

Appendix 10-1

Flood Risk Assessment

East Reading Mass Rapid Transit Scheme

Flood Risk Assessment



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Executive Summary

This Flood Risk Assessment (FRA) has been prepared by Peter Brett Associates LLP (PBA) to support a planning application for the proposed East Reading Mass Rapid Transit (MRT) scheme to the east of Reading town centre.

The East MRT scheme is a segregated fast track public transport, pedestrian and cycle route that will support enhanced accessibility and continued sustainable growth in Reading, Wokingham Borough and the wider area. The purpose of the East Reading MRT scheme is to improve the attractiveness of travelling more sustainably, therefore reducing private car trips, easing forecast congestion and air quality along the existing highway network, particularly on the A4 corridor.

The East MRT is proposed to link the A3290 at Thames Valley Park, from a proposed new Park & Ride facility, to Napier Road, Reading town centre and the railway station. It will run to the south of the River Thames and crosses the River Kennet at Kennetmouth.

The Environment Agency (EA) Flood Zone map and detailed hydraulic modelling indicates the proposed East MRT route on the west side of Kennetmouth lies within Flood Zone 2 'Medium Probability' of the River Thames, defined as follows:

Flood Zone 2 'Medium Probability' (between a 1 in 100 (1%) and 1 in 1,000 (0.1%) annual probability of river flooding),

On the east side of Kennetmouth, the route lies in **Flood Zone 3b 'Functional Floodplain'**, until it reaches the Thames Valley Park and Ride site in Flood Zone 1 'Low Probability' ((less than 1 in 1,000 (0.1%) annual probability of river or sea flooding).

Flood Zone 3b 'Functional Floodplain' (land where water has to flow or be stored)

The proposed development consists of '*Essential Infrastructure*' development which is considered appropriate within Flood Zone 2 and Flood Zone 3a, and acceptable in Flood Zone 3b subject to the Exception Test (ref: (reference National Planning Policy Framework (NPPF) Planning Practice Guidance Table 3).

In considering the proposals, the following key aspects have been addressed:-

- Vulnerability to flooding from all sources.
- No increased flood risk to third parties as a result of the development.

Flood risk will be appropriately mitigated through measures including:

- The proposed bridge soffit levels are set in excess of a minimum of 600mm above the modelled 1 in 100 (1%) annual probability plus climate change flood level, in accordance with EA and Reading Borough Council (RBC) requirements to address flood risk.
- The proposed bridge soffit corresponds with the adjacent structures, providing headroom clearance of 6.8 metres above SHWL at the centre of the navigation channel, to meet the navigation constraints for this reach of the River Thames and Kennet.
- A flood compensation scheme to mitigate impacts on floodplain storage capacity.
- The proposed development will not have a detrimental impact on floodplain storage capacity or flow routes over the proposed route, up to the modelled 1 in 100 (1%) annual probability plus appropriate climate change flood level.

- Incorporation of surface water drainage arrangements to ensure no detrimental impact on surface water and no increase in flood risk elsewhere.

As such, the FRA confirms that the development is safe, it does not increase flood risk and does not detrimentally affect third parties, in accordance with the objectives of the NPPF.

1 Introduction

1.1 Scope of Flood Risk Assessment (FRA)

- 1.1.1 This Flood Risk Assessment (FRA) has been prepared by Peter Brett Associates LLP (PBA) on behalf of Reading Borough Council (RBC) Highways and Transport Department, to support a planning application for the proposed East Reading Mass Rapid Transit (MRT) scheme.
- 1.1.2 The scheme consists of the construction of a segregated fast-track public transport, pedestrian and cycle bridge and viaduct, comprising concrete bridge structure with a river span of 59.5m and a land span of 316m, supported by concrete columns, steel beams and reinforced soil embankment, together with new footpath links and existing footpath alterations, replacement supermarket car parking provision, junction improvements and landscaping
- 1.1.3 The report is based on the available flood risk information for the site as detailed in **Section 1.2**, and prepared in accordance with the planning policy requirements set out in **Section 1.3**. The scope of the FRA is consistent with the 'Site-specific Flood Risk Assessment Checklist' from the National Planning Policy Framework (NPPF) Planning Practice Guidance:

<https://www.gov.uk/guidance/flood-risk-and-coastal-change#Site-Specific-Flood-Risk-Assessment-checklist-section>

- 1.1.4 The FRA focuses on assessing the practical flood risk issues at the site as follows:
- Identification of all the potential sources of flooding at the site from all sources (i.e. fluvial, tidal, pluvial, groundwater, surface water);
 - Assessment of the existing flood risk at the site and the potential impact of the proposals;
 - Consideration of the flood risk implications, taking into account the potential allowance for climate change over the lifetime of the development, and the identification of the measures to mitigate flood risk.
- 1.1.5 PBA has many years of experience in, amongst other areas, the assessment of flood risk, hydrology, flood defence and river engineering.

1.2 Sources of Information

- 1.2.1 The FRA has been prepared based on the following sources of flood risk information (as the development lies across both Reading Borough and Wokingham Borough, flood risk documents from both planning authorities are referenced):
- **Topographic survey** of the study area by MK Surveys (drawing reference 22109, sheets 1-5, dated April 2016);
 - **Proposed development drawings** prepared by PBA;
 - Environment Agency (EA) **online flood maps** (<http://maps.environment-agency.gov.uk/wiyby/>);
 - **EA Product 4 flood data** (EA reference **BE_1310_01**, dated July 2016);
 - **EA Product 7 flood data** (received April 2016), providing the EA Thames (Reading Complex Change) 1D-2D hydraulic model, re-run by PBA to generate flood levels based on the new EA climate change allowance requirements;

- The Reading Borough Council (RBC) **Strategic Flood Risk Assessment (SFRA)**, released in March 2009;
- The **RBC Preliminary Flood Risk Assessment (PFRA)**, released in June 2011.
- The **Wokingham Borough Council Strategic Flood Risk Assessment (SFRA)** dated February 2012;
- The **Wokingham Borough Council (WBC) Preliminary Flood Risk Assessment (PFRA)** dated June 2011.

1.3 Policy Context

- 1.3.1 This FRA has been prepared in accordance with the relevant national, regional and local planning policy and statutory authority guidance as follows:

- National policy regarding flood risk as contained within the **National Planning Policy Framework (NPPF)** dated March 2012, issued by Communities and Local Government, the online **Planning Practice Guidance** released in March 2014 (updated April 2015), and the EA '**Flood Risk Assessments: Climate Change Allowances**' guidance released in February 2016;
- Local policy contained within the Reading Borough Local Development Framework '**Core Strategy**', adopted January 2008, with alteration adopted January 2015, with specific reference to Policy '**CS35: Flooding**' which states:

"Planning permission will not be permitted for development in an area identified as being at high risk of flooding, where development would reduce the capacity of the flood plain to store floodwater, impede the flow of floodwater or in any way increase the risks to life and property arising from flooding."

- Local planning policy contained within the '**Wokingham Borough Local Development Framework Adopted Core Strategy Development Plan Document**' dated January 2010. **Policy CP1 – Sustainable Development** states:

'Planning permission will be granted for development proposals that avoid increasing (and where possible reduce) risks of or from all forms of flooding (including from groundwater).

It is essential that future development is planned carefully... steering it away from areas that are most at risk from flooding and ensuring that it does not exacerbate existing flooding problems.

It is essential that the developer/ applicant consider the possible change in flood risk over the lifetime of the development because of climate change.

SUDS can be used to minimise the risk and impact of flooding. Developers will be expected to provide and fund effective SUDS maintenance regimes. New development should be designed to be resilient to flooding as appropriate';

1.4 Caveats and Exclusions

- 1.4.1 This FRA has been prepared in accordance with the NPPF and Local Planning Policy. The proposed flood management and surface water management strategies are based on the relevant British Standards (BS8533), the standing advice provided by the EA or based on common practice.

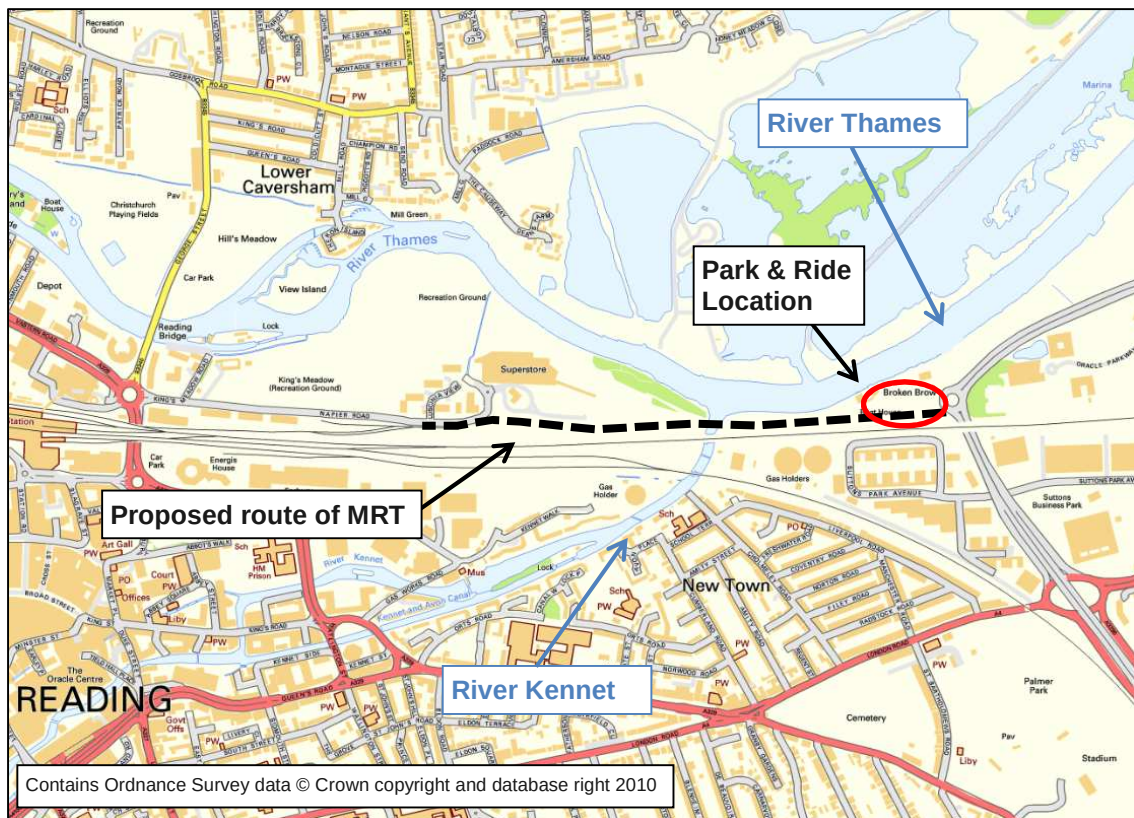
- 1.4.2 The Construction (Design and Management) Regulations 2015 (CDM Regulations) will apply to any future development of this site which involves “construction” work, as defined by the CDM Regulations.
- 1.4.3 The approach for the FRA and proposals for the surface water management strategy are based on the requirements of the EA and RBC/WBC in their role as Lead Local Flood Authorities (LLFAs) over parts of the site.
- 1.4.4 The findings of this FRA are based on data available at the time of the study and on the subsequent assessment that has been undertaken to date but we would recommend the end user reviews the validity of the flood data on an annual basis with the EA. They relate to current development proposals as outlined in **Section 5**.

2 Site Setting

2.1 Site Description

- 2.1.1 The East Reading Mass Rapid Transit (MRT) scheme is intended to provide a dedicated public transport link between the centre of Reading in the east to the recently approved Park and Ride facility at Thames Valley Park to the west (TVP P&R).
- 2.1.2 The proposed East MRT runs from Napier Road along a route to the immediate south of the Tesco Extra superstore and carpark (parallel with the railway line to the south), crossing the River Kennet at Kennetmouth, and continuing west along a corridor between the River Thames and the railway line and adjacent to the TVP P&R.
- 2.1.3 The site west of the River Kennet the site lies within the administrative boundary of the Borough of Reading, whereas the land east of the River Kennet lies within Wokingham Borough.

Figure 2.1: Site Location



2.2 Topography

- 2.2.1 Topography survey has been obtained for the proposed route and surrounding area. This is detailed on 'Drawing 2210/1' – 'Drawing 2210/4' (dated April 2016) in **Appendix A**.
- 2.2.2 The data for the site indicates a wide variation in ground levels from Napier Road towards Thames Valley Park. Ground levels on Napier Road at the junction with Luscinia View are approximately 36.9m AOD, rising towards the Tesco superstore roundabout at approximately 37.7m AOD.

