7 Flood Risk and Water Quality

7.1 Flood Risk Assessment

Lincoln Eastern Bypass
Flood Risk Assessment

5 November 2012

Produced for

Lincolnshire COUNTY COUNCIL

Prepared by

mouchel
building great relationships

Mercury Court
Tithebarn Street
Liverpool
L2 2QP

T 0151 237 4200

Document Control Sheet

Project Title	Lincoln Eastern Bypass
Report Title	Flood Risk Assessment
Report ref no.	1030171-FRA
Version	1
Status	Final
Report Date	5 November 2012

Record of Issue

Version	Status	Author	Date	Checked by	Date	Approved by	Date
1	Final	J Jones & M Richardson	02/11/2012	O Drieu	05/11/2012	A Taylor	05/11/2012

Distribution

Date	Organisation	Contact	Format	Copies
05/11/2012	Lincolnshire County Council	Lee Rowley	Pdf	1

Limitations

This report is presented to Lincolnshire County Council in respect of Lincoln Eastern Bypass Flood Risk Assessment and may not be used or relied on by any other person. It may not be used by Lincolnshire County Council in relation to any other matters not covered specifically by the agreed scope of this Report.

Notwithstanding anything to the contrary contained in the report, Mouchel Limited is obliged to exercise reasonable skill, care and diligence in the performance of the services required by Lincolnshire County Council and Mouchel Limited shall not be liable except to the extent that it has failed to exercise reasonable skill, care and diligence, and this report shall be read and construed accordingly.

This report has been prepared by Mouchel Limited. No individual is personally liable in connection with the preparation of this report. By receiving this report and acting on it, the client or any other person accepts that no individual is personally liable whether in contract, tort, for breach of statutory duty or otherwise.

Contents

Figures

Tables

List of Abbreviations

DEFRA	Department for Food and Rural Affairs
EA	Environment Agency
FRA	Flood Risk Assessment
CFMP	Catchment Flood Management Plan
LCC	Lincolnshire County Council
LEB	Lincoln Eastern Bypass
LTS	Lincoln Transport Strategy
NPPF	National Planning Policy Framework
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage Systems
UKCIP	United Kingdom Climate Impacts Programme

Executive Summary

Mouchel was appointed by Lincolnshire County Council (LCC) to carry out a Flood Risk Assessment (FRA) to support the planning application for the proposed Lincoln Eastern Bypass (LEB). The Flood Risk Assessment has been carried out in accordance with National Planning Policy Framework (NPPF) in England, which states that a Flood Risk Assessment is required for all proposed developments within Flood Zones 2 and 3.

The aim of the assessment is to establish the existing and future risks of flooding to the existing site and proposed development, to assess the potential impacts on flood risk elsewhere and to determine any flood mitigation measures required.

The LEB was identified as being of key significance to the delivery of the Lincoln Transport Strategy (LTS). It will allow traffic to bypass Lincoln city centre, alleviating the current traffic related problems. In 2009, planning permission was granted for the LEB, as a dual carriageway. Proposals for the LEB have recently been revised and a new planning application is being submitted for the LEB as a single carriageway road, which this FRA will support.

In accordance with the NPPF, the sequential and exception test have been performed to avoid inappropriate development in areas of flood risk. All other reasonable alternative routes for the LEB have been investigated. However, due to the nature of the development, the road has to cross over the River Witham and therefore there are no other reasonably available routes for this type and scale of development in lower flood risk zones.

The risk of flooding from all sources has been assessed, utilising information from the *Lincoln Eastern Bypass Flood Risk Assessment* produced in 2009 and through consultation with the Environment Agency. The potential impacts of climate change on flooding have also been considered.

The main source of flood risk in the Lincoln area is fluvial, which is currently well managed. Existing defences currently provide protection against a flood event with a 1% chance of occurring each year (1 in 100 year) from the River Witham and South Delph. Flood risk from other sources is not considered to be significant at this site and will not be worsened by the proposed road.

Management of surface water is a key aspect of Proposed Scheme. Without suitable management, there would be an increase in surface water runoff rate and total runoff volume due to the increase in impermeable area. Flood risk will be mitigated through the use of Sustainable Drainage Systems (SuDS) in the form of attenuation ponds. These will attenuate flows from the new road and discharge at the existing greenfield runoff rate to ensure that flooding is not increased elsewhere.

