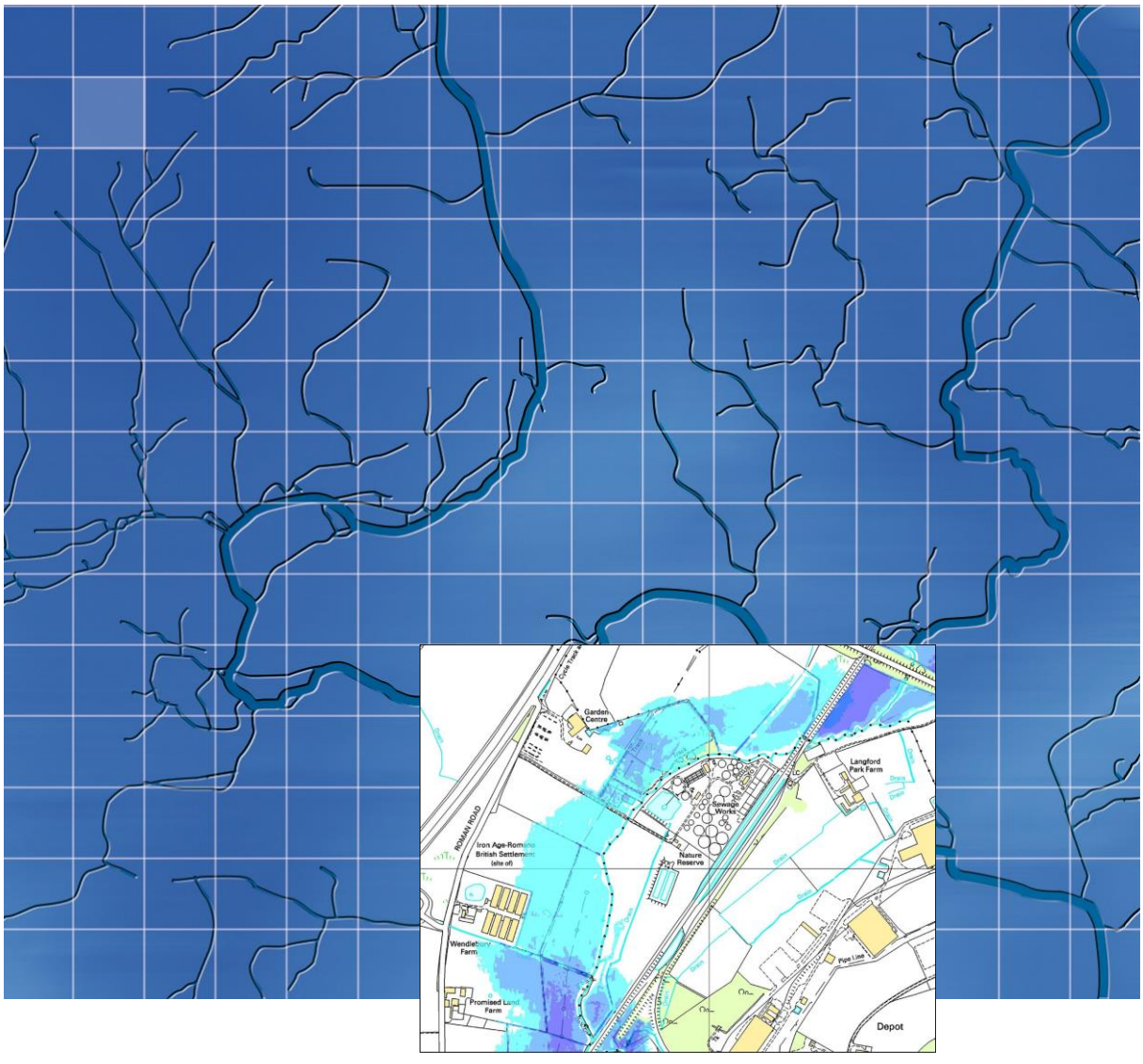
Network Rail and Chiltern Railways

May 2014

EWR-P1-Level 3 FRA: MOD Sidings (West)



Wallingford HydroSolutions Limited

Network Rail and Chiltern Railways

EWR P1 - Level 3 FRA: MOD Sidings (West)

Document issue details

WHS1160

Version number	Issue date	Issue status	Issuing Office
V1	12th May 2014	DRAFT	Cardiff

For and on behalf of Wallingford HydroSolutions Ltd.

Prepared by E. Hampton

Approved by P. Blackman
Position *Technical Director*

Date **12th May 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.

WHS

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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. The proposed works to the Ministry of Defence (MOD) Sidings considered within this report were not included within this original study having been proposed during 2013 as a result of Ministry of Defence requests.

This report considers proposed works immediately north of AP5 of the original study as shown on Figure 1. The MOD Sidings development can be split into three geographical units; east, central and west. The developments in the east and central unit have been considered in an earlier report[2]. This report considers those works within the western work units. The western development comprises embankment structural strengthening on the main line, as well as the construction of a new rail connection embankment to the Ministry of Defence site.

For consistency, the development considered within this report will be referred to simply as the MOD Sidings (West).

1.2 Scope of Level 3 FRA

This document constitutes a Level 3 Flood Risk Assessment for the proposed works at the MOD Sidings (West), 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.

This FRA document has been commissioned to address the flood risk issues that result from the construction of the MOD Sidings (West) embankment works and construction of a new connection to the MOD site. The location of the MOD Sidings (West) is shown in Figure 1. As part of the MOD Sidings (West), the existing railway embankment is to be strengthened to allow for a dual mainline track, and improved connectivity to the MOD train hub will be achieved through provision of an

[1] WHS. 2010. Chiltern Railways Bicester to Oxford Improvements Level 2 Flood Risk Assessment
[2] WHS. 2014. EWR P1 – Level 3 FRA: MOD Sidings (East and Central).

additional connection line. 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.