- 2.2.3 Levels on the existing Tesco Extra store access road vary between 37.3m AOD and 37.5m AOD, with similar levels in the car parking area.
- 2.2.4 East of the Tesco superstore and west of the River Kennet, there is a large wooded/landscaped area with levels ranging between 37.0m AOD and 37.5m AOD.
- 2.2.5 To the east of the River Kennet, levels are at approximately 36m AOD on the tarmac footpath by the River Thames, with some isolated areas located at lower elevations.
- 2.2.6 Levels rise from this area towards the Thames Valley Park Drive roundabout where levels range between 37.5m AOD and 38.9m AOD (see **Figure 3.4**).

2.3 Watercourses and Flood Defences

- 2.3.1 The **River Thames** is the dominant watercourse in the study area, flowing east through the area and separating Reading from Caversham.
- 2.3.2 The River Thames passes through Caversham Lock approximately 1.2km upstream of the proposed route, and Sonning Lock approximately 3.5km downstream of the proposed route. Sonning Lock maintains a Standard Head Water Level (SHWL) within the upstream reach at a level of 35.15m AOD for navigation purposes.

Figure 2.2: View east along River Thames at Kennetmouth



- 2.3.3 In this location, the Caversham Lakes lies on the north side of the river; a series of lakes created by gravel extraction works between Caversham and Sonning Eye which incorporate a marina and the Redgrave Pinsent Rowing Lake, which opened in 2006.
- 2.3.4 The **River Kennet** is the second major watercourse in the Reading area. The Kennet flows through the centre of Reading, partly as the Kennet and Avon Canal.
- 2.3.5 After passing through Blake's Lock, the River Kennet flows under two railway bridges and the listed Horseshoe Bridge at Kennetmouth before it outfalls into the River Thames.

Figure 2.3: View north along River Kennet towards Thames Confluence at Kennetmouth



2.4 Geology

- 2.4.1 Detailed geotechnical investigations have been undertaken by PBA in support of the scheme in the 'Phase 1 Ground Condition Assessment' (PBA, July 2016), and the 'Phase 2 Ground Condition Assessment' (PBA, May 2017).
- 2.4.2 The Phase 2 report provides an overview of the ground conditions as follows:

"The ground conditions revealed by the investigations comprise Made Ground to between 1.5 and 2.20 m depth overlying Alluvium to between 2.5 and 3.9 m depth, River Terrace Deposits to between 5.4 and 8.0 m depth and Chalk a maximum investigated depth of 25 m. Groundwater level was measured between about 1.6 and 2.4 m depth with a hydraulic gradient in a general direction to the north-east towards the River Thames".

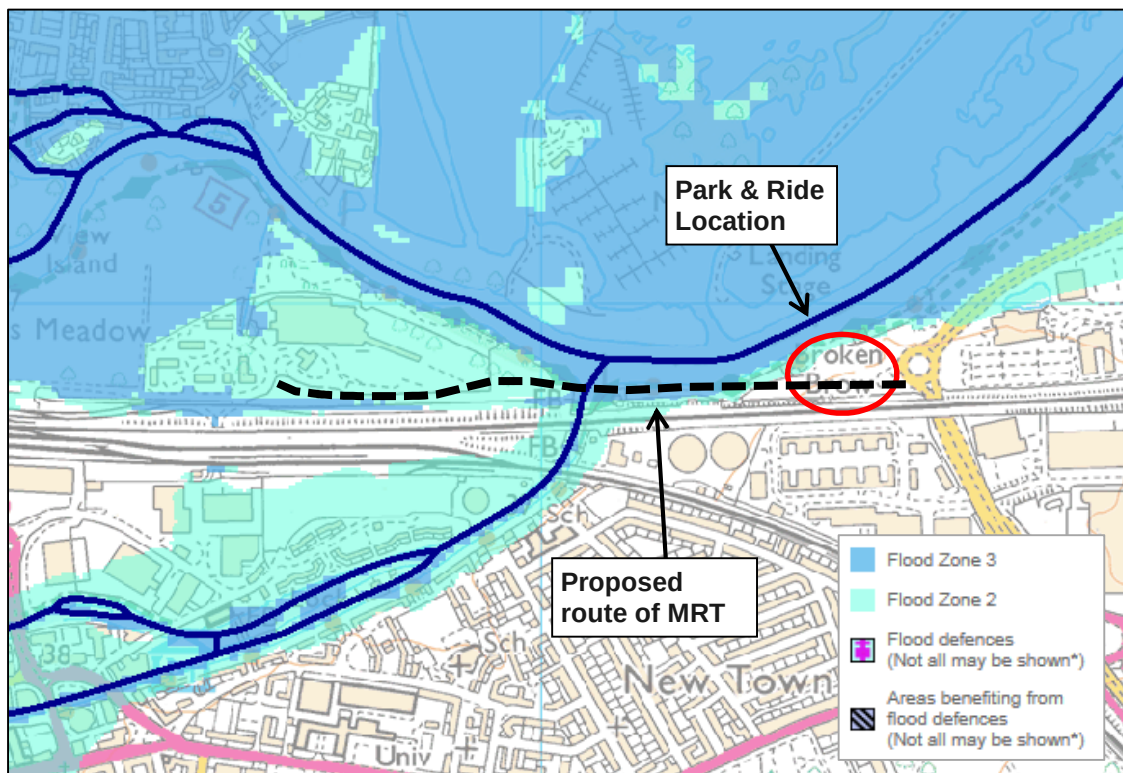
3 Flood Risk

3.1 EA Flood Maps

Flood Zone Map

- 3.1.1 The first phase in identifying whether a site is potentially at risk of flooding is to consult the EA's online Flood Zone map (**Figure 3.1**). This provides an initial indication of the probability of fluvial/tidal flooding to an area, which is refined by the use of more detailed site-specific level survey and modelled flood levels.

Figure 3.1: EA Flood Zone Map



- 3.1.2 The Flood Zone map indicates that the land on the west side of the confluence of the River Kennet, lies within **Flood Zone 2 'Medium Probability'** (between a 1 in 100 (1%) and 1 in 1,000 (0.1%) annual probability of river flooding). There is a narrow corridor of **Flood Zone 3 'High Probability'** (1 in 100 (1%) or greater annual probability of river flooding) which runs partly along the southern side of the Tesco site and south of the proposed route.
- 3.1.3 On the east side of Kennetmouth, the route lies in **Flood Zone 3 'High Probability'**, until it runs adjacent to the TVP P&R in **Flood Zone 1 'Low Probability'** ((less than 1 in 1,000 (0.1%) annual probability of river or sea flooding).
- 3.1.4 The Flood Zone map does not differentiate between Flood Zone 3a 'High Probability' and Flood Zone 3b 'Functional Floodplain' – the area of 'Flood Zone 3' encompasses both Zones 3a and 3b and further detailed analysis is required to delineate between the two.

EA Flood Risk from Reservoirs Map

3.1.5 The EA provide maps showing the risk of flooding in the event of a breach from reservoirs, based only on large reservoirs (over 25,000 cubic metres of water). These confirm that the site is partially at risk of flooding from a reservoir breach, around the confluence of the River Kennet and the River Thames. This analysis is based on modelling of a breach in the Whiteknights Reservoir, approximately 1.7km to the south-west of the proposed route, in the grounds of Reading University (the only designated reservoir in the Reading area).

3.1.6 The EA are the enforcement authority for the Reservoirs Act (1975) and all large raised reservoirs are inspected and supervised by reservoir panel engineers. The EA website states:

'Reservoir flooding is extremely unlikely to happen. There has been no loss of life in the UK from reservoir flooding since 1925. All large reservoirs must be inspected and supervised by reservoir panel engineers. As the enforcement authority for the Reservoirs Act 1975 in England, we ensure that reservoirs are inspected regularly and essential safety work is carried out'.

3.1.7 The risk of such an occurrence is therefore considered negligible.

EA Surface Water Flood Risk Map

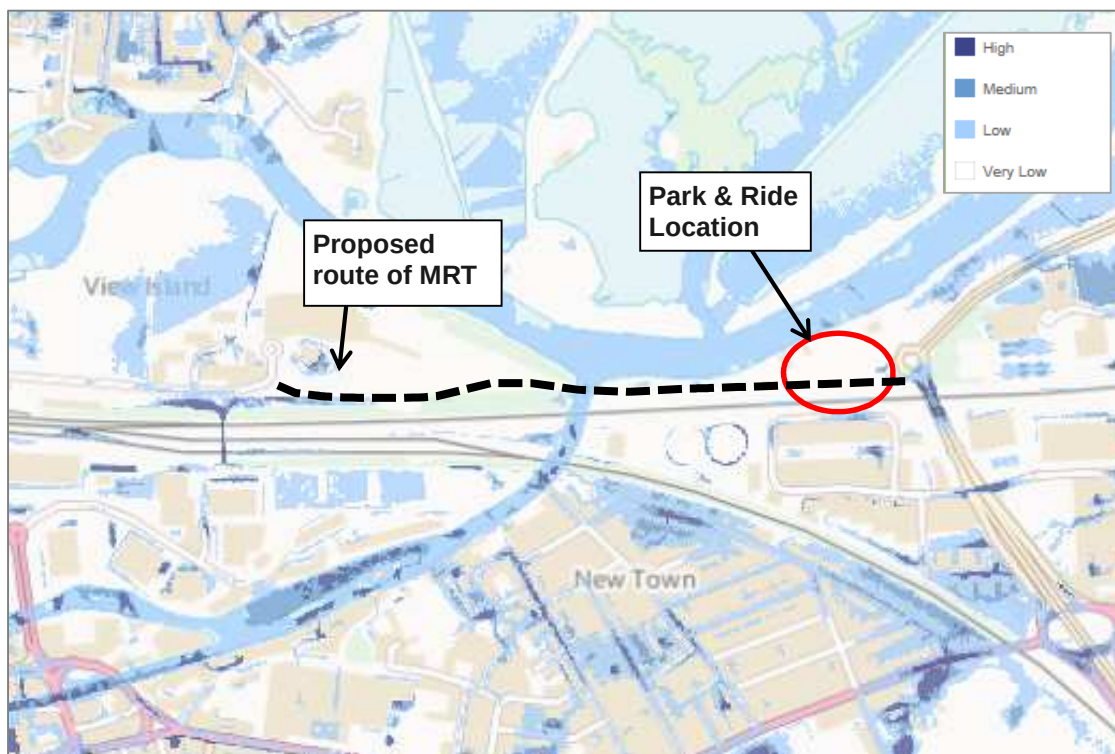
3.1.8 The EA 'updated Flood Map for Surface Water' ('uFMfSW') shows where areas could be potentially susceptible to surface water flooding in an extreme rainfall event. The latest mapping assesses flooding resulting from severe rainfall events based on the following three scenarios:

- 1 in 30 (3.3%) annual probability rainfall event ('High' risk);
- 1 in 100 (1%) annual probability rainfall event ('Medium' risk);
- 1 in 1000 (0.1%) annual probability rainfall event ('Low' risk).

3.1.9 The EA have released an online 'Flood Risk from Surface Water' map, which is reproduced in **Figure 3.2**.

3.1.10 This shows that the proposed East MRT predominately lies in an area at 'Very Low' risk of flooding from surface water (i.e. less than 1 in 1000 (0.1%) annual probability of surface water flooding).

