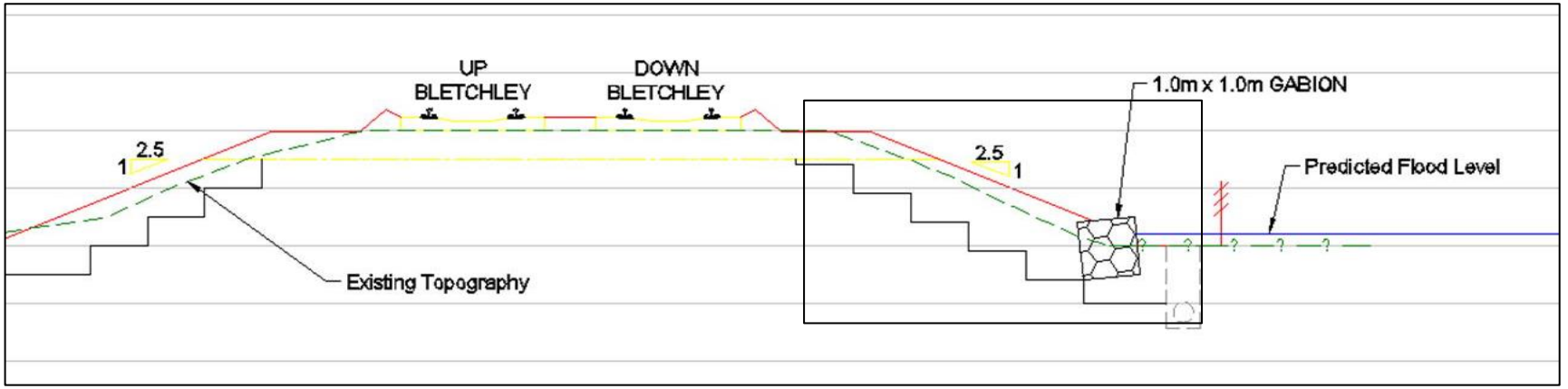

Figure 7 – Typical Design Cross Section Showing the Proposed Earthworks Solutions of Simple Regrade on the East and Regrade and Gabion Wall on the West.