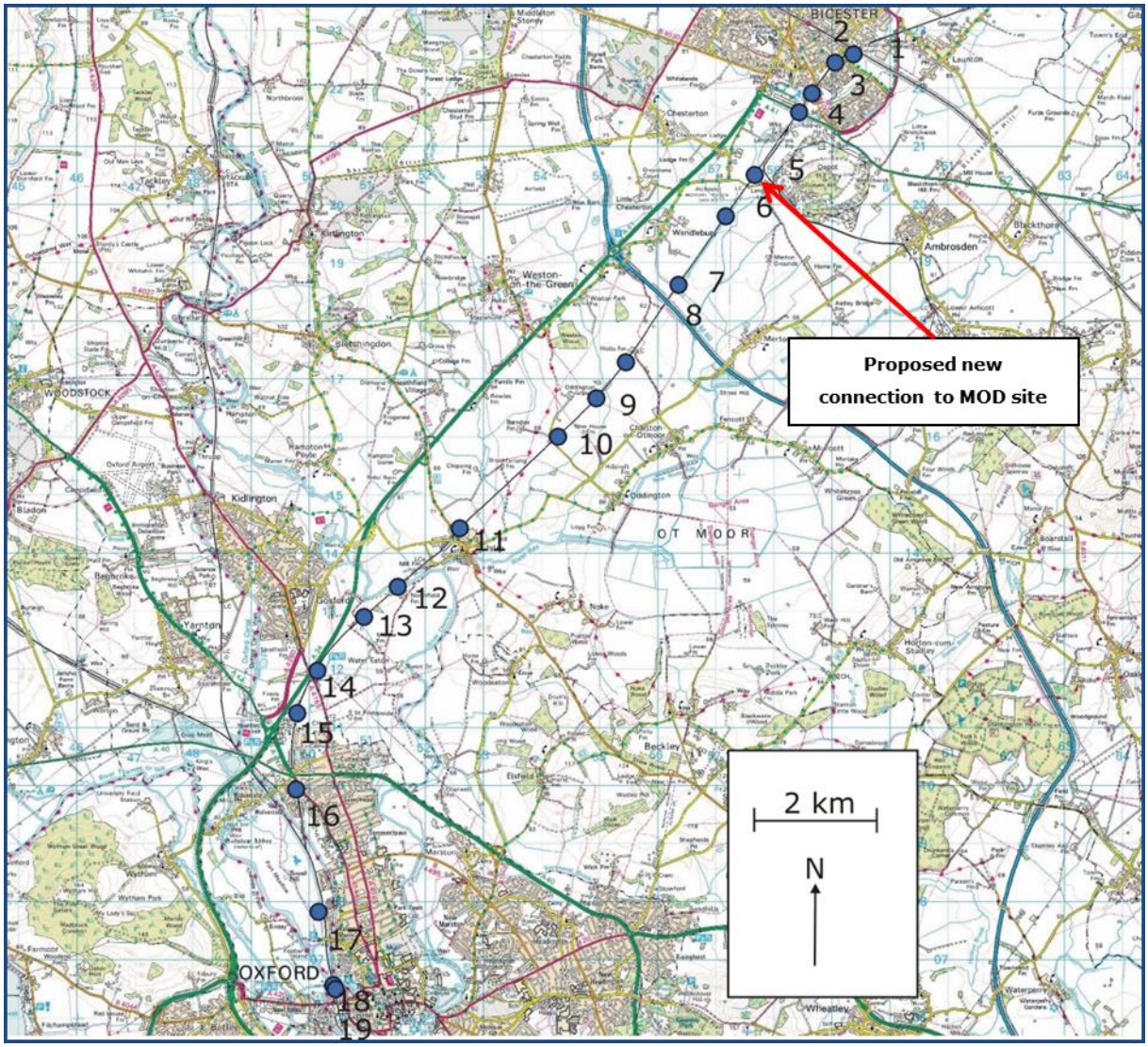

Figure 1 – Scheme Overview Showing Assessment Points.

2 Site Description

2.1 Overview

EWR P1 is a major package of infrastructure investments including the dualling of the line between Bicester town and Oxford North Junction.

The proposed development referred to as MOD sidings has been split into three geographically distinct sub units, East, Central and West. A summary of the location of these sub units is provided by Figure 2. A flood risk assessment[2] for works proposed within the Central and Eastern units has already been submitted to the Environment Agency and Local Planning Authority (Cherwell DC Ref: 14/00076/DISC). Formal acceptance by the Environment Agency of the proposed works was received on 9th May 2014 (EA Ref: WA/2014/117442/02-L01).

This site specific Level 3 FRA considers works proposed within the western sub unit of the MOD sidings development immediately north of Assessment Point 5 of the Bicester to Oxford works.