Figure 3.2: EA Surface Water Flood Risk Map

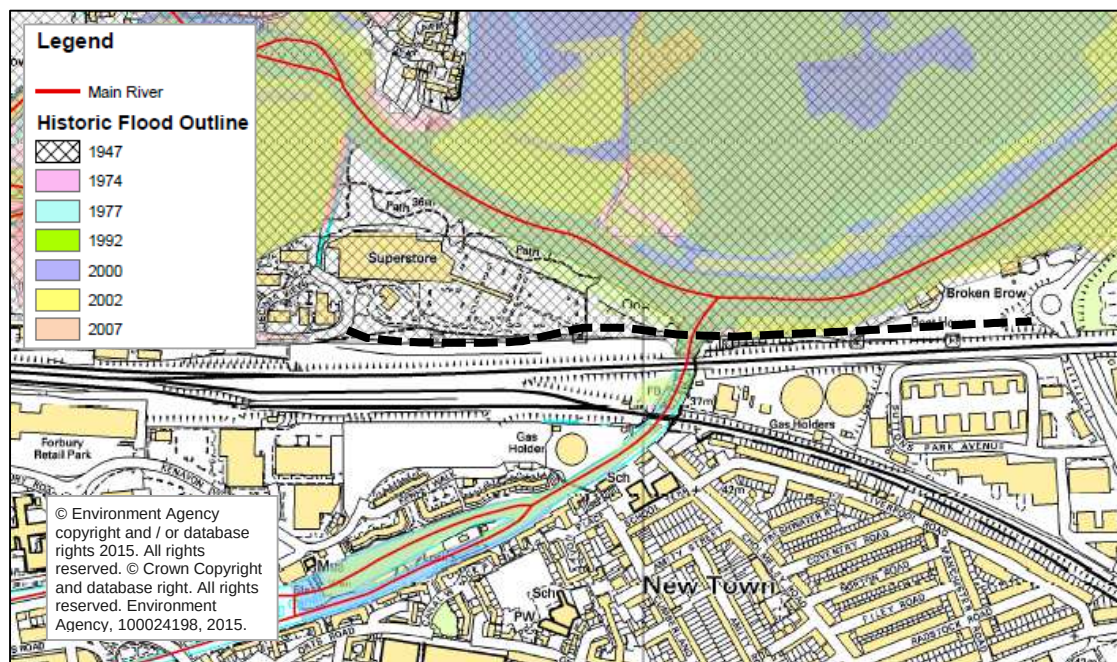


- 3.1.11 It should be noted that the surface water maps are generated using a generic methodology on a national scale, whereby rainfall is routed over a ground surface model. The analysis does not take account of any specific local information on below-ground drainage infrastructure and infiltration, although an adjustment is included in urban areas to account for the impact of sewerage and a standard infiltration allowance based on soil type. Consequently, the mapping provides a guide to potentially vulnerable areas based on the general topography of an area.

EA Historic Flood Map

- 3.1.12 The historic flood map provided as part of the EA Product 4 data shows the impacts to the area of a range of floods, on both the River Thames and River Kennet.
- 3.1.13 As shown on **Figure 3.3**, the proposed East MRT route to the west of Kennetmouth is largely unaffected by the recorded flood events, with the exception of the major flood of 1947, which is shown to have affected the area now occupied by the Tesco Extra store and car parking. The 1947 flood was the greatest flood of the last century (and the greatest flood since 1894) and was largely due to rare meteorological circumstances whereby an extensive period of heavy snowfall was rapidly followed by a rapid thaw combined with heavy rainfall, which could not percolate into the still frozen ground.

Figure 3.3: EA Historic Flood Map



- 3.1.14 The proposed East MRT route over the low lying land over the eastern part of Kennetmouth (see **Figure 3.4**) has been more significantly impacted by flooding in more recent events, with flooding occurring in 1947, 1974, 1992 and 2002. It is probable that other floods affected the area but this is difficult to verify due to the number of layers on the drawing.

Figure 3.4: View west along River Thames footpath (land east of Kennetmouth)



3.2 Preliminary Flood Risk Assessments

RBC Preliminary Flood Risk Assessment

- 3.2.1 The RBC Preliminary Flood Risk Assessment (PFRA) provides a high level screening exercise which involves collecting information on historic and potential future floods for Reading Borough.

The information of specific relevance to the proposed East MRT route west of Kennetmouth is as follows:

- **PFRA Figure 4.2** 'EA Historic Flood Map' indicates the area to the west of the River Kennet is located within the historic floodplain.
- **PFRA Figure 5.2** 'EA Flood Map For Surface Water (FMfSW): 1 in 200 year chance of flooding in any year' indicates some 'Deep (>0.3m)' surface water flooding to the west of the River Kennet, but it is noted that this mapping has been superseded by the updated EA surface water mapping discussed in **Section 3.1**.
- **PFRA Figure 5.4** 'Areas Susceptible to Groundwater Flooding' shows the proposed East MRT route to be located in an area identified as high ('≤75%') potential susceptibility to groundwater flooding. This is based on a relatively coarse analysis of underlying ground conditions (ratings are provided per 1 kilometre square area) rather than specific historic flooding records.

3.2.2 Copies of the aforementioned Figures are provided in **Appendix D**. It should be noted that the resolution of the aforementioned map prevents a clear assessment of the locations, and the impacts, of flooding to the site as they provide a Borough-wide overview.

WBC Preliminary Flood Risk Assessment

3.2.3 The WDC Preliminary Flood Risk Assessment (PFRA) provides a high level screening exercise for Wokingham Borough which involves collecting information on historical and potential future floods for the area. The information of specific relevance to the proposed East MRT route east of Kennetmouth is as follows:

- o **PFRA Figure 5-1** 'Historical Flooding Incidents' does not show the proposed East MRT route as being impacted by flooding, although this mapping appears to concentrate on flooded properties (the route would not therefore be identified, due to the lack of dwellings in the area);
- o **PFRA Figure 6-1** 'Flood Map for Surface Water' shows does not indicate significant surface water flooding over the proposed East MRT route west of Kennetmouth. As noted previously, that this mapping has been superseded by the updated EA surface water mapping discussed in **Section 3.1**;
- o **PFRA Figure 6-2** 'Areas Susceptible to Groundwater Flooding' shows the site is in an area that is at 'very high' (>75%) risk of groundwater flooding (caveats on the applicability of this data have been made when referencing the RBC PFRA);

3.2.4 Copies of the aforementioned Figures are provided in **Appendix D**.

3.3 Strategic Flood Risk Assessments

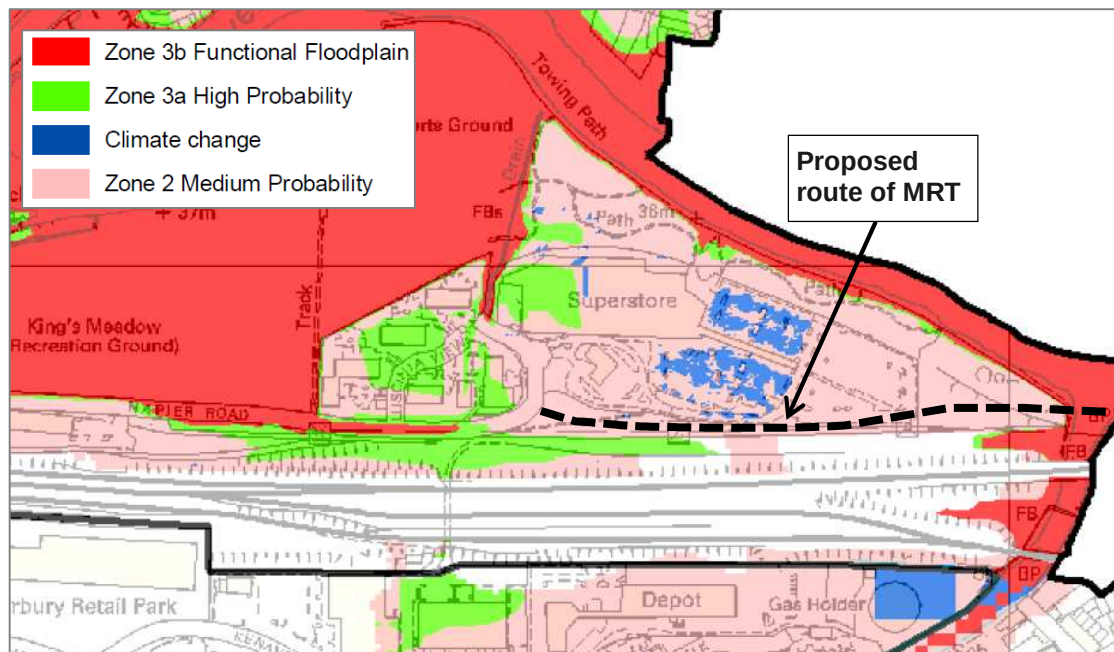
RBC Strategic Flood Risk Assessment

3.3.1 As noted in **Section 1.2**, the RBC Strategic Flood Risk Assessment (SFRA) was released in March 2009 and provides flood risk information on a borough-wide scale, see Figures located in **Appendix D**. The information of specific relevance to the route to the west of Kennetmouth is as follows:

- **SFRA Figure 2** 'Historical River Flooding' indicates the area of land at the western side of the River Kennet is located within the historical floodplain. No information is provided for the land at the eastern side of the River Kennett as this is not located within the Reading Borough boundary;

- **SFRA Figure 3 'City Centre Flood Zone Map'** provides a detailed overview of flood risk to Reading City Centre. The site is shown to be located mostly within Flood Zone 2 'Medium Probability' (pink shading) however the area of the River Kennet is located within Flood Zone 3b;

Figure 3.5: Extract of RBC SFRA Figure 3 'City Centre Flood Zone Map'

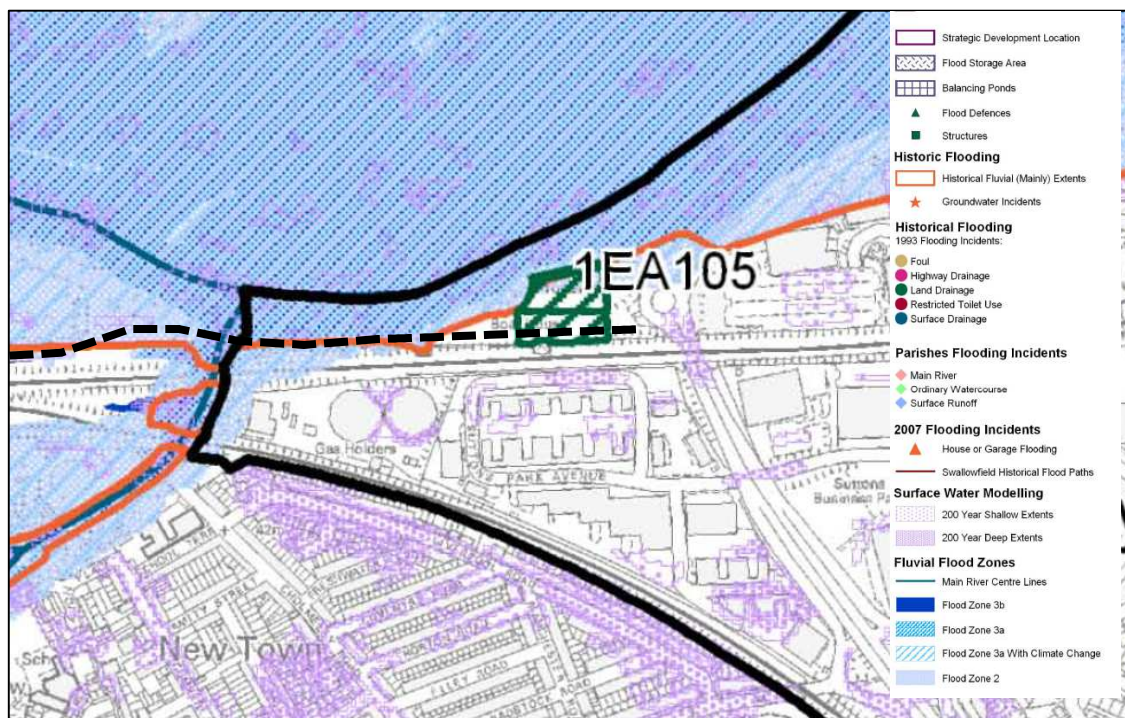


WBC Strategic Flood Risk Assessment

3.3.2 As noted in **Section 1.2**, the WBC Strategic Flood Risk Assessment (SFRA) was released in February 2012 and provides flood risk information on a borough-wide scale, see Figures located in **Appendix D**. The information of specific relevance to the route to the east of Kennetmouth is as follows:

- **SFRA Map 6a-1 and 6a-2 'Historical Flooding'** shows the recorded flood extents for a range of major events across the Borough, from 1947 to 2009. This confirms that the proposed East MRT route east of Kennetmouth has been subject to frequent flooding and was affected in 1947, 1968, 1974, 2003 and 2007. Further events may have impacted the site, but due to the scale of mapping and the amount of data it is not possible to provide further clarification;
- **SFRA Map 6c 'Overview of Fluvial Flood Zones'** indicates the proposed East MRT route east of Kennetmouth lies within Flood Zone 3b 'Functional Floodplain', rising into Flood Zone 2 'Medium Probability' at the TVP P&R site (note, this appears to be from outdated Flood Zone mapping as the current maps – see **Figure 3.1** – shows the TVP P&R in Flood Zone 1 'Low Probability'.
- **SFRA Figure 7-5 'Character Areas Map 5 of 17'** provides an overview of the flood risk information over the site – see **Figure 3.6**. This reconfirms the Flood Zoning above and is also overlaid with surface water flood mapping, although as noted with the RBC SFRA data, the surface water mapping has been updated by the EA and the current best available data in relation to this is shown in **Figure 3.2**.