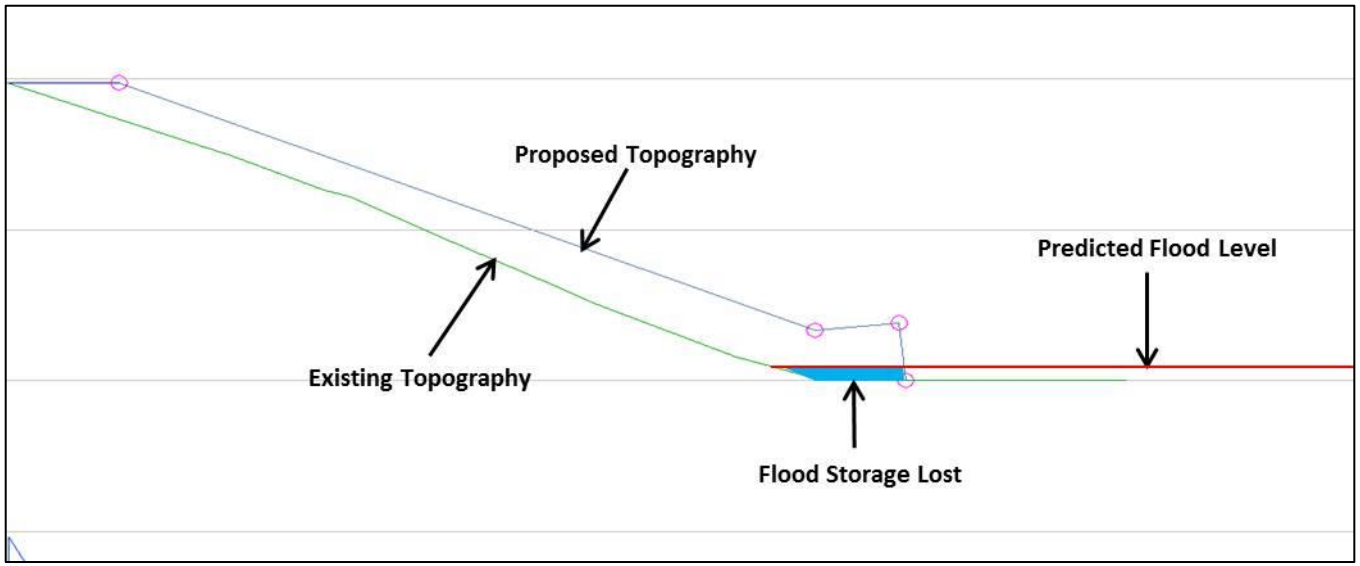

Figure 8 – Example of Calculation Method for Flood Storage Loss at each Cross-section along the Embankment.

Table 1 – Floodplain Storage Volume Lost at each Design Cross-Section at 200mm Level Bands for the Lower Cherwell Floodplain.

Section	Embankment Face	Volume loss by level band (m^3) Level Band (mAOD)							
		58.0 to 58.2	58.2 to 58.4	58.4 to 58.6	58.6 to 58.8	58.8 to 59.0	59.0 to 59.2	59.2 to 59.4	59.4 to 59.6
121480	NW	-	-	-	-	4	1	1	1
	SE	-	-	-	-	-	-	-	-
121500	NW	-	-	-	-	-	-	-	0.2
	SE	-	-	-	-	-	0.8	1.8	-
121520	NW	5.8	9	8.8	7.6	6.4	5.2	4	0.6
	SE	-	-	-	-	-	2.4	2.2	-
121540	NW	-	-	-	-	-	1.6	2.8	0.4
	SE	-	-	-	-	-	0.4	0.6	-
121560	NW	-	-	-	-	0.2	2.2	2.4	0.4
	SE	-	-	-	-	-	-	-	-
121580	NW	-	-	-	-	-	-	0.4	0.2
	SE	-	-	-	-	-	3.4	6.4	-
121600	NW	-	-	-	-	-	-	-	-
	SE	-	-	-	-	-	-	-	-
121620	NW	-	-	-	-	-	-	-	-
	SE	-	-	-	-	-	-	-	-
121640	NW	-	-	-	-	-	-	-	-
	SE	-	-	-	-	-	-	-	-
121660	NW	-	-	-	-	-	-	-	-
	SE	-	-	-	-	-	-	-	-
121680	NW	-	-	-	-	-	-	-	-
	SE	-	-	-	1.2	1.4	2.4	3.2	-
121700	NW	-	-	-	-	-	-4.2	-3.8	-1.4
	SE	-	-	1.2	2.6	2.6	2.6	2	-
121720	NW	-	-	-	-2.4	-7.6	-6.4	-5.6	-2.4
	SE	-	-	3.2	4	4	4.2	3.4	-
121740	NW	-	-	-	-	-	0.4	1	1.2
	SE	-	-	4.6	5.2	5.2	5.2	4.8	-
121760	NW	-	-	-	1	2.2	1.2	1.2	0.6
	SE	-	-	3.6	4.8	4.8	4.6	4.2	-
121780	NW	-	-	0.2	1.6	3.4	2.2	2.4	1.2