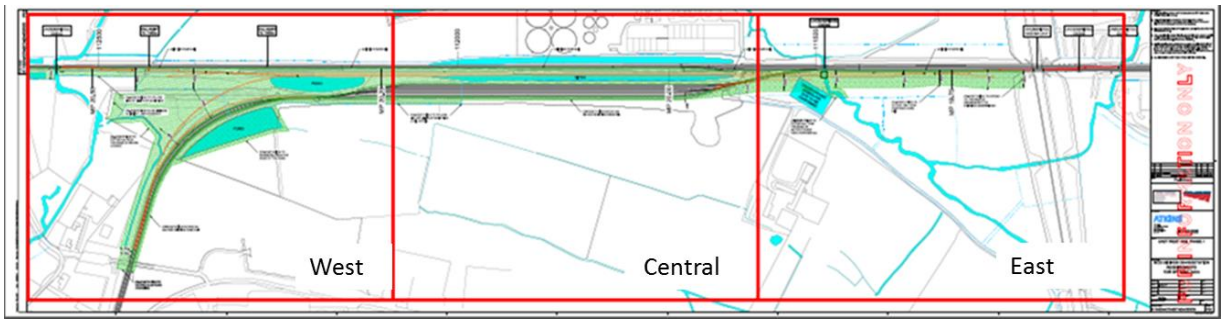

Figure 2 – MOD Sidings Development Scheme, Geographical Zones.

2.2 Description of the Proposed Works

There are two distinct areas of work within the western area and a description of these is provided separately in the following section. For reference, Figure 3 highlights the two areas described.

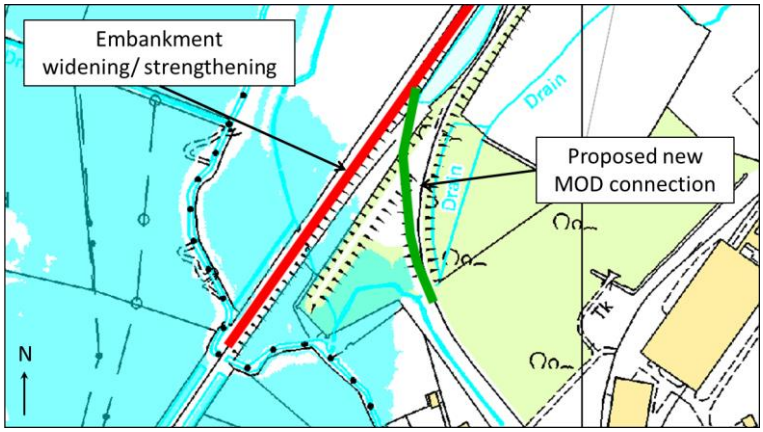

Figure 3 – Location of embankment strengthening works and proposed new connection to MOD site

2.2.1 Mainline Strengthening / Widening

In order to allow the dual tracking of the line between Bicester and Oxford, embankment widening / strengthening is required. This will be achieved through a number of methods. To the north of the embankment the existing berm will be slightly widened by an average of approximately 1.25m between the Langford Brook Over-bridge and the edge of the flood extent. To the south of the embankment, in order to reduce the impact on flood plain storage, the use of gabion walling is proposed (also used in sections on the north). This reduces the associated widening considerably and has been undertaken following discussions with the Environment Agency.

2.2.2 Proposed New MOD Connection

A new rail connection to the MOD site has also been designed as part of this development. This requires the re-landscaping of the existing embankment and earthworks between the mainline and MOD. This area is raised above the floodplain and the works cause no encroachment onto the flood plain.

Given no earthworks are proposed within the 1 in 100 year plus climate change flood extent, no compensatory storage is required.

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 at the MOD Sidings (West). 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 Bicester hydraulic model[3] has been approved for use for this study by the Environment Agency and has been updated with more up to date floodplain topography and updated to reflect best modelling practices. 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 MOD Sidings embankment widening using the updated and extended Bicester model[4] previously reviewed by the Environment Agency.

- Calculation of the subsequent flood storage volumes lost as a result of the embankment widening works and proposed new connection. This uses detailed earthworks design sections provided by Atkins[5] to assess volumes of floodplain lost.

- Assessment of the potential for level for level storage within the current Limits of Deviation boundary (LOD).

If this is not possible, provision will be made for compensatory floodplain storage on a volume for volume basis, with an element of over compensation.

[3] PBA. 2009. Bicester Hydraulic Model.
[4] WHS. 2013. MOD Sidings Hydraulic Model.
[5] Atkins. 2014. Provided detailed earthworks section of the MOD West development in AutoCAD format.

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 sections5 of the proposed works within the 1 in 100 year (plus an allowance for climate change) flood zone at 10m 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 an updated version of the Environment Agency Bicester Model[3] (previously reviewed by the EA) are used to delineate the inundation area and obtain design flood levels for the 1:100 year (plus climate change allowance) event. WHS has undertaken work to upgrade and extend the existing model with more up to date topographic data and a finer resolution 2D grid to facilitate modelling of the proposed works. Further details of the modelling undertaken are found within the previous MoD East and Central FRA submission[2].

3.2 Predicted Flood Level

This study uses an updated version of the Environment Agency Bicester model, which has been updated with more detailed topographical data and extended downstream to the River Ray. Details of the modelling undertaken have been provided in the previous MoD East and Central FRA submission [2] and the model has been reviewed by the Environment Agency.

The hydraulic model predicted that the maximum 1 in 100 year plus climate change flood level on the northern side of the main railway embankment is 63.74mAOD whilst on the southern side this is lower at 63.50mAOD.

In comparison with Environment Agency supplied data, the predicted flood levels to the south are 0.05m lower than the Environment Agency data (63.62mAOD). To the north, the predicted flood level from this study is 0.32m lower than the Environment Agency data (64.08mAOD).

The difference to the south is considered to be as a result of the previous Environment Agency model being based on JFLOW data. Although the WHS predicted level is lower, the flood extent is larger due to a refined topographical grid being used. The difference in the north is due to a refined downstream boundary condition by extension of the model. The original ISIS model suggested a downstream slope of 1 in 1712m, whereas the actual slope downstream between the upstream bridge cross section and the confluence of the Langford Brook and Gagle Brook based on topographic survey data[6] is 1 in 319m.