Figure 3.6: Extract of WBC SFRA Figure 7-5 'Character Areas Map'



3.4 EA Modelled River Thames Flood Data

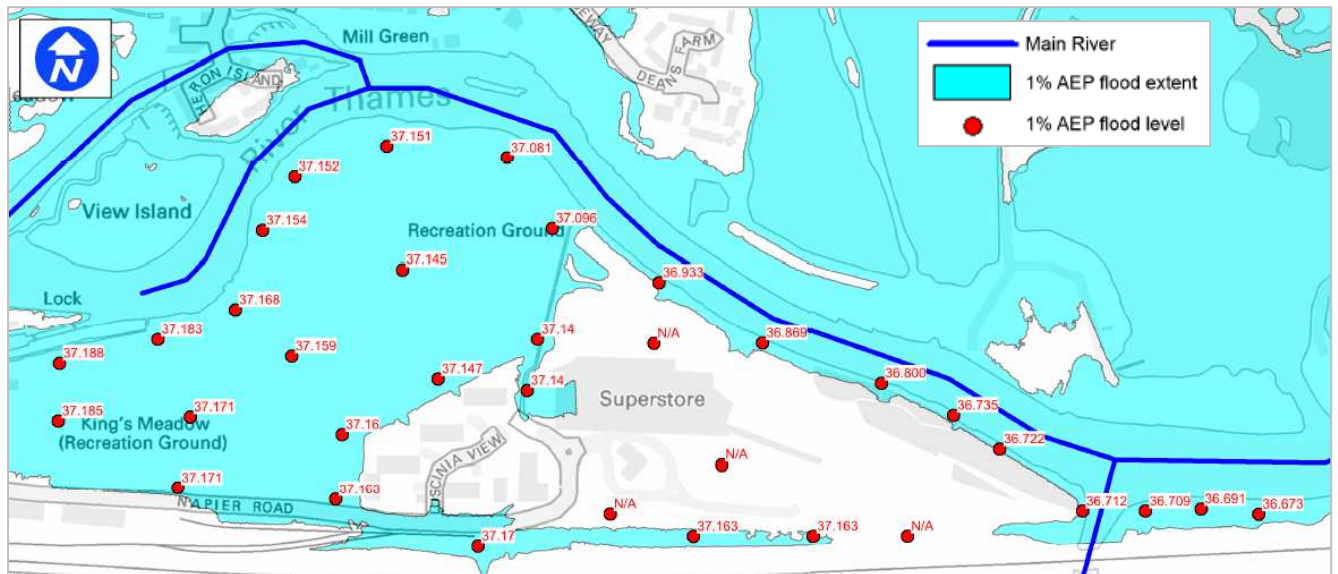
- 3.4.1 The EA have provided detailed flood risk information for area of the proposed route of the East MRT from the River Thames (Reading Complex Change) Flood Alleviation Study completed in June 2011.
- 3.4.2 Hydraulic modelling is also available for the River Kennet (River Kennet Flood Study 2007, Tyle Mill to the Thames confluence). However, a review of the model outputs confirmed that the River Thames was the dominant flood risk in the vicinity and exceeded the equivalent peak flood levels on the River Kennet for a specified annual probability flood event.
- 3.4.3 PBA refined the EA 2-dimensional modelled flood extents in the first instance by re-sampling the EA TUFLOW result grids in conjunction with EA LiDAR data. This provided new area-specific flood extents (with flood level outputs); see **Figures 28791_MI009** and **28791_MI011** in **Appendix E**.
- 3.4.4 More detailed flood extents have been generated using the site-specific topographic survey and are also provided in **Appendix E** (see **PBA Drawing 28791/4001/004** and **PBA Drawing 28791/4001/010**).

Current 1 in 20 (5%) Annual Probability Event

- 3.4.5 Interrogation of the EA hydraulic model confirms that the proposed East MRT route west of Kennetmouth is unaffected in the 1 in 20 (5%) annual probability scenario, although the event does impact across King's Meadow and encroaches on a short length of Napier Road at a flood level of 36.86m AOD.
- 3.4.6 Over the land east of Kennetmouth, the 1 in 20 (5%) annual probability flood level falls from 36.51m AOD to 36.47m AOD along the proposed East MRT route – indicating maximum flood depths of approximately 500mm (note some of this area is also affected in the more frequent 1

Current 1 in 100 (1%) Annual Probability Event

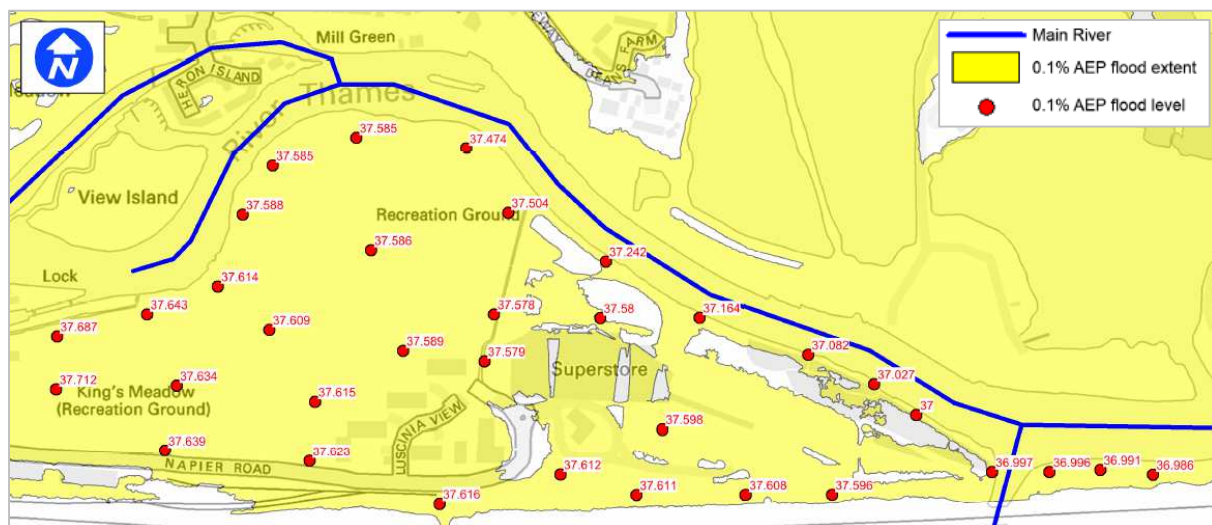
Figure 3.7: EA Modelled 1 in 100 (1%) Annual Probability Flood Extent



3.4.10 The TVP P&R lies on land at above 39.0m AOD and therefore significantly above the modelled 1 in 100 annual probability floodplain by approximately 2 metres.

3.4.11 The extreme 1 in 1000 (0.1%) annual probability event has a significant impact on the area, with flooding extending across the majority of the Tesco Extra store and surrounding car park; see **Figure 3.8**.

Figure 3.8: EA Modelled 1 in 1000 (0.1%) Annual Probability Flood Extent



- 3.4.12 A maximum flood level of 37.62m AOD is generated in the Napier Road/Tesco Extra area – approximately 450mm higher than the 1 in 100 annual probability flood level.
- 3.4.13 The Tesco Extra car park is typically at a level of 37.4m AOD, resulting in maximum flood depths of approximately 200mm. Flooding along Napier Road is to a maximum depth of 720mm.
- 3.4.14 The increase to in-channel flood levels (i.e. from the 1 in 100 annual probability flood level) is typically 250mm to 300mm. At Kennetmouth the extreme 1 in 1000 annual probability flood level is 37.0m AOD, falling gradually with the water surface to approximately 36.63m AOD near the TVP P&R. This compares to existing ground levels at approximately 36.0m AOD, indicated maximum flood depths of typically 600-700mm at this location.
- 3.4.15 The TVP P&R lies on land at above 39.0m AOD and therefore significantly above the modelled 1 in 100 annual probability floodplain by over 2 metres.
- 3.4.16 It is noted that the provided EA model outputs included modelled flood levels for a 1 in 100 annual probability +20% allowance for climate change event. However, this allowance has been superseded by the new climate change allowances in the EA guidance released in February 2016 and the implications of this new guidance are discussed in **Section 4**.

4 Impact of Climate Change

- 4.1.1 In considering flood risk to the site, it is necessary to fully consider the potential impacts of climate change for the lifetime of the development within the mitigation measures.
- 4.1.2 In February 2016 the EA released new guidance on the application of climate change allowances in flood risk assessments:
- <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>
- 4.1.3 This guidance provides contingency allowances for potential increases in peak river flow in Table 1, and for potential increases in rainfall intensity in Table 2. The latter requires consideration in any surface water drainage strategy for new development and is discussed in **Section 6.5**.
- 4.1.4 The peak river flow allowances table provides a range of allowances based on percentile (i.e. the degree of certainty of an event occurring, based on the range of climate change scenarios assessed through scientific investigations). The provided allowances are also subject to the vulnerability classification of the proposed use and the river basin district of the site.
- 4.1.5 The conditions at the site and consequent peak river flow allowances to be considered as part of the FRA are as detailed in **Table 4.1**.

Table 4.1: Climate Change – Peak River Flow Allowances

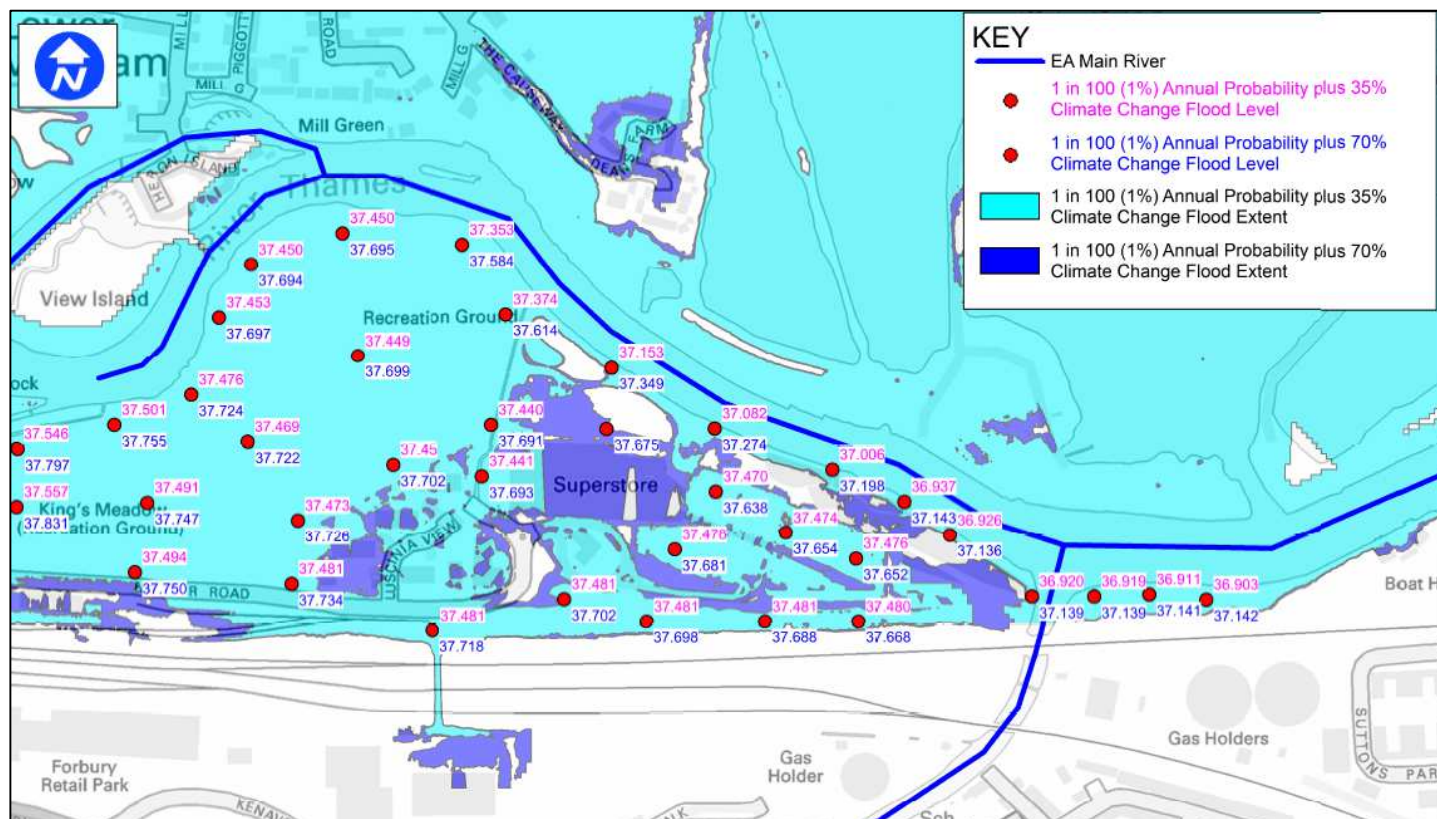
River Basin District	Flood Zone	Flood Risk Vulnerability Classification	Range of Climate Change Allowances requiring consideration (2070–2115)	
			Higher Central	Upper End
Thames	2 (west of Kennetmouth)	Essential Infrastructure	+35%	+70%
	3b (east of Kennetmouth)		-	+70%

- 4.1.6 The EA have previously stated the following (in response to the EIA scoping exercise):

“We expect the new Climate Change allowances (released in February 2016) to be incorporated into the design of the development, with flood risk mitigation design standards built to at least the 35% allowance. However, if, when tested, the upper allowance of 70% shows model outputs with a significant change in risk, we would expect design standards to reflect these. It will be for the applicant to justify which allowance you have used, showing the results of the detailed assessment.”