Section	Embankment Face	Volume loss by level band (m^3) Level Band (mAOD) 58.0 to 58.2	58.2 to 58.4	58.4 to 58.6	58.6 to 58.8	58.8 to 59.0	59.0 to 59.2	59.2 to 59.4	59.4 to 59.6
	SE	-	-	2.2	4.6	4.6	4.6	4	-
121800	NW	-	-	0.2	2	4	3.4	3	1.4
	SE	-	-	0.6	4.2	5	5.4	5.4	-
121820	NW	-	-	-	0.56	2.6	3.4	2.8	1.4
	SE	-	-	-	3.6	4.6	4.8	4.6	-
121840	OX UB 45 Underbridge	-	-	-	4.8	11.8	13.4	13.28	4.28
121860	NW	-	-	-	9.72	10.44	10.44	10.44	5.04
	SE	-	-	-	3.24	7.92	11.16	10.08	-
121880	NW	-	-	-	2.4	2.6	2.6	2.8	1.4
	SE	-	-	0.6	2.8	4.4	5	4.6	-
121900	NW	-	-	-	-0.6	-0.4	-	0.2	0.2
	SE	-	-	1.6	2.2	3.4	3.8	3.6	-
121920	NW	-	-	-	-	-	-	-	-
	SE	-	-	-	-	-	-	-	-
121940	NW	-	-	-	-	-	-	-	-
	SE	-	-	-	-	-	-	-	-
121960	NW	-	-	-	-	-	-	-	-
	SE	-	-	-	-	-	-	-	-
121980	NW	-	-	-	-	-	-	-	-
	SE	-	-	-	-	-	-	-	-
122000	NW	-	-	-	-0.4	0.8	3	4.4	2.4
	SE	-	-	-	-	-	-	-	-
122020	NW	-	-	-	-	-	-0.2	-0.4	0.6
	SE	-	-	-	-	-	-	-	-
Totals		**5.8**	**9**	**26.8**	**64.72**	**88.36**	**100**	**103.2**	**18.72**
							Sum of Totals		**416.6**

3.4 Viability of Level for Level Storage

The EA has confirmed that level for level storage is required when providing compensatory storage. The total volume of floodplain storage lost is 417m^3 as summarised in section 3.3 between 58.0mAOD (lowest ground level) and 59.54mAOD (maximum predicted flood level).

An assessment of the availability of suitable land to provide the compensatory storage has been undertaken within the Lower Cherwell floodplain. Throughout the process of identifying suitable locations for storage there are a number of key factors that have been considered that include:

- Storage is to be provided within the TWA boundary, as close as possible to the point of impact.
- Ensuring compensatory storage areas can be hydraulically connected to the floodplain.
- Identifying areas that can provide the required storage on a level for level basis.

Review of the levels and areas available locally within the Lower Cherwell floodplain indicate that there is sufficient space available within the TWA (Land to be Acquired and Used) boundary to provide level for level storage. The areas identified within Figure 9 provide adequate ground levels and space to accommodate the required level for level storage. This was confirmed through the checking of ground levels based on LiDAR data. Cross sections taken along and across the proposed areas also confirm the mitigation potential as highlighted in Figure 10, Figure 11 and Figure 12.