[6] Interlock Surveys. 10th March 2013. Langford Brook Survey

3.3 Floodplain Storage Loss Analysis

The volume of floodplain storage lost as a result of the embankment work and construction of the new connection has been calculated to inform the design of any compensatory 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 sections5 at 10 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 bandings. See Figure 4 for a typical earthworks cross section of the embankment widening work and Figure 5 for details of how the cross-sectional area lost under the Q100+CC flood event 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. 10m 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 volumes of floodplain storage predicted to be lost as a result of the proposed works at 200mm level bandings at each cross section. The total storage volume lost is 124m^3.

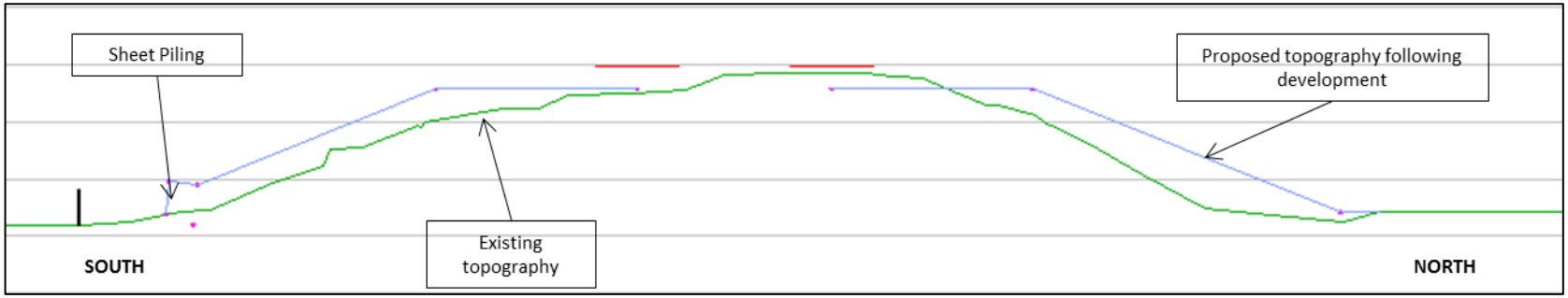

Figure 4 – Typical Design Cross Section at MOD West (Mainline) showing the proposed berm widening on the northern side, and change in topography using gabion walling on the southern side.

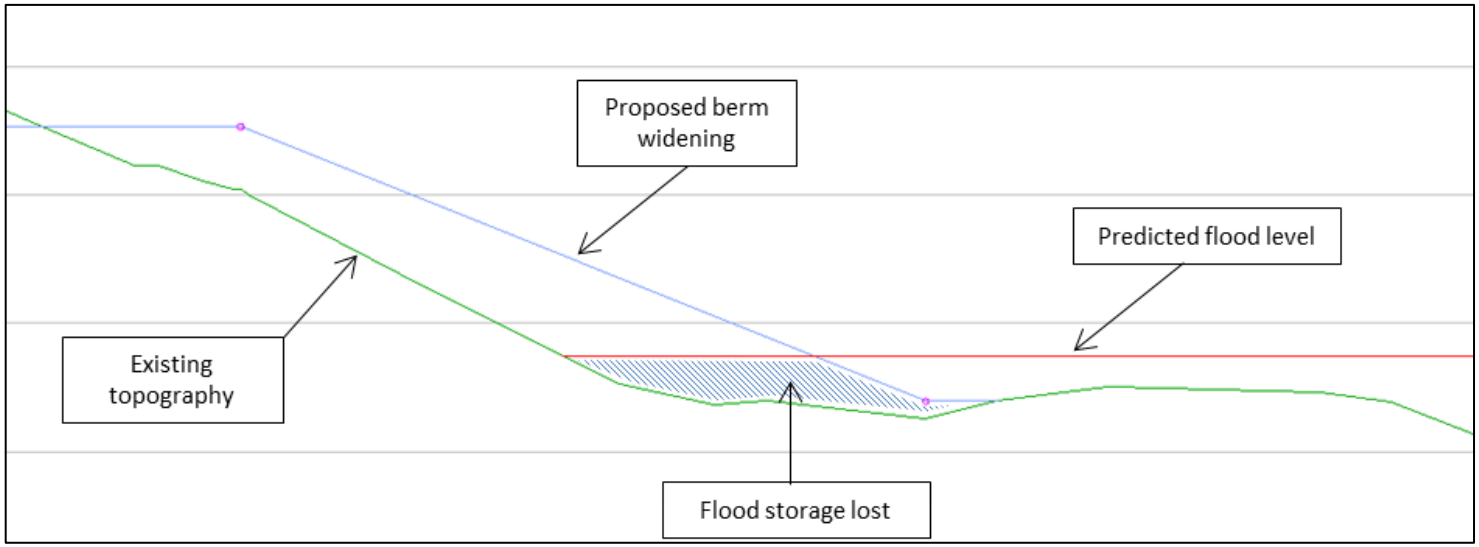

Figure 5 – Example of Calculation Method for Flood Storage Loss / Gain at each Cross-section along the embankment.