- 4.1.7 PBA have obtained the EA Thames (Reading Complex Change) 1D-2D hydraulic model and have re-run the model using the new climate change peak river flow allowances for the +35% and +70% scenarios – see PBA Modelling Technical Note in **Appendix F**.
- 4.1.8 The PBA modelled extents are shown in **Figure 4.1** (also see ‘**Drawing 28791_MI012**’ in **Appendix E**). They indicate that most of the proposed route is affected in the +35% ‘Higher Central’ and +70% ‘Upper End’ climate change scenarios.

Figure 4.1: 1 in 100 annual probability +35% and +70% allowances for climate change extents



4.1.9 The modelled climate change scenario flood levels are used as a benchmark in the consideration of mitigation measures as discussed in **Section 6**.

5 Proposed Development and Sequential Test

5.1 Proposed Development

5.1.1 The proposed development is described as follows.

“Construction of a segregated fast-track public transport, pedestrian and cycle bridge and viaduct, comprising concrete bridge structure with a river span of 59.5m and a land span of 316m, supported by concrete columns, steel beams and reinforced soil embankment, together with new footpath links and existing footpath alterations, replacement supermarket car parking provision, junction improvements and landscaping.”

5.1.2 The proposed development comprises the following:

- creation of a new route for public transport only, including cycleway and footway between Napier Road and the A3290 at Thames Valley Park proposed Thames Valley Park and Ride;
- the erection of a new bridge over the River Kennet;
- formation of a new T-junction with Napier Road;
- connection to the proposed Thames Valley Park & Ride;
- development of new and improved footpath links to Tesco and the towpath; and
- associated infrastructure and landscaping.

5.1.3 The route extends from the A3290 and A4 (Thames Valley Business Park) along the southern bank of the River Thames and north of the Great Western Railway Line. The route crosses the mouth of the River Kennet and then travels along Napier Road into to Central Reading.

5.1.4 Details of the proposals by PBA are provided in **Appendix B**.

5.2 Flood Risk Vulnerability

5.2.1 NPPF PPG ‘Flood Risk and Coastal Change’ Table 2 confirms the ‘Flood risk vulnerability classification’ of a site, depending upon the proposed usage. This classification in NPPF PPG ‘Flood Risk and Coastal Change’ Table 2 confirms the ‘Flood risk vulnerability classification’ of a site, depending upon the proposed land usage. This classification is subsequently applied to PPS Table 3 to determine whether:

- The proposed development is suitable for the flood zone in which it is located, and;
- Whether an Exception Test is required for the proposed development.

5.2.2 The analysis undertaken in **Section 3** confirms that the western part of the East MRT lies in **Flood Zone 2 ‘Medium Probability’** while the eastern part lies within **Flood Zone 3b ‘Functional Floodplain’**.

5.2.3 The proposed East MRT is classed as ‘Essential Infrastructure’ development (‘Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk’), which is considered appropriate within Zone 2, and appropriate in Flood Zone 3b subject to the Exception Test.

5.3 NPPF Sequential Test

- 5.3.1 The NPPF follows a sequential risk-based approach in determining the suitability of land for development in flood risk areas, with the intention of steering all new development to the lowest flood risk areas.
- 5.3.2 The Sequential Test is a planning-led exercise to demonstrate that there are no 'reasonably available alternative sites' for the development at lower probability of flooding.
- 5.3.3 Details on the Sequential Test are provided separately in support of the planning application.

5.4 NPPF Exception Test

- 5.4.1 The proposed East MRT route on the east side of Kennetmouth is shown to fall within Flood Zone 3b 'Functional Floodplain'. The Exception Test has been carried out in accordance with the NPPF to demonstrate the significant benefits of the proposed development. The NPPF paragraph 102 states:

"...For the Exception Test to be passed:

it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared; and

a site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall."

- 5.4.2 The first part of the Exception Test is addressed by the significant benefits of the East MRT scheme; a segregated fast track public transport, pedestrian and cycle route that will support enhanced accessibility and continued sustainable growth in Reading, Wokingham Borough and the wider area. The purpose of the East Reading MRT scheme is to improve the attractiveness of travelling more sustainably, therefore reducing private car trips, easing forecast congestion and air quality along the existing highway network, particularly on the A4 corridor.
- 5.4.3 The scheme will seek to achieve the following key aims:
 - Provide a sustainable alternative solution to accommodate future travel demand on the London Road corridor;
 - Increase capacity for movement of people thereby reducing journey times and forecast congestion, as well as improving reliability of journeys along the corridor;
 - Support economic development in Reading Town Centre, east Reading, Wokingham and within the Thames Valley;
 - Develop a high quality, sustainable system which provides a sustainable alternative to the private car;
 - Facilitate a future MRT network for Reading and the Thames Valley;
 - Allow access for mobility impaired and pushchairs.
- 5.4.4 The details provided within this FRA address the second part of the Exception Test and demonstrate that the proposals:

- remain operational and safe for users in times of flood;
- result in no net loss of floodplain storage;
- do not impede water flows and do not increase flood risk elsewhere.

5.4.5 In conclusion, the provided information confirms that the Exception Test has been passed and the proposed development is appropriate, in flood risk terms.

6 Flood Mitigation Strategy

6.1 Introduction

- 6.1.1 The analysis undertaken in **Section 3** confirms that the proposed East MRT route lies partly within Flood Zone 2 'Medium Probability' and partly within Flood Zone 3b 'Functional Floodplain'.
- 6.1.2 The following section provides an overview of the mitigation measures incorporated into the scheme to ensure no detrimental impact, in flood risk terms, to third parties.

6.2 Bridge Soffit Levels

- 6.2.1 The standard EA requirement is for bridge soffit levels to be set a minimum of 600mm above the modelled 1 in 100 annual probability plus allowance for climate change floodplain.
- 6.2.2 The EA provided further information in relation to this in their EIA scoping response which states:

"The soffit of the proposed bridge over the River Kennet will need to be built to a height appropriate to the outcome of the analysis completed with the new Climate Change allowances. We would expect the soffit level to be set at least to the 1 in 100 plus 35% allowance level, as stated above, if your analysis of the upper allowance shows significant impacts on the site, it will be for the applicant to justify which allowance they have applied to this development".

- 6.2.3 The key modelled flood levels at the River Kennet confluence are as follows:
- River Thames SHWL (Sonning Lock) = 35.15m AOD
 - 1 in 100 annual probability level = 36.71m AOD
 - 1 in 100 annual probability +35% climate change allowance level = 36.92m AOD
 - 1 in 100 annual probability +70% climate change allowance level = 37.14m AOD
- 6.2.4 The proposed bridge has been designed so that the soffit level ties in the adjacent bridges over the River Kennet, at a level of 41.95m at mid span, and it drops by approximately 400mm to typically 41.5m AOD.
- 6.2.5 As such, the minimum level of the underside of the deck is over 4 metres above even the 'upper end' +70% climate change scenario and, therefore, significantly in excess of EA requirements in relation to flood risk.
- 6.2.6 This requirement is surpassed by the navigation constraints for this reach of the River Thames and Kennet, and since the proposed bridge corresponds with the adjacent structures, providing headroom clearance of 6.8 metres above SHWL at the centre of the navigation channel, it is considered that this exceeds any such requirements in this regard.

6.3 Conservation of Flood Storage and Flow Routes

- 6.3.1 Any new development located in the vicinity of a watercourse should be constructed such that it does not detrimentally impact on flow routes or reduce the available floodplain storage over a site; either of which could potentially cause an increase in flood levels on-site or elsewhere. This is considered up to the benchmark of the 1 in 100 (1%) annual probability plus allowance for climate change fluvial floodplain.

- 6.3.2 Any loss in floodplain storage capacity due to encroachment of the proposed development footprint (for example, bridge abutments, bridge landings, ramps and steps and any widening or ground raising to facilitate the new carriageway surface) requires appropriate compensatory measures, the location of which has been discussed and agreed with RBC. The baseline climate change allowance flood event up to which the mitigation measures should be considered is set out in **Section 4**.

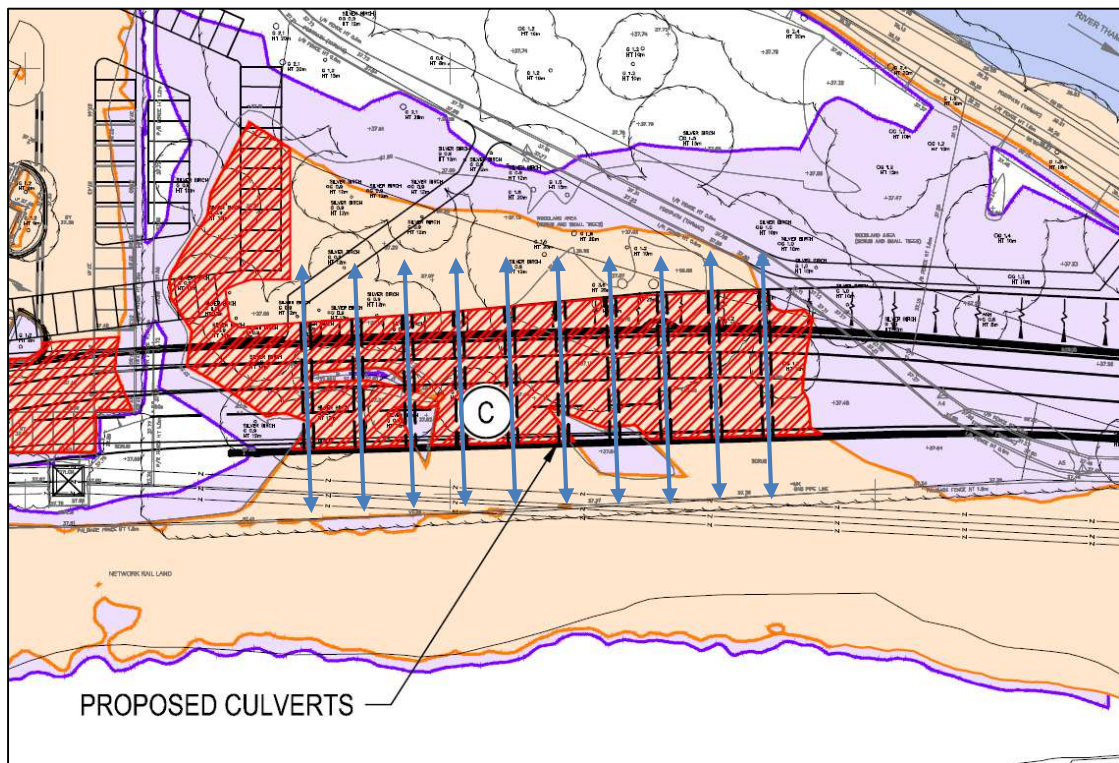
Land East of Kennetmouth

- 6.3.3 **PBA Drawing 28791/4001/011** in **Appendix E** provided an overview of the flood storage analysis across the eastern part of the proposed route.
- 6.3.4 The proposed East MRT route on land east of Kennetmouth lies within Flood Zone 3b 'Functional Floodplain'; therefore the 1 in 100 annual probability +70% scenario is applied to the analysis.
- 6.3.5 This area is subject to flooding from the adjacent River Thames on a frequent basis (with shallow flooding occurring in events as frequent as 1 in 5 (20%) annual probability). Therefore, to minimise the impacts of the East MRT it is proposed that the structure is elevated as a viaduct across this section – from the Kennetmouth crossing to the TVP P&R.
- 6.3.6 The structure is to be supported on sets of 4 pillars, set approximately 25m apart. The calculated losses in floodplain storage resulting from the elements of the structure below the reference 1 in 100 annual probability +70% allowance for climate change flood level are mitigated by ground lowering at two locations within this area to provide improvements in floodplain storage capacity on a full level-for-level basis in accordance with EA requirements.
- 6.3.7 The proposals result in an overall improvement in floodplain storage capacity of 242m³, up to the 1 in 100 annual probability +70% allowance for climate change flood level, while the fully open structure will ensure there is no detrimental impact on flood flow routes.