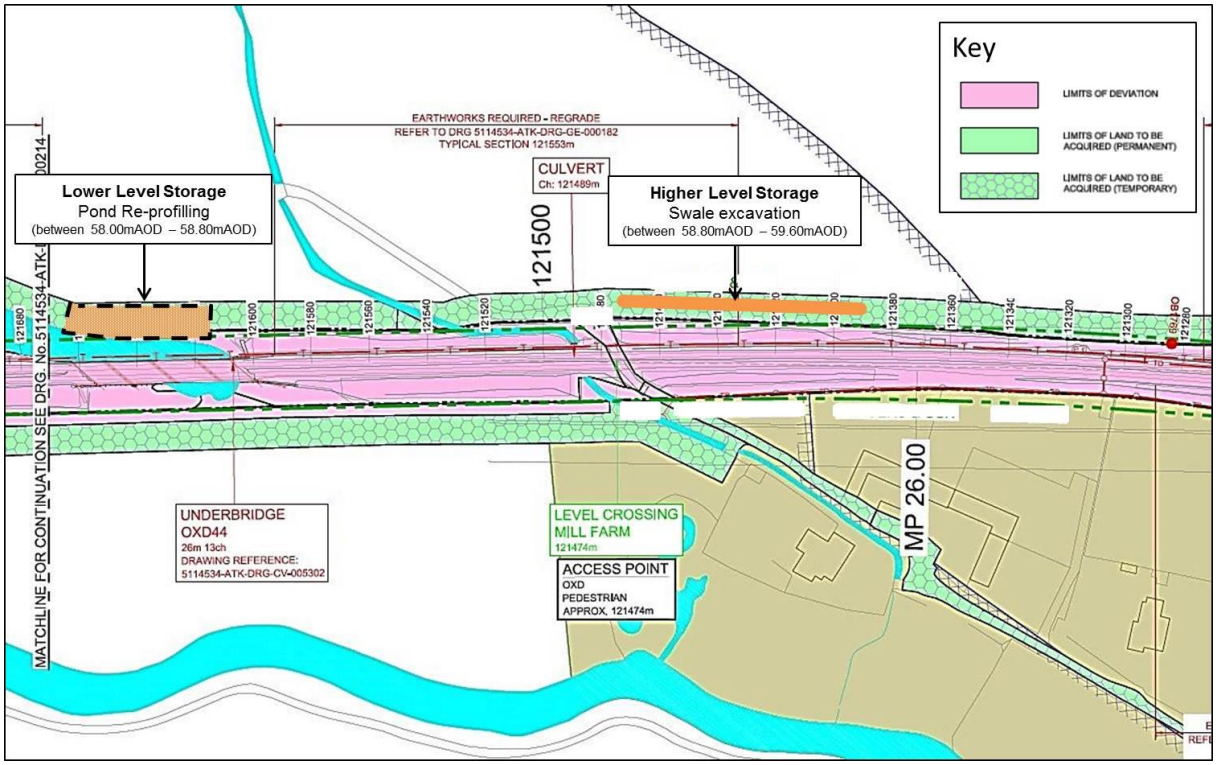

Figure 9 – Locations Considered for Provision of Level for Level Compensatory Floodplain Storage. (Base map taken from the Atkins Coordination Drawings. 2012)