Table 1 – Floodplain Storage Volume Lost at each Design Cross-section at 200mm Level Bands

		Volume loss by level band (m^3)			
		Level Band (mAOD)			
Section	Embankment Face	63.0 to 63.2	63.2 to 63.4	63.4 to 63.6	63.6 to 63.8
112540	N	-	-	-	-
	S	-	1.0	1.4	-
112530	N	-	-	-	-
	S	-	0.5	1.3	-
112520	N	-	2.9	4.4	2.3
	S	-	1.0	1.15	-
112510	N	-	2.0	3.6	2.3
	S	-	0.9	1.0	-
112500	N	0.1	1.8	2.9	2.5
	S	-	0.8	0.9	-
112490	N	-	1.1	3.4	2.6
	S	-	0.4	0.8	-
112480	N	-	1.4	4.0	2.8
	S	-	0.3	0.4	-
112470	N	-	2.7	4.5	2.9
	S	-	0.7	0.5	-
112460	N	-	1.7	4.2	2.9
	S	-	0.5	0.6	-
112450	N	-	0.5	3.4	2.9
	S	0.1	1.0	1.0	-
112440	N	-	-	1.9	2.9
	S	0.6	0.6	0.14	-
112430	N	-	0.9	1.2	0.3
	S	-	0.1	0.5	-
112420	N	0.3	1.7	1.7	0.6
	S	-	-	-	-
112410	N	-	0.3	1.8	2.0
	N	-	-	-	-
112400	S	-	-	1.6	2.3
	N	-	-	-	-
112390	S	-	0.4	3.6	2.3
	N	-	-	-	-
112380	N	-	0.8	3.0	2.5
	S	-	-	-	-
112370	N	-	0.6	2.8	2.4
	S	-	-	-	-
112360	N	-	-	0.4	1.3
	S	-	-	-	-
Totals		**1.1**	**26.6**	**58.09**	**37.8**
				Sum of Totals	**124.4**

3.4 Viability of Level for Level Storage

3.4.1 Initial Assessment of Viability

The Environment Agency has confirmed that level for level storage is considered preferential when providing compensatory storage. The total volume of floodplain storage lost is 124.4m^3 as summarised above and is lost between a level of 63.0mAOD (lowest ground level) and 63.74mAOD (maximum predicted flood level).

An assessment of the availability of suitable land to provide the compensatory storage has been undertaken in the vicinity of the site. 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 LOD 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 LOD boundary indicate that insufficient area is available to provide level for level storage.

Outside of the LOD boundary, the area identified within Figure 6 provides the potential for level for level storage. This was confirmed through the checking of ground levels based on LiDAR data as summarised in Figure 7. Cross sections taken along and across the area also confirm the mitigation potential as highlighted by Figure 8 .

This area is a redundant rail embankment structure. Network Rail has confirmed that this area is available for use as compensatory storage. As such a detailed viability assessment was undertaken.

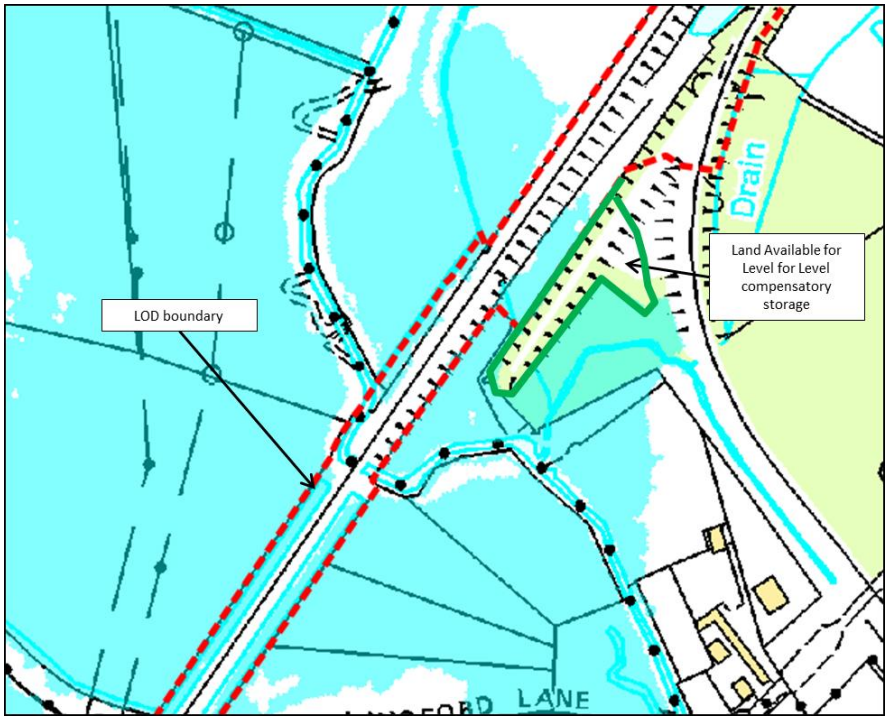

Figure 6 – Location considered for provision of level for level storage.