Land West of Kennetmouth

- 6.3.8 **PBA Drawing 28791/4001/012** in **Appendix E** provided an overview of the flood storage analysis across the western part of the proposed route.
- 6.3.9 The proposed East MRT route on land west of Kennetmouth lies within Flood Zone 2 'Medium Probability'. As such, there is a negligible impact on floodplain storage or flow routes for flood event up to the current 1 in 100 annual probability scenario. However, the proposed East MRT route is impacted in the 1 in 100 annual probability +35% allowance for climate change scenario.
- 6.3.10 The impact of the proposals on floodplain storage capacity is relatively minor at the western end of the route (i.e. where it passes the Tesco petrol station), as the proposed vertical alignment of the proposed route is at approximately the same level as the existing ground.
- 6.3.11 However, the impacts become more notable where the proposed road deck begins to rise towards the Kennetmouth crossing, and the hydraulic connectivity into areas of floodplain storage in extreme flood events is maintained by the incorporation of 10no. 1.1m wide box culverts within the embankment – see **Figure 6.1**.
- 6.3.12 The mechanism of flooding within this area is such that the proposals will not detrimentally impact on flow routes (i.e. the area serves an offline storage function rather than a conveyance route, and even then only in severe events exceeding the 1 in 100 annual probability flood). The analysis confirms the proposals result in an overall improvement in floodplain storage capacity of 497m³, up to the 1 in 100 annual probability +35% allowance for climate change flood level.

Figure 6.1: Extract of PBA Drawing 28791/4001/012 showing flood culvert locations

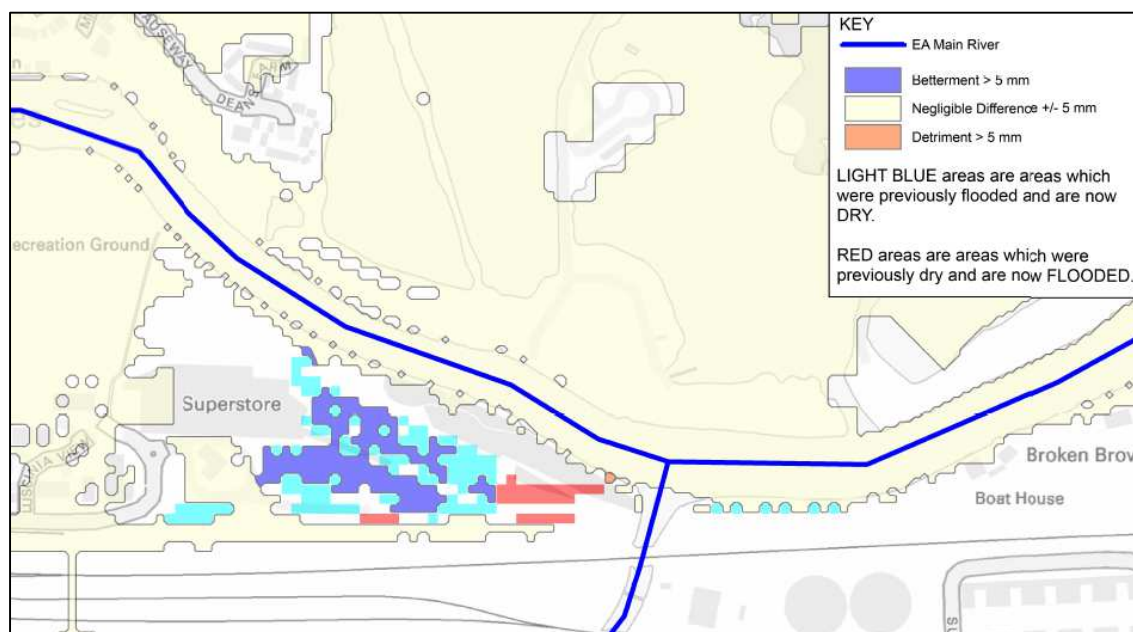


- 6.3.13 It is noted that there is a small loss of 41m^3 in floodplain storage in the top level band. However, it should be noted that the area where storage is being impacted is 'offline' (i.e. the floodwater typically spills over a raised threshold to spill into the area of storage over the Tesco car park) and, therefore, does not strictly adhere to the requirements for 'level-for-level' floodplain compensation but instead is dependent on the overall storage provision. Furthermore, it is noted that the current proposals result in overall cumulative gains in storage across all level bands, and significant level-for-level gains in all other bands.
- 6.3.14 In conclusion, the proposed East MRT scheme and incorporated mitigation proposals result in an overall improvement in floodplain storage capacity, up to the relevant flood levels allowing for climate change, of 740m^3 .

Post-Development Scenario Modelling

- 6.3.15 The impact of the proposals on flood levels has been fully considered through the transposing of the proposed East MRT structure into a 'post development scenario' version of the EA River Thames hydraulic model, as discussed below.
- 6.3.16 The post-development scenario has been simulated for the present day 1 in 100 annual probability scenario, and the climate change allowance scenarios discussed in **Section 4** (i.e. 1 in 100 annual probability +35%/+70% allowance for climate change). The results have been compared to the existing model baseline to assess any impacts of the proposed development on flood levels in the vicinity.
- 6.3.17 **Figure 6.2** shows the impact of the development on modelled flood levels in the +35% 'Upper End' climate change scenarios (also full details in **Drawings 28791_MI015, MI016 and MI018** in **Appendix E**).

Figure 6.2: Impact of development on flood levels - 1 in 100 annual probability +35% climate change scenario



6.3.18 The PBA analysis in **Table 6.1** summarises the modelled impacts of the proposals.

Table 6.1: Post Development – Modelling Impacts to Peak Flood Levels

Flood Event	Drawing Reference	Summary of Modelled Impacts
Current 1 in 100 Annual Probability	28791_MI018	No measurable impacts within application area. Isolated areas of detriment and betterment in small areas of detriment up in (i) the underpass south of Napier Road (up to 20mm), and (ii) in the centre of Caversham Lakes (up to 50mm). These areas are surrounded by wide areas of negligible impact, indicating such measured impacts are due to irregularities in model result output files.
1 in 100 Annual Probability +35% allowance for climate change	28791_MI015	Detrimental Impacts: Small isolated locations of detriment are limited to the woodland on west side of Kennetmouth (maximum increase of 35mm) and a smaller area adjacent to Luscinia View (maximum increase of 7mm). Betterment Impacts: Area of betterment across Tesco car park, with reduction in flood level of between 30mm and 90mm.
1 in 100 Annual Probability +70% allowance for climate change	28791_MI016	Detrimental Impacts: Areas of detriment are limited to the immediate vicinity of the proposed development and the Tesco site, with maximum increases of 5mm to 10mm along the route south of Tesco, and an area of 20mm detriment to the north of the Tesco store. Betterment Impacts: Area of betterment across Tesco car park, with reduction in flood level of between 10mm and 15mm.

6.3.19 In summary, the modelling confirms that the impact of the development proposals is negligible or very small, and is limited to the immediate vicinity of the proposed East MRT.

6.4 Safe Access Arrangements

- 6.4.1 The nature of the proposed development is such that there is no 'occupancy' that would be impacted and require provision of a safe access route, but the impacts of access on the East MRT have been considered.
- 6.4.2 The TVP P&R, and the majority of the elevated East MRT route, lie significantly above the modelled flood levels and within Flood Zone 1. However, the route to and from the East MRT is affected by flooding from the Thames as it extends south across King's Meadow and impacts on Napier Road:
- For flood events less severe than 1 in 20 (5%) annual probability, the East MRT route is unaffected;
 - In the 1 in 20 annual probability flood event, floodwater does extend onto part of Napier Road where it borders King's Meadow, but the depths would be very shallow and passable by vehicles, cyclists and pedestrians;
 - In the 1 in 100 annual probability event, Napier Road and the western landing of the East MRT are impacted by flood depths of 270mm – i.e. a 'danger for some' based on the guidance in the EA document *'Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purpose – Clarification of the Table 13.1 of FD2320/TR2 and Figure 3.2 of FD2321/TR1'*;
- 6.4.3 It should be noted that as a slow responding catchment, there would be significant advance warning of potential flooding. There is a significant advance notice of flooding from the River Thames and in both 2003 and the recent events of 2014, there was widespread public awareness of flooding several days before the area was affected.
- 6.4.4 Based on the analysis above, the East MRT route would only be significantly affected in an event of 1 in 100 annual probability standard or greater – i.e. more severe than any recorded event of the 20th Century. As such, due to the wider impacts in the area, RBC and WBC would be fully aware of the situation before the East MRT was affected, and would be coordinating evacuation/management procedures in liaison with the emergency services and EA.

6.5 Surface Water and SuDS

- 6.5.1 The NPPF recognises that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface runoff from development sites, and recommends that priority is given to the use of Sustainable Drainage Systems (SuDS) in new development, this being complementary to the control of development within the floodplain.
- 6.5.2 As of April 2015, the LLFA has become a statutory consultee on planning applications for surface water management. As the LLFA, RBC and WBC are responsible for the approval of surface water drainage systems within new development and such guidance will play a key role in determining the acceptability of surface water drainage measures in new development.
- 6.5.3 The key design criteria for aspects of the surface water drainage system are detailed in the DEFRA document 'Non Statutory Technical Standards for Sustainable Drainage Systems'. The proposed surface water drainage strategy for the development is shown on **PBA drawing 28791/2009/CIV/008** in **Appendix E** and can be summarised as follows:

Land East of Kennetmouth (and river crossing)

- 6.5.4 The eastern extents of the scheme (including the proposed River Kennet crossing and viaduct to the TVP P&R site) drain an area of approximately 0.3ha. The proposed network drains a catchment made up of the impermeable footway and cycleway and proposed carriageway.

- 6.5.5 Due to the need to keep the viaduct as slender as possible (to reduce visual impact), the use of a combined kerb drainage system is proposed either side of the cambered carriageway. This will collect the surface water runoff to a low point (adjacent to the TVP P&R site), prior to entering a carrier drain. The carriageway presents a potential risk of pollutants entering the surface water drainage network, so an oil interceptor is proposed along the carrier drain run, prior to surface water entering a cellular storage tank attenuation system.
- 6.5.6 To prevent water ingress into the system from groundwater, the cellular storage system will be wrapped in a geotextile membrane.
- 6.5.7 The storage has been designed to accommodate a 1 in 100-year (1% annual probability) + 70% climate change flood event. This is to ensure that during such an event and with fluvial flooding from the River Thames, storage will still be functional. The surface water runoff will then discharge from the cellular storage tank into a manhole (incorporating a flow control device) and then into the River Thames at a controlled runoff rate of 5 l/s; this is the minimum rate considered to be achievable whilst managing the risk of blockage of a flow control device to an acceptable level in accordance with best practice (ref. EA/DEFRA 'Preliminary Rainfall Runoff Management for Developments Rev E').
- 6.5.8 During storm events, the proposed outfall will be partially or fully submerged, so a non-return flap valve will be incorporated.

Land West of Kennetmouth

- 6.5.9 The western side of the scheme (running from Napier Road to the Kennet Mouth) drains an area of approximately 0.56ha. Again, the proposed network drains one distinct type of catchment made up of the impermeable footway/cycleway and proposed carriageway.
- 6.5.10 The intention is to use a slot drainage channel system which will run both sides of the cambered carriageway for most the length as these systems provide an element of attenuation. A series of road gullies are also proposed on the approach to the river crossing.
- 6.5.11 The surface water will be picked up by a pipe at the longitudinal low point within the carriageway alignment (adjacent to Tesco) before entering a precast concrete box culvert (again providing attenuation) installed beneath the proposed footway / cycleway, into an oil inceptor and continuing to a flow control device, prior to discharging into the River Thames, again at a controlled rate of 5l/s for the reasons set out above. A non-return flap valve will be installed on the outfall.

Tesco Car Park

- 6.5.12 In liaison with Tesco, localised amendments to the existing surface water drainage network (repositioning of gullies, etc) within the Tesco car park will be provided. The proposed East MRT scheme will necessitate realigning a section of the car park access road and parking spaces, resulting in a reduction of the existing impermeable area. To address this, a new section of car parking is to be provided, although the proposed impermeable area will not exceed that lost through realignment works. It is therefore envisaged that there will be no negative impact to the overall impermeable surface draining into the existing Tesco car park surface water drainage system.
- 6.5.13 The final drainage design will be subject to detailed design. Discharge into the River Thames, and other works within 8m of either the River Thames or River Kennet, will require Flood Defence consent to be obtained in due course from the EA. This will be sought once detailed design for the proposed drainage system and outfalls have been developed post planning approval.

7 Conclusions

- 7.1.1 This Flood Risk Assessment (FRA) has been prepared by Peter Brett Associates LLP (PBA) to support a planning application for the proposed Mass Rapid Transit (MRT) scheme to the east of Reading town centre.
- 7.1.2 The Environment Agency (EA) Flood Zone map and detailed hydraulic modelling indicates:
- The proposed East MRT route on the west side of Kennetmouth lies within **Flood Zone 2 'Medium Probability'** (between 1 in 100 (1%) and 1 in 1000 (0.1%) annual probability of river flooding).
 - On the east side of Kennetmouth the proposed route is located within **Flood Zone 3b 'Functional Floodplain'** (greater than a 1 in 1000 (0.1%) annual probability of river flooding), rising into Flood Zone 1 'Low Probability' (less than 1 in 1,000 (0.1%) annual probability of river or sea flooding) at the Thames Valley Park and Ride site.
- 7.1.3 The proposed 'Essential Infrastructure' development is deemed appropriate development within the Flood Zones in which it is located, subject to the Sequential Test and the Exception Test.
- 7.1.4 The new EA climate change guidance requires consideration of increases in peak river flow in the range of +35% to +70%. Using the existing EA hydraulic model, PBA have undertaken modelling of the climate change scenarios and used these as a basis for mitigation proposals as follows:
- The bridge soffit is over 4 metres above the 'upper end' 1 in 100 annual probability +70% climate change allowance scenario flood level and, therefore, significantly in excess of EA requirements in relation to flood risk;
 - The proposed bridge corresponds with the adjacent structures, providing headroom clearance of 6.8 metres above Standard Head Water Level (SHWL) at the centre of the navigation channel, exceeding any navigations requirements in this reach of the watercourses;
 - The impact on floodplain storage and flood flow routes is mitigated by the following:
 - o The East MRT is constructed as a viaduct on the east side of the River Kennet, with the floodplain impacts minimised to the small non-floodable support structure along this section;
 - o Flood compensation measures through ground lowering are provided along the route of the East MRT to ensure the floodplain storage capacity is not compromised, resulting in a net gain in storage capacity over the site;
 - o The East MRT embankment on the west side of Kennetmouth incorporates culverts to maintain flow routes into the surrounding landscaped areas, which provide a flood storage function in severe flood events (exceeding the 1 in 100 annual probability event).
 - o It is noted that there is a loss of 100m³ in floodplain storage in the top level band, but this is addressed through an overall cumulative gain in storage of 420m³, and the post development modelling confirms that any detrimental impact is very small (35mm or less), localised and not significant.
 - Access routes via the East MRT are only affected in events up of 1 in 100 annual probability or greater. There would therefore be significant advance warning of any

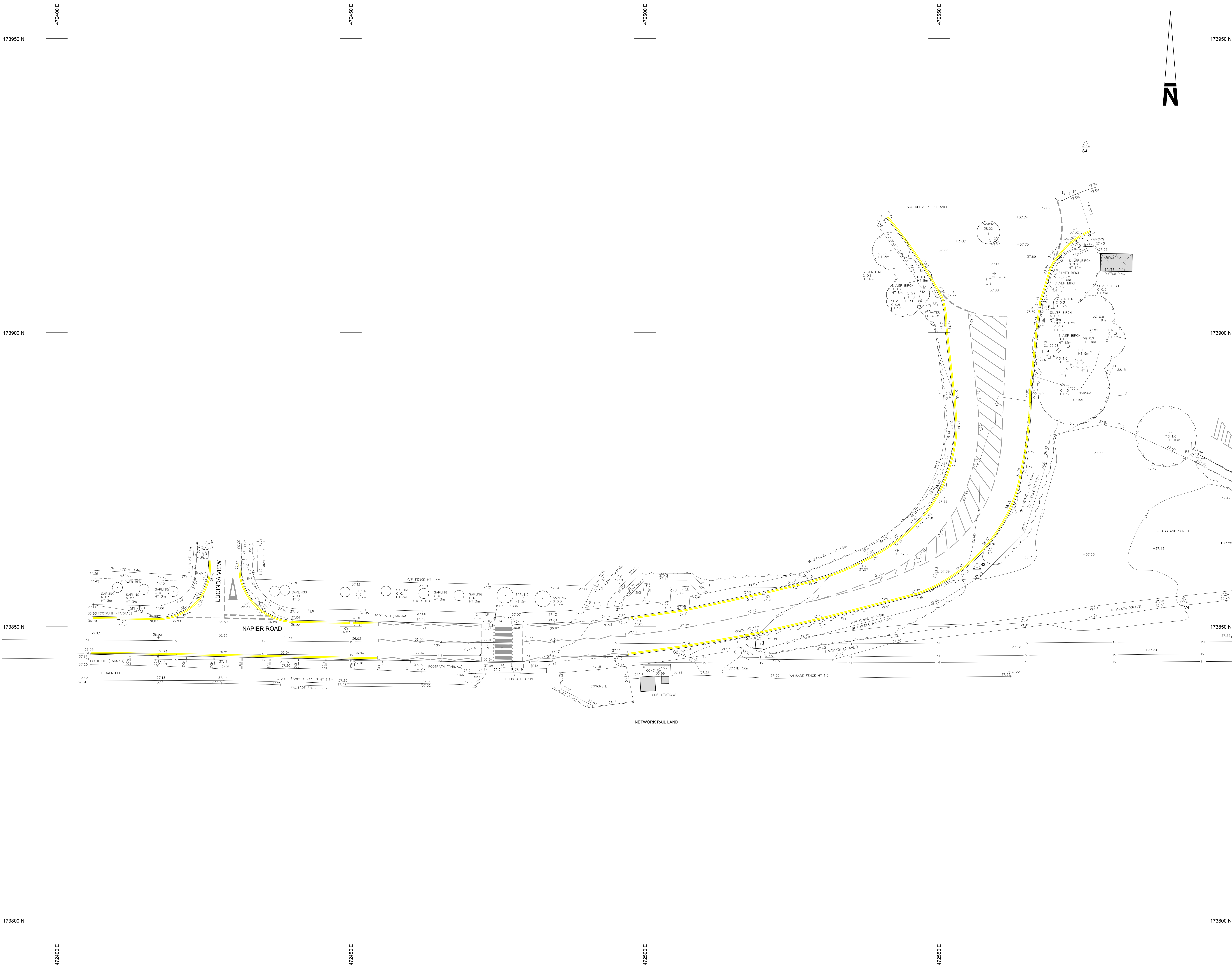
flooding before the route was affected and emergency response measures would be in effect for the surrounding area before any impacts to the MRT.

- Appropriate mitigation will be incorporated into the development to address the flood risk associated with surface water runoff to ensure no increase from existing runoff rates. The surface water drainage strategy will feature on site attenuation measures and controlled discharge and will be prepared using SuDS measures where appropriate and in accordance with the Building Regulations hierarchy and the requirements of Reading Borough Council (RBC) and Wokingham Borough Council (WBC) as the Lead Local Flood Authorities (LLFAs).

7.1.5 In conclusion, the FRA demonstrates that the users of the proposed MRT scheme will be safe and there will be no increase in flood risk elsewhere; thus meeting the requirements of the National Planning Policy Framework (NPPF).

Appendix A - Topographic Survey

- 22109 Eastern Expressway Topographical Survey (April 2016) – Sheets 1 - 5



Nodes:

1. GRID AND LEVELS BASED ON JOB 1735 022411, UNIDENTIFIED

TERRAIN SURVEYS TO

2. TREE AND HEDGE SPECIES HAVE BEEN IDENTIFIED AS ACCURATELY AS POSSIBLE BUT SHOULD BE CROSSED CHECKED IN CRITICAL AREAS

Station	Coordinate Table			
	Description	Northing	Level	
A1	ROAD NAIL	472925.427	173860.531	37.477
A2	ROAD NAIL	472926.428	173812.190	37.482
A3	ROAD NAIL	472959.075	173860.289	37.783
A4	ROAD NAIL	473000.974	173861.680	38.126
A5	ROAD NAIL	473024.404	173828.798	37.502
A6	ROAD NAIL	473024.404	173828.798	37.502
A7	ROAD NAIL	473051.023	173874.493	38.136
A8	ROAD NAIL	473207.585	173945.055	38.400
A9	ROAD NAIL	473254.097	173939.476	38.476
B1	ROAD NAIL	473100.576	173857.068	36.040
B1A	ROAD NAIL	473380.611	173837.333	36.091
B1B	ROAD NAIL	473380.611	173837.333	36.091
O12	ROAD NAIL	473074.281	173904.487	36.123
O13	ROAD NAIL	473306.551	173876.632	36.115
S1	ROAD NAIL	473352.822	173852.822	36.204
S2	ROAD NAIL	473516.252	173845.230	36.451
S3	ROAD NAIL	472556.454	173860.095	35.139
S4	ROAD NAIL	472574.097	173869.875	35.134
S5	ROAD NAIL	472711.079	173869.875	35.134
S6	ROAD NAIL	472878.617	173875.582	35.434
S6A	ROAD NAIL	472878.617	173875.582	35.434
S7	ROAD NAIL	472962.733	173861.088	35.561
S8	ROAD NAIL	472880.126	173895.951	36.362
S8C	ROAD NAIL	472880.126	173895.951	36.362
S9	ROAD NAIL	472896.726	173865.504	36.434
S9A	ROAD NAIL	472896.726	173865.504	36.434
V1	ROAD NAIL	472698.033	173862.810	37.458
V2	ROAD NAIL	472698.033	173862.810	37.458
V3	ROAD NAIL	472625.094	173888.247	37.279
V4	ROAD NAIL	472625.094	173888.247	37.279
V5	ROAD NAIL	472691.506	173854.329	37.429

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Sheet Layout: [Not to Scale]

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Topographical Survey			
Scale	Sheet Size	Sheet Number	Date
1:200	A0	1	April 2016
Project Number:	Rev:	Surveyed By:	Approved By:
22109	☐	EP	AJ / JS








Coordinate Table				
Station	Description	Easting	Northing	Level
A1	ROAD NAIL	472562.49	137860.53	37.477
A2	ROAD NAIL	472591.19	137861.33	37.423
A3	ROAD NAIL	472599.07	137890.28	37.783
A4	ROAD NAIL	473007.94	137861.68	37.393
A5	ROAD NAIL	473052.79	137862.79	37.353
A6	ROAD NAIL	473052.42	137884.93	36.206
A7	ROAD NAIL	473052.03	137874.49	37.346
A8	ROAD NAIL	473045.05	137874.33	36.334
A9	ROAD NAIL	472917.10	137926.476	34.134
B1	ROAD NAIL	473100.576	137857.848	36.040
B1A	ROAD NAIL	473088.12	137857.353	36.040
B2	ROAD NAIL	473169.07	137870.207	36.069
O12	ROAD NAIL	47324.281	137904.487	36.123
S1	ROAD NAIL	473311.14	137876.818	37.014
S2	ROAD NAIL	473311.14	137850.812	37.014
S2	ROAD NAIL	472506.252	137845.230	37.451
S3	ROAD NAIL	472531.14	137860.950	37.451
S4	ROAD NAIL	472547.972	137931.892	37.616
S5	ROAD NAIL	472671.073	137968.075	37.616
S6	ROAD NAIL	472671.073	137968.075	37.616
S6A	ROAD NAIL	472676.612	137899.820	37.541
S7	ROAD NAIL	472676.612	137881.088	37.434
S7C	ROAD NAIL	472860.124	137895.961	37.352
S8	ROAD NAIL	472917.108	137857.408	36.408
S9	ROAD NAIL	472962.500	137862.500	36.408
S9	ROAD NAIL	472874.373	137865.018	37.558
V1	ROAD NAIL	472698.333	137862.811	37.432
V2	ROAD NAIL	472698.333	137869.788	37.432
V3	ROAD NAIL	472625.094	137858.247	37.279
V4	ROAD NAIL	472591.609	137854.337	37.429

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Topographical Survey			
Scale 1:200	Sheet Size: A0	Sheet Number: 2	Date: April 2016
Project Number: 22109		Rev: ☐	Surveyed By: EP
		Approved By: AJ / JS	
			