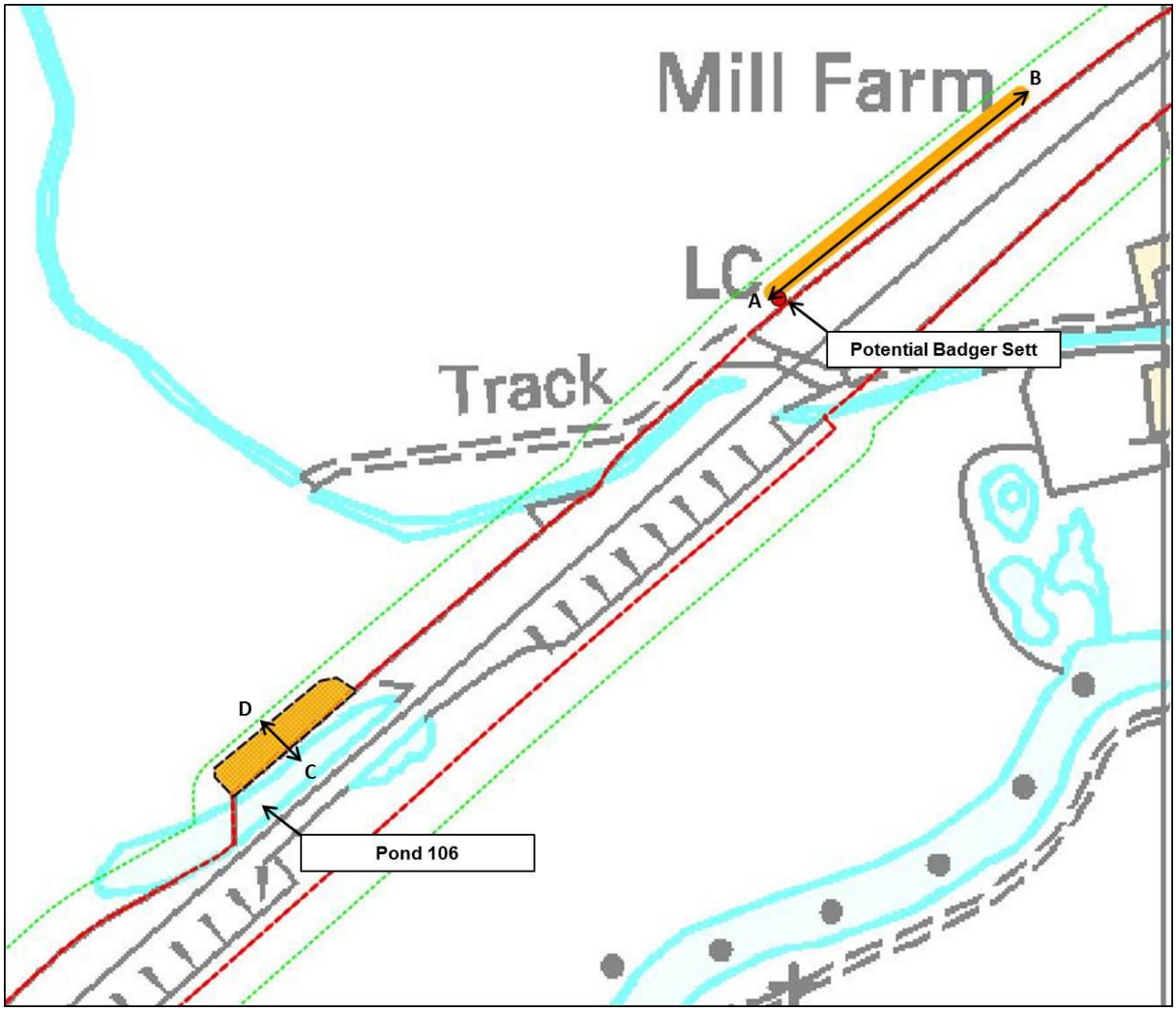

Figure 10 – Cross Section Location Plan – (Cross Sections Based on LiDAR (2m resolution).

To provide the lower level storage (i.e between 58.00mAOD to 58.80mAOD) a ground reprofiling excavation adjacent to the existing pond 106 is proposed as per Figure 10. Pond 106 was home to a population of newts that have since been translocated into receptor sites in the local area during construction. Therefore, the pond reprofilling work would be acceptable from an ecological perspective if the pond was restored to its previous state and provides suitable newt habitat post-construction. This solution will offer multiple benefits by providing the required compensatory floodplain storage volume requirement and additionally it can be designed to improve biodiversity and create a larger newt habitat.