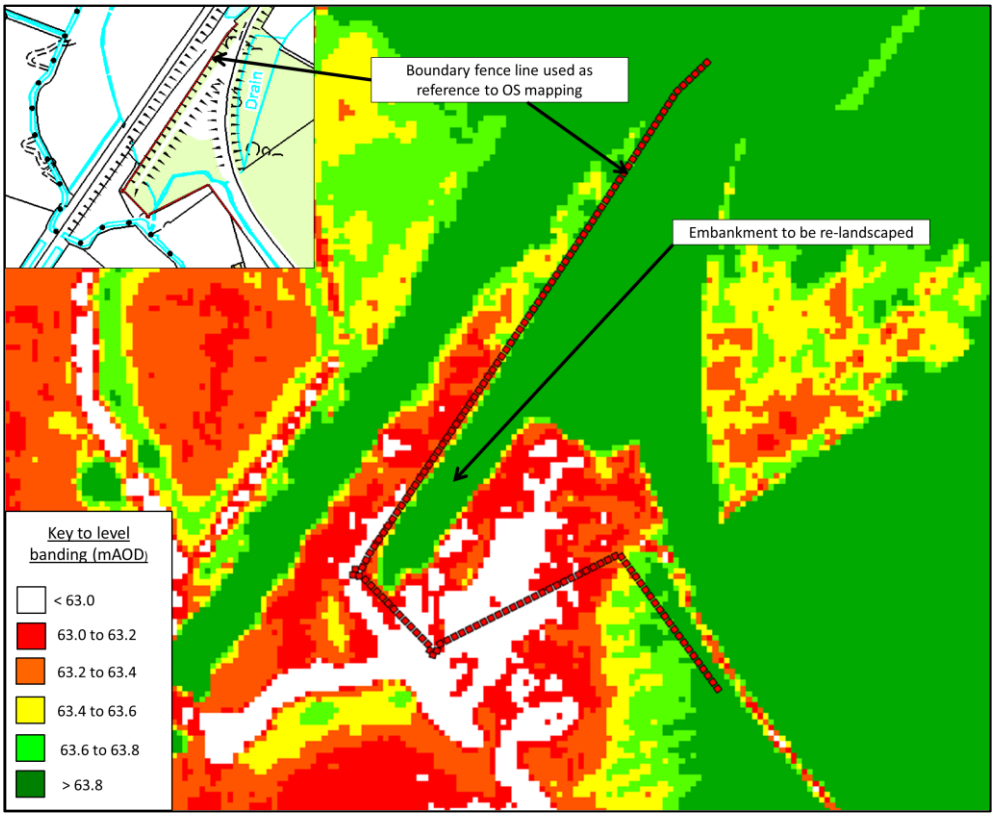

Figure 7 – Topographic assessment using LiDAR – highlighting the potential for the existing redundant berm to be re-landscaped and provide flood mitigation.

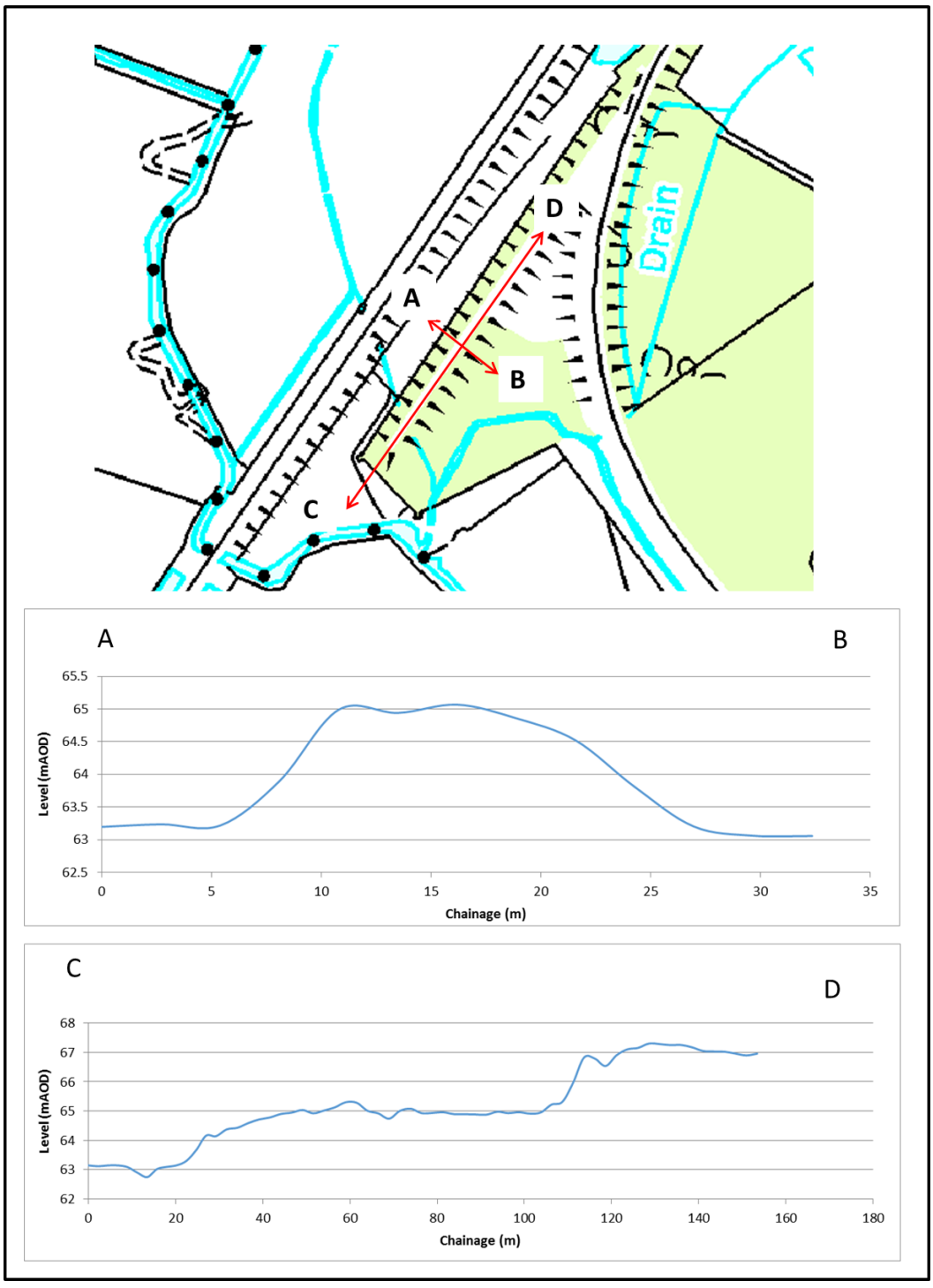

Figure 8 – Topography of this redundant railway embankment – based on LiDAR (2m resolution).