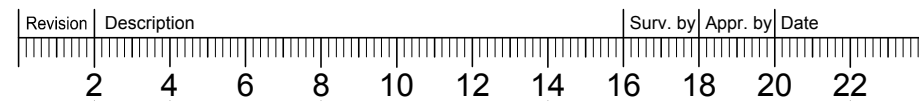
Coordinate Table				
Station	Description	Easting	Northing	Level
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A2	ROAD NAIL	472926.944	137931.190	37.423
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A4	ROAD NAIL	473007.574	138161.680	37.502
A5	ROAD NAIL	473004.404	138552.798	37.393
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A7	ROAD NAIL	473051.023	138474.493	36.136
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B1	ROAD NAIL	473170.576	138587.848	37.009
B2	ROAD NAIL	473170.576	138587.848	37.009
B3	ROAD NAIL	473170.576	138587.848	37.009
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B194	ROAD NAIL	473170.576	138587.848	37.009
B195	ROAD NAIL	473170.576	138587.848	37.009
B196	ROAD NAIL</			

TOPOGRAPHICAL KEY

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Sheet Layout: [Not to Scale]

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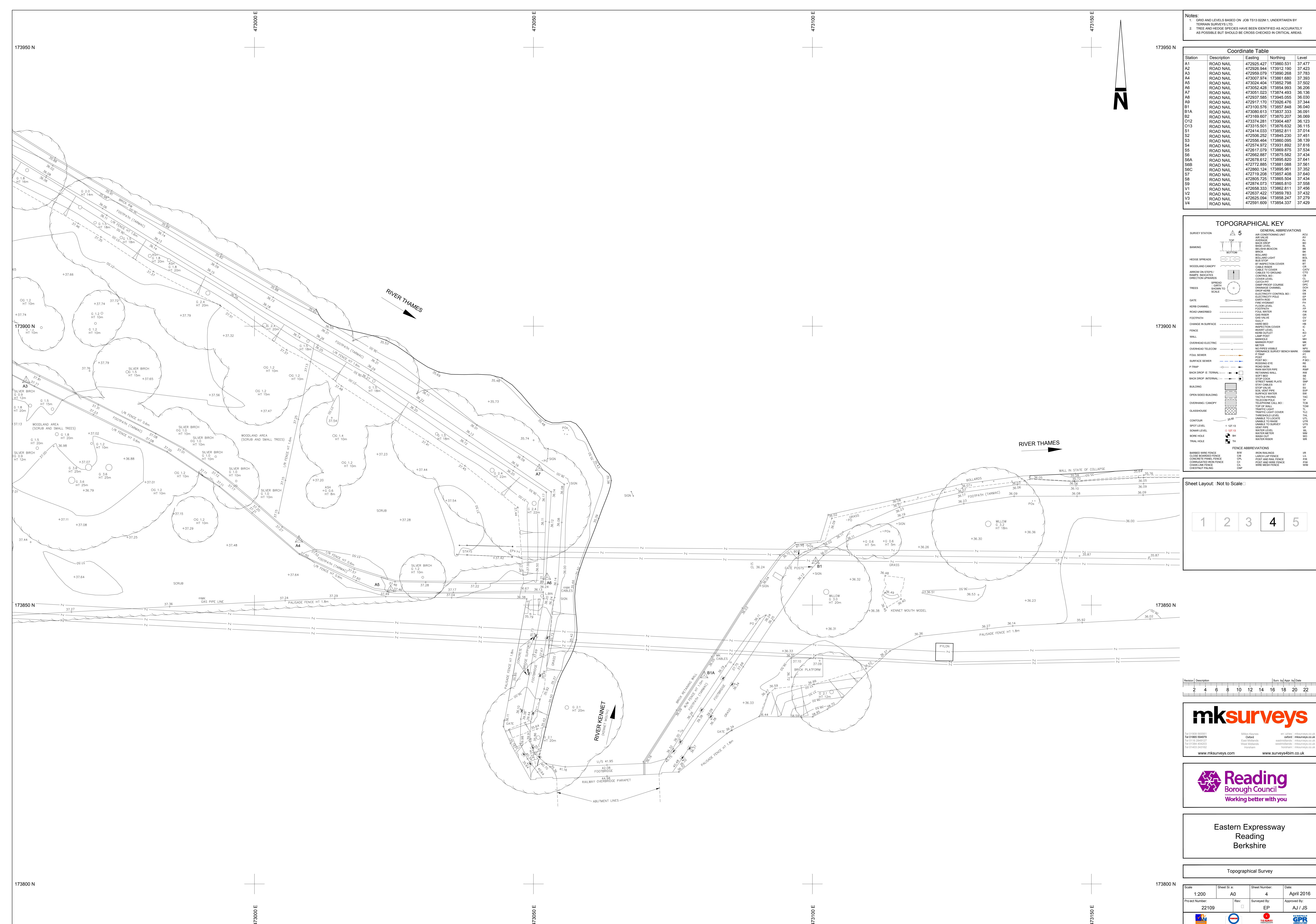


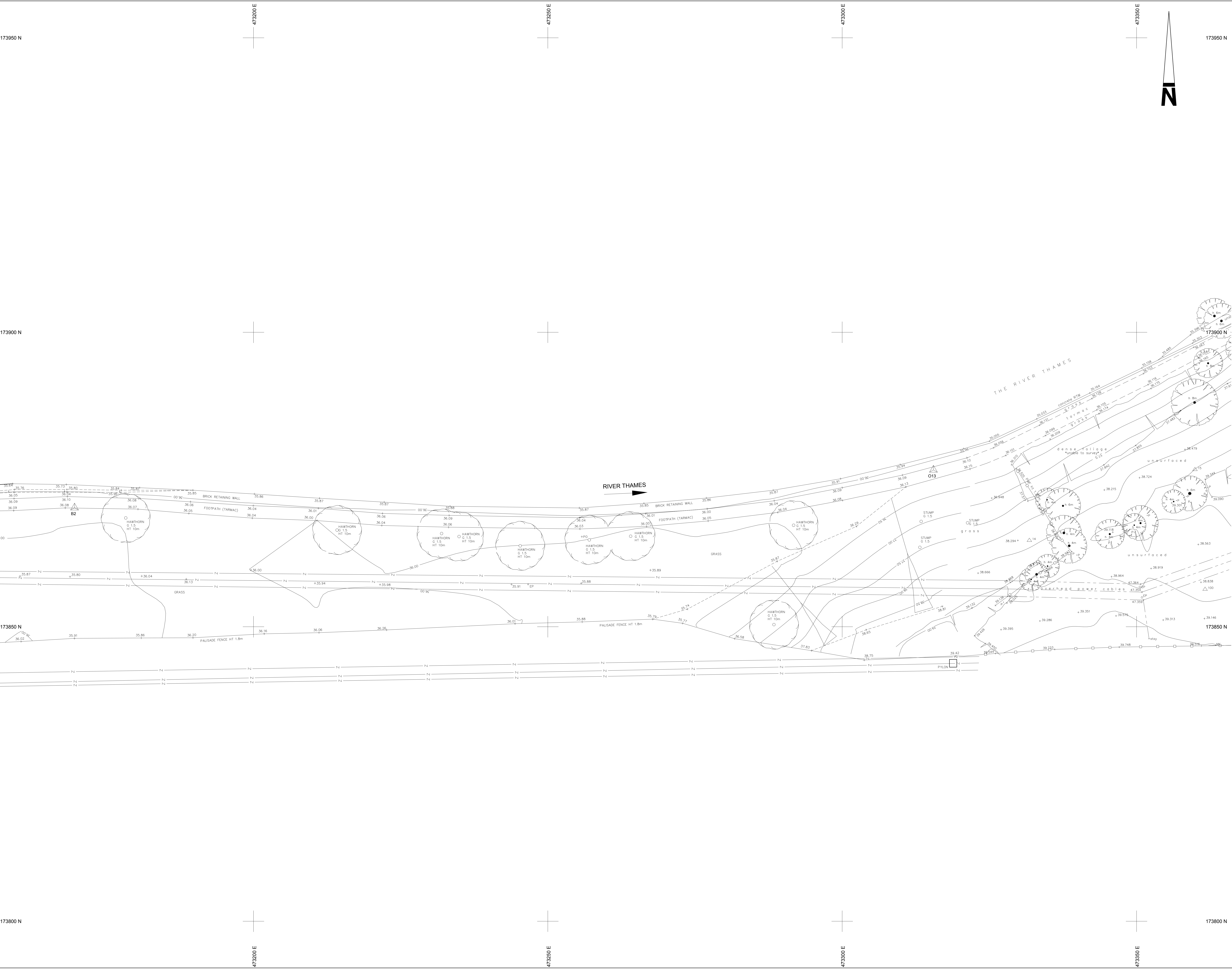
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Topographical Survey

Scale 1:200	Sheet Size: A0	Sheet Number: 3	Date: April 2016
Project Number: 22109	Rev: ☐	Surveyed By: EP	Approved By: AJ / JS
			





Notes:
1. GRID AND LEVELS BASED ON JOB TS13 022M1. UNDERTAKEN BY TERRAIN SURVEYS LTD.
2. TREE AND HEDGE SPECIES HAVE BEEN IDENTIFIED AS ACCURATELY AS POSSIBLE BUT SHOULD BE CROSS CHECKED IN CRITICAL AREAS.

Coordinate Table			
Station	Description	Easting	Northing
A1	ROAD NAIL	472925.427	173860.531
A2	ROAD NAIL	472926.944	173912.190
A3	ROAD NAIL	472959.079	173890.258
A4	ROAD NAIL	473007.974	173861.680
A5	ROAD NAIL	473024.404	173852.798
A6	ROAD NAIL	473052.428	173854.993
A7	ROAD NAIL	473051.023	173874.493
A8	ROAD NAIL	472937.585	173945.055
A9	ROAD NAIL	472917.170	173926.476
B1	ROAD NAIL	473100.576	173857.848
B1A	ROAD NAIL	473080.613	173837.333
B2	ROAD NAIL	473169.907	173870.207
O12	ROAD NAIL	473374.281	173904.407
O13	ROAD NAIL	473315.501	173876.632
S1	ROAD NAIL	472414.033	173852.811
S2	ROAD NAIL	472506.552	173845.230
S3	ROAD NAIL	472559.464	173860.055
S4	ROAD NAIL	472574.972	173831.892
S5	ROAD NAIL	472617.079	173869.875
S6	ROAD NAIL	472662.887	173876.592
S6A	ROAD NAIL	472678.612	173895.820
S6B	ROAD NAIL	472712.585	173881.088
S6C	ROAD NAIL	472850.124	173895.981
S7	ROAD NAIL	472719.208	173857.408
S8	ROAD NAIL	472805.725	173865.504
S9	ROAD NAIL	472814.073	173865.810
V1	ROAD NAIL	472658.333	173862.811
V2	ROAD NAIL	472637.422	173859.783
V3	ROAD NAIL	472525.094	173858.247
V4	ROAD NAIL	472591.609	173854.337

TOPOGRAPHICAL KEY	
SURVEY STATION	GENERAL ABBREVIATIONS
BANKING	ACU
HEDGE SPREADS	AD
WOODLAND CANOPY	AE
ARROW ON LIPS / RAMP INDICATES DIRECTION UPWARDS	AF
TREES	AG
GATE	AH
RIVER CHANNEL	AI
FOOTPATH	AJ
CHANGE IN SURFACE	AK
FENCE	AL
WALL	AM
OVERHEAD ELECTRIC	AN
OVERHEAD TELECOM	AO
FOUL SEWER	AP
SURFACE SEWER	AQ
P-TRAP	AR
BACK DROP E-TERMINAL	AS
BACK DROP INTERNAL	AT
BUILDING	AV
OPEN SIDED BUILDING	AW
OVERHANG / CANOPY	AX
GLASSHOUSE	AY
CONTOUR	AZ
SPOT LEVEL	BA
SONAR LEVEL	BB
BORE HOLE	BC
TRIAL HOLE	BD
BARBED WIRE FENCE	BE
CLOSE BORDED FENCE	BF
CONCRETE PANEL FENCE	BG
CONCRETE POST AND RAIL FENCE	BH
CHAIN LINK FENCE	BI
CRIBSTAK FENCE	BJ
IRON RAILINGS	BK
LARGE LAMP FENCE	BL
POST AND RAIL FENCE	BM
WIRE FENCE	BN
WIRE MESH FENCE	BO

Sheet Layout: Not to Scale				
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Revision	Description	Surv. by	App. by	Date						
2	4	6	8	10	12	14	16	18	20	22

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Topographical Survey

Scale	Sheet No.	Sheet Number	Date
1:200	A0	5	April 2016

Project Number	Rev.	Surveyed By	Approved By
22109		EP	AJ / JS