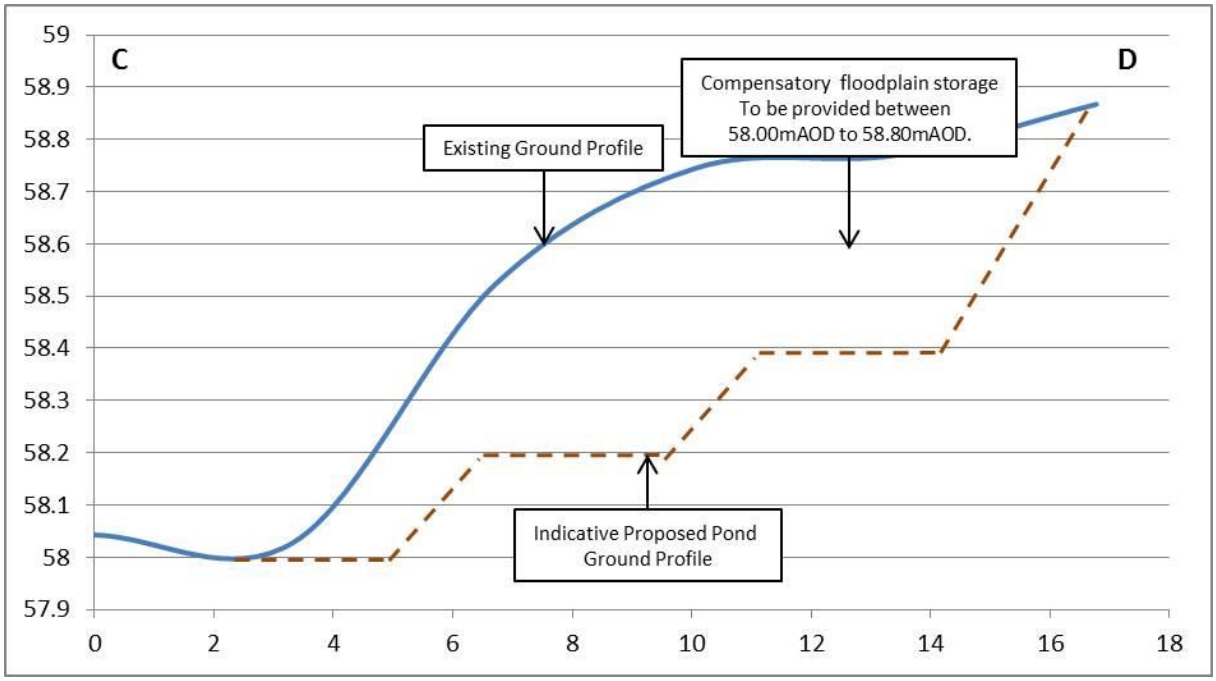

Figure 11 – Lower Level Storage Indicative Cross Section (Set to Cross Sections Location shown in Figure 10).

To provide the higher level storage (i.e between 58.80mAOD to 59.54mAOD) a swale type excavation down to 58.80mAOD as per Figure 12 will be provided. This swale will need to be approximately 85m long by 6 - 7m wide. However, to ensure that the swale can be retained within the LOD (Land to be Acquired and Used) boundary a more engineered excavation will be required at the eastern end of the swale as an excavation of greater than 1m will be required to provide storage volume down to the 58.80mAOD level. Continuity of drainage will also need to be provided through the old Northfield Farm level crossing to provide a connection to the Mill Stream and ensure that the storage area is utilised during an extreme flood event. Additionally, works may affect a potential badger sett to the west of the proposed swale. The Scheme ecologist has confirmed that if required this badger sett can be closed because of the lack of activity observed during the recent ecological surveys.