3.4.2 Detailed Assessment of Viability

The analysis is worked from south to north, along the disused embankment feature. This ensures the flood mitigation is hydraulically connected to the predicted flood extent and removes the risk of the provision of storage isolated from the flood waters.

First an approximate plan area was calculated that would be required to compensate at the various level bands. Given the level bands have been calculated at 0.2m intervals, the total compensatory volume lost at each band was multiplied by 0.2 to allow a plan area to be achieved.

The embankment is approximately 18m in width (this is a conservative estimate). Using this figure, the required distance along the embankment which would be required to be removed can be assessed. Atkins confirmed that any slopes to be designed should meet a 1 in 2.5 gradient.

Using the information and data collated a proposed landscaping long section has been created as shown by Figure 9. The change in ground level proposed is outlined in more detail within Table 2. Through this assessment it is predicted that re-landscaping would be required up to approximately 25m away from the foot of the embankment.

Confirmation that this area of works (450m^2) will achieve the required storage was carried out through a point inspection of all DTM LiDAR grid cells within this area.

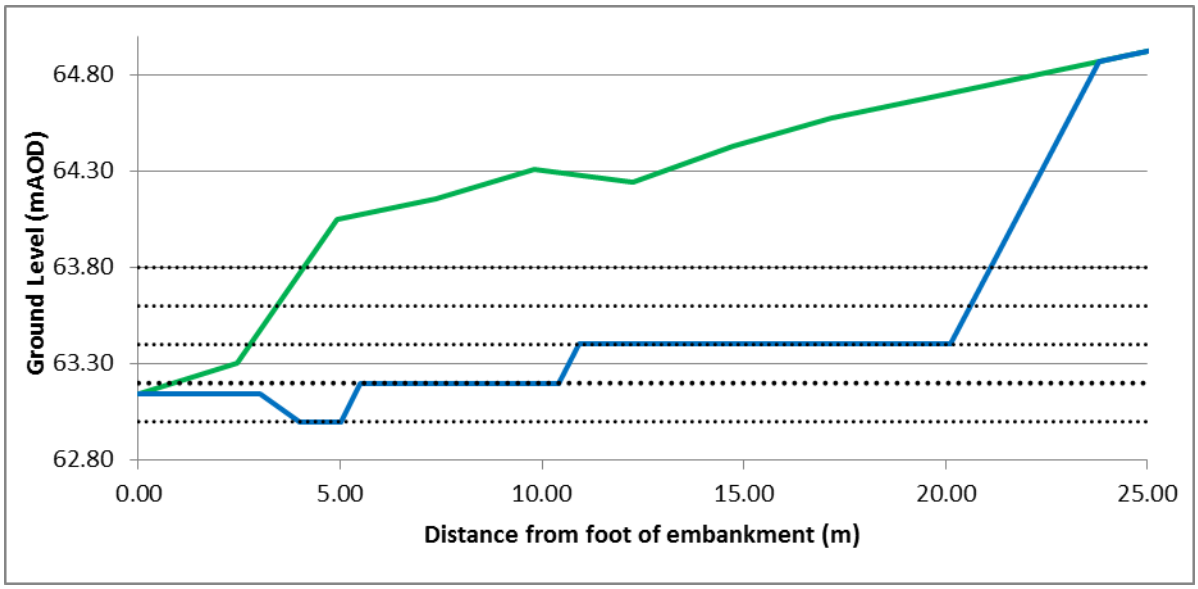

Figure 9 – Proposed re-landscaping of embankment to allow for level for level flood compensatory storage (Green = Existing topography, Blue = Proposed, Black dash = 0.2m banding for guidance)

Table 2 – Ground level (existing and proposed) with chainage along berm from the foot of the embankment.

Existing Topography		Proposed Re-landscaping	
Distance from foot of embankment (m)	Ground level (mAOD)	Distance from for of embankment (m)	Ground level (mAOD)
0.00	63.15	0.00	63.15
2.45	63.30	3.00	63.15
4.91	64.05	4.00	63.00
7.36	64.16	5.00	63.00
9.81	64.31	5.50	63.20
12.26	64.24	10.40	63.20
14.72	64.43	10.90	63.40
17.17	64.58	20.12	63.40
19.62	64.68	23.80	64.87
24.53	64.90	24.53	64.90
26.98	65.01	26.98	65.01

Figure 10 – Proposed area of re-landscaping required for level for level storage mitigation

3.4.1 Compensation design

Following on from WHS recommendations, Atkins have provided final designs to show the proposed mitigation for construction. The final design is based on more detailed site topography.

Based on this, an increased length of embankment will be removed 30m back from the point at which the highest depth banding is reached (63.6-63.8mAOD) to achieve the required volumes based on more detailed topographic data. This will also result in provision of over compensation of volume. Appendix 1 of this report includes the design drawings provided by Atkins in May 2014.

4 Conclusions

The key conclusions of this FRA are as follows:

- The proposed MOD Sidings embankment widening would lead to a reduction in floodplain storage assessed to be a loss of 124.4m^3.
- Flood compensation on a level for level basis can be achieved through the removal and re-landscaping of part of an existing redundant rail embankment.
- The location of the flood compensation is outside the LOD Boundary, however Network Rail have confirmed that the land is available for use in this manner.
- The proposed mitigation volumes designed by Atkins to achieve level for level storage will result in a net gain in floodplain storage as a result of the proposed development.

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 16 metres of the Langford Brook or 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 MOD Sidings 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.