The conclusion of this FRA is that provided the recommended mitigation measures are implemented, the development will be safe from flooding without increasing the risk of flooding elsewhere.

1 Introduction

1.1 Background

Mouchel was appointed by Lincolnshire County Council (LCC) to carry out a Flood Risk Assessment (FRA) as part of the planning application for the Lincoln Eastern Bypass (LEB).

The FRA has been carried out in accordance with the National Planning Policy Framework (NPPF)[1] and in consultation with the Environment Agency (EA). The NPPF sets out the framework for planning decisions made by local, regional and national government and the EA. It further advises that Flood Risk Assessments are required for all developments in Flood Zones 2, 3a and 3b (as defined in section 3.2 of this report) and for all development sites in Flood Zone 1 that are 1 hectare or greater. The proposed development site partially in Flood Zones 2 and 3; therefore, a Flood Risk Assessment is required.

The Lincoln Transport Strategy (LTS) produced in 2004, investigated the issues and challenges facing transport in the Lincoln area. The LEB was identified as being of key significance to the delivery of the LTS.

The A15 is currently the primary north-south route between Humberside and Peterborough, passing through the city of Lincoln. It uses the only road crossing of the River Witham to the east of the city for 18 miles. As a result, there are frequent delays and congestion in Lincoln city centre. There are also concerns over the safety of pedestrians using the route. The LEB would allow traffic to bypass Lincoln city centre, alleviating many of the traffic related problems currently experienced.

In 2009, planning permission was granted for the LEB, designed as a dual carriageway at the time. To support the planning application a FRA was produced by Jacobs in 2009[2]. Proposals for the LEB have recently been revised and a new planning application is being submitted for the LEB as a single carriageway road. This FRA will therefore support the planning application for the proposed single carriageway. Much of the information in *Lincoln Eastern Bypass Flood Risk Assessment* produced in 2009 is still relevant and as such will be referred to throughout this report.

1.2 Aims

The aim of this assessment is to establish the flood risk associated with the LEB, in line with the requirements of the NPPF. The objectives are summarised as follows:

[1] 'National Planning Policy Framework' and 'Technical Guidance to the National Planning Policy Framework', Department for Communities and Local Government (2012).

[2] 'Lincoln Eastern Bypass Flood Risk Assessment', Jacobs (2009).

- Establish the existing and future risks from flooding to the existing site and proposed development,
- Assess the potential impacts of the development on flood risk elsewhere,
- Determine any necessary mitigation measures required to manage flooding issues at the site in a sustainable way.

1.3 Data Sources

1.3.1 Data Collection

Mouchel has contacted the following organisations to collect data and discuss the implications of the Proposed Scheme.

- Environment Agency
- Anglian Water Services
- Lincolnshire County Council

1.3.2 Previous Studies

There are many previous studies which are relevant to the Proposed Scheme. The documents listed below were summarised in *Lincoln Eastern Bypass Flood Risk Assessment* produced in 2009 and provided information for the assessment.

- Lincoln Eastern Bypass Environmental Statement, Babtie (2003)
- Lincoln Policy Area – Strategic Flood Risk Assessment, JBA (2004)
- Witham Catchment Flood Map Improvements, Upper Witham Hydraulic Modelling Report, Faber Maunsell (2007)
- River Witham Catchment Flood Management Plan (CFMP), Environment Agency (2008)
- Lincoln Integrated Urban Drainage Pilot – SLD2309, Faber Maunsell (2008)
- Lincoln Water Cycle Study, Faber Maunsell (2008)
- Lincoln Eastern Bypass Stage 2 Environmental Assessment Report, Jacobs (2008)

1.3.3 *Lincoln Policy Area SFRA (2010)*

The Strategic Flood Risk Assessment (SFRA) for Lincoln Policy Area has been updated in 2010[3]. The Proposed Scheme lies entirely within the Lincoln Policy Area. The SFRA, is summarised in the following paragraphs.

The SFRA is a combined Level 1 and Level 2 SFRA, prepared in accordance with Planning Policy Statement 25: Development and Flood Risk (PPS25). The SFRA is a planning tool enabling the local authority to make informed decisions and select the most appropriate development sites, away from areas of greatest vulnerability to flooding in and around Lincoln.

Hydraulic modelling was undertaken to establish realistic indicative flood outlines in key areas that take into account defences and consider how water flows within a floodplain. The flood scenarios considered were the 1 in 100 year with climate change and 1 in 1000 year with climate change, flood events. The modelling produced expected depths and velocities of flood water, allowing for the risk to people and properties to be assessed. The study also considered the effect of defences and the risk of flooding caused by failure (due to breach) or overtopping.

The main source of flood risk in the Lincoln Policy Area is identified in the SFRA as fluvial flooding. Historically, the city has experienced several large flood events, most notably in 1947 and 1958. As a result, controlled washlands, pumping stations, and control gates were introduced to the area in an attempt to manage flooding.

The SFRA provides guidance relating to the management of future development. It provides advice on FRAs, with supporting guidance on reducing flood risk and making developments safe.

[3] Lincoln Policy Area Strategic Flood Risk Assessment, JBA (February 2010).

2 Location and Development Description

2.1 River Witham Catchment

The City of Lincoln is located within a ridge in the Lincolnshire Heights, a north–south limestone ridge, through which the River Witham flows. The River Witham is flanked by the North Delph to the north and the South Delph to the south. The Canwick Fen Drain lies south of the South Delph.

The River Witham and South Delph act as one watercourse in larger floods and act as the main flood conveyance, flowing out of Lincoln in an easterly direction. Flood flows are generally contained within the flood embankments on the north bank of the River Witham and the south bank of the South Delph.

Maps showing the site location and the watercourses in the area, taken directly from the *Lincoln Eastern Bypass Flood Risk Assessment* produced in 2009 are contained within Appendix A.

2.2 Proposed Development

The Proposed Scheme will provide a road link between the A158 Wragby Road Roundabout and the A15 south of Bracebridge Heath. The Proposed Scheme, presented in

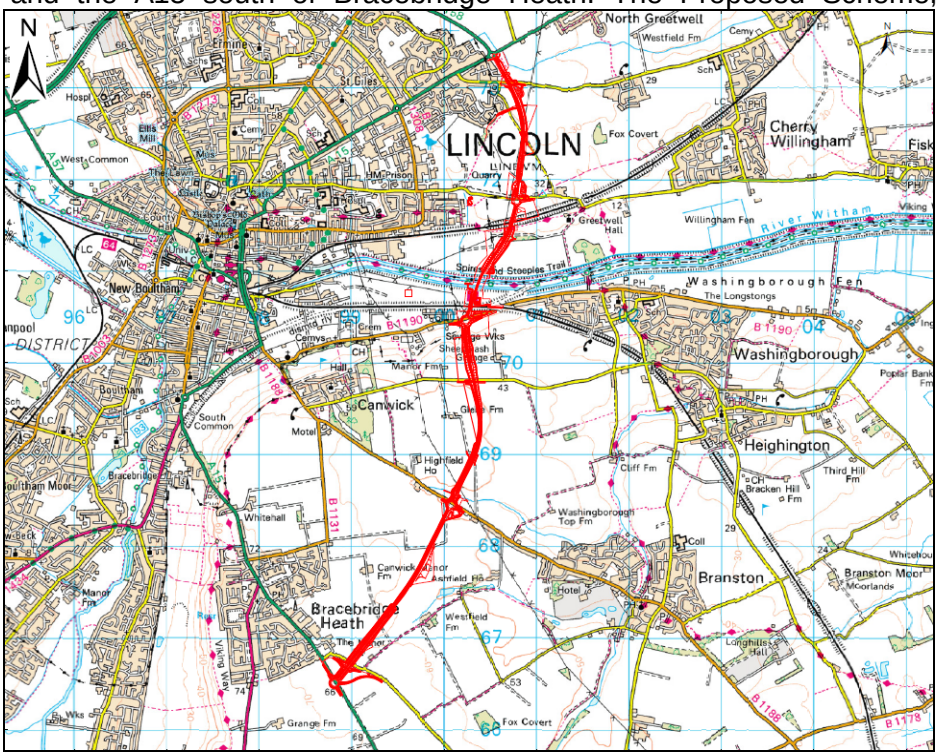