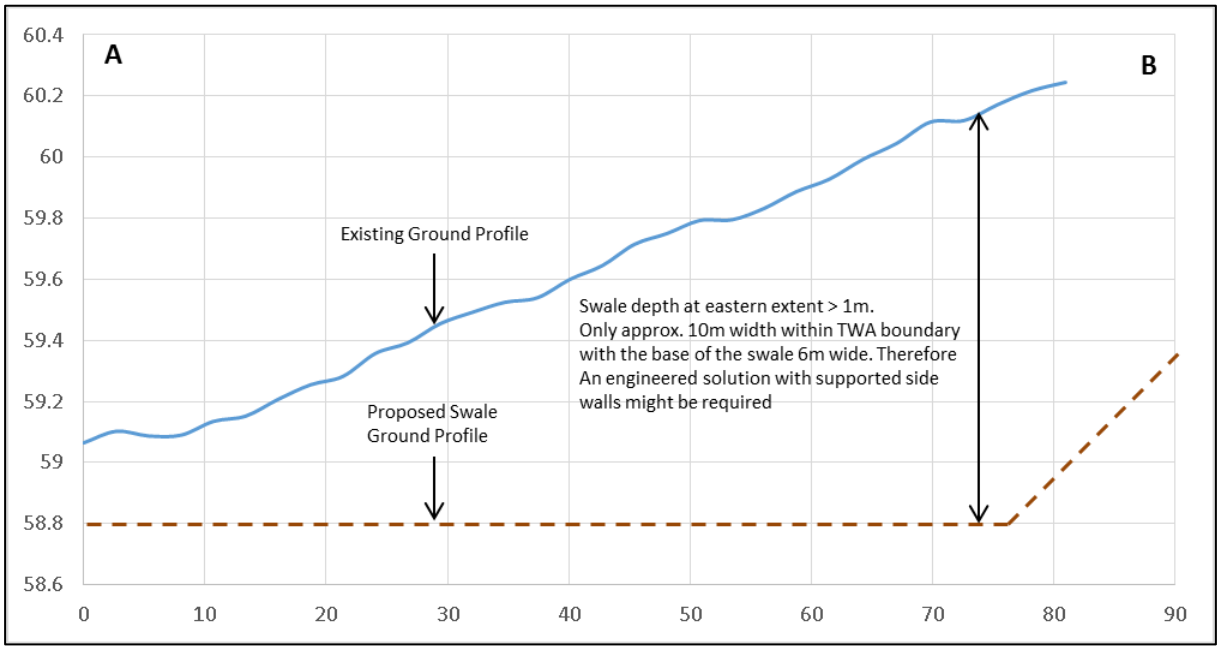

Figure 12 – Higher Level Storage Indicative Cross Section (Set to Cross Sections Location shown in Figure 10).

This initial assessment has conducted a review of ground levels and areas within the TWA boundary that are suitable to be used for compensatory floodplain storage. Detailed design of the storage areas will be undertaken by Atkins through a detailed ground modelling exercise to accurately design storage areas based on the volumes and levels provided in Table 1

4 Conclusions

The key conclusions of this FRA are as follows:

- The proposed embankment widening works between Wolvercote and Islip would lead to a reduction in floodplain storage of 417m^3 and includes the volume lost due to the closure of the OXD UB 45 Underbridge.

- Flood compensation on a level for level basis will be provided through the provision of two separate solutions that include:

  - The lower level storage (i.e between 58.0mAOD to 58.8mAOD) is to be provided via re-profiling of the existing Pond 106. This will create a wider slightly deeper pond that will provide a larger newt habitat. This pond should be designed to enhance local biodiversity by incorporating a staged type excavation.

  - The higher level storage (i.e between 58.8mAOD to 59.54mAOD) is provided via a swale excavation within the TWA (Land to be Acquired and Used) boundary. To ensure that this structure can be retained within that boundary a more engineered solution will be required. Continuity of drainage will need to be provided through the old Northfield Farm level crossing to provide a connection to the Mill Stream.

- Please see 3.4 for full details of storage area locations and solutions.

- Detailed design of the storage areas will be undertaken by Atkins through a detailed ground modelling exercise to accurately design storage areas based on the volumes and levels provided in Table 1.

- The proposed storage areas are located within the TWA boundary where Network Rail has powers to build permanent mitigation works. This land would be handed back to the owner of the land once the works are complete.

4.1 Future Considerations

A 'Works Approval' is to be submitted separately in due course for the proposed works in this area, under the provisions of Schedule 15 of the TWA Order. Works Approvals will also be required for any temporary works within Flood Zones 2 and 3.

There are some points that need to be considered by the contractor in relation to the temporary works required during the construction phase of the Wolvercote to Islip embankment widening. These include:

- All compounds, stockpiles and other works will need to be kept outside Flood Zones 2 & 3 and be sited within Flood Zone 1.

- All temporary haul roads within Flood Zones 2 and 3 will need to be kept at grade to avoid any requirement for compensatory flood storage.

- All roads should be constructed with a permeable hard-core or stone surface to avoid increasing the impermeable footprint of the site.

Chiltern Railways and Network Rail will submit applications for the permanent Works Approvals and the Contractor will submit applications for temporary works approvals, where necessary.