Appendix 1

Drawing Number 5114534-ATK-DRG-GE-070121 B02

UNDERBRIDGE OXD40 (BROOK)
REFER TO DRG 5114534-ATK-DRG-CV-001211

REGRADE WITH CESS SUPPORT WALL (ASSET 9)
REFER TO DRG 5114534-ATK-DRG-GE-070162

REGRADE (ASSET 8)
REFER TO DRG 5114534-ATK-DRG-GE-070156

REGRADE AND GABION TOE WALL
(ASSET 6) REFER TO DRG
5114534-ATK-DRG-GE-070152

STRUCTURE INTERFACE

CULVERT OXD 20M 37CH
REFER TO STRUCTURES STRATEGY REPORT
5114534-ATK-CST-RPT-04001

1.5 m GABION HEIGHT

FINISHED GROUND LEVELS AT TOE OF GABION WALL TO FALL FROM APPROXIMATELY 63.600 AT CH112400m TO 63.300 AT CH112420m

OVERHEAD CABLES

WATERCOURSE

DN 112527

DN 112411

DOWN BLETCHLEY

UP BLETCHLEY

UP 112544

UP 112540

UP 112520

UP 112500

UP 112480

UP 112460

UP 112421

UP 112414

REFER TO DRG 5114534-ATK-DRG-GE-070131

GABION HEIGHT 1.5 m

GABION HEIGHT 1.0 m

CULVERT OXD 20M 37CH
REFER TO STRUCTURES STRATEGY REPORT
5114534-ATK-CST-RPT-04001

REGRADE AND GABION TOE WALL (ASSET 6)
REFER TO DRG 5114534-ATK-DRG-GE-070152

REGRADE (ASSET 8)
REFER TO DRG 5114534-ATK-DRG-GE-070156

REGRADE AND GABION TOE WALL
(ASSET 6) REFER TO DRG
5114534-ATK-DRG-GE-070152

FINISHED EARTHWORK SLOPE TO BE REGRADED TO 1V:2.5H AND TIED INTO EXISTING EMBANKMENT OVER 5m MIN. LENGTH

EXISTING EMBANKMENT TO BE REMOVED DOWN TO A FINISHED LEVEL OF 63.15m ALLOWING FOR 150mm TOPSOIL COVER TO PROVIDE FLOOD STORAGE COMPENSATION

Pond

MATCHLINE FOR CONTINUATION SEE DRG. No.5114534-ATK-DRG-GE-001047

MATCHLINE FOR CONTINUATION SEE DRG. No.5114534-ATK-DRG-GE-070122

NOTES:

1. DO NOT SCALE THIS DRAWING.
2. CHAINAGE SHOWN ON DRAWING IS PROJECT SPECIFIC IN METRES AND REFERENCED TO DOWN BLETCHLEY LINE.
3. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.
4. ALL LEVELS IN METRES TO PROJECT DATUM.
5. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH DRAWING 5114534-ATK-DRG-GE-070120.
6. DRAWING BASED ON TRACK MODEL REFERENCE 5114534-ATK-MOD-TR-000052 AND SURVEY MODEL REFERENCE 5114534-MOD-SU-000001.
7. DRAINAGE OMITTED FOR CLARITY. REFER TO 5114534-ATK-DRG-DR-200000 SERIES DRAWINGS FOR DETAILS.
8. SUBJECT TO THE FINDINGS OF ADDITIONAL NEWT SURVEYS THE CONSTRUCTION OF A NEWT RELOCATION POND MAY BE REQUIRED WITHIN THE EXTENT OF THE PROPOSED EARTHWORKS. THE LOCATION AND DETAILS OF ANY NEWT RELOCATION PONDS SHALL BE SUBJECT TO A SEPARATE SUBMISSION.

LEGEND:

- PROPOSED TRACK ALIGNMENT
- CESS
- SLOPE
- BERM
- TRANSITION ZONE
- BACKFILLING OF EXISTING DITCH
- SHEET PILE WALL
- GABION WALL (INDICATED GABION HEIGHTS INCLUDE ALLOWANCE FOR 0.5m BELOW GROUND EMBEDMENT
- CESS SUPPORT WALL
- NEW NETWORK RAIL BOUNDARY
- SETTING OUT POINT
- SETTLEMENT MONITORING POINT (REFER TO DRG. 5114534-ATK-DRG-GE-070189)
- TYPICAL DESIGN SECTION
- HAZARD LOCATION

AFFECTED SERVICES:

- HV EHV MAIN (OVERHEAD)

Rev	Date	Description of Revisions	Drawn	Chkd	Appr
B02	06/05/14	OXD40 TIE-IN & FLOOD COMPENSATION	BS	JPB	RD

Status: FOR APPROVAL

Chiltern Railways
Marylebone Station,
Great Central House,
Melcombe Place,
London, NW1 6JJ

NetworkRail

Contractor(s)

ATKINS
The Axis
10 Holliday Street
Birmingham
West Midlands
B1 1TF
Tel: +44 (0)121 483 5000
Fax: +44 (0)121 483 6333

Project: EAST WEST RAIL PHASE 1

Drawing Title: GENERAL ARRANGEMENT OXD LINE AND MOD SIDINGS EARTHWORKS

Designed	J.BARKER	Signed	Date 03/12/2013
Drawn	G.ALLEN	Signed	Date 03/12/2013
Checked	S.BUTLER	Signed	Date 03/12/2013
Approved	R.DOWN	Signed	Date 03/12/2013
Scale(s)	1:250 @ A1	ELR & Mileage	OXD
Alternative Reference	112545 TO 112395	Sheet	1 of 9
Drawing Number	5114534-ATK-DRG-GE-070121	Revision	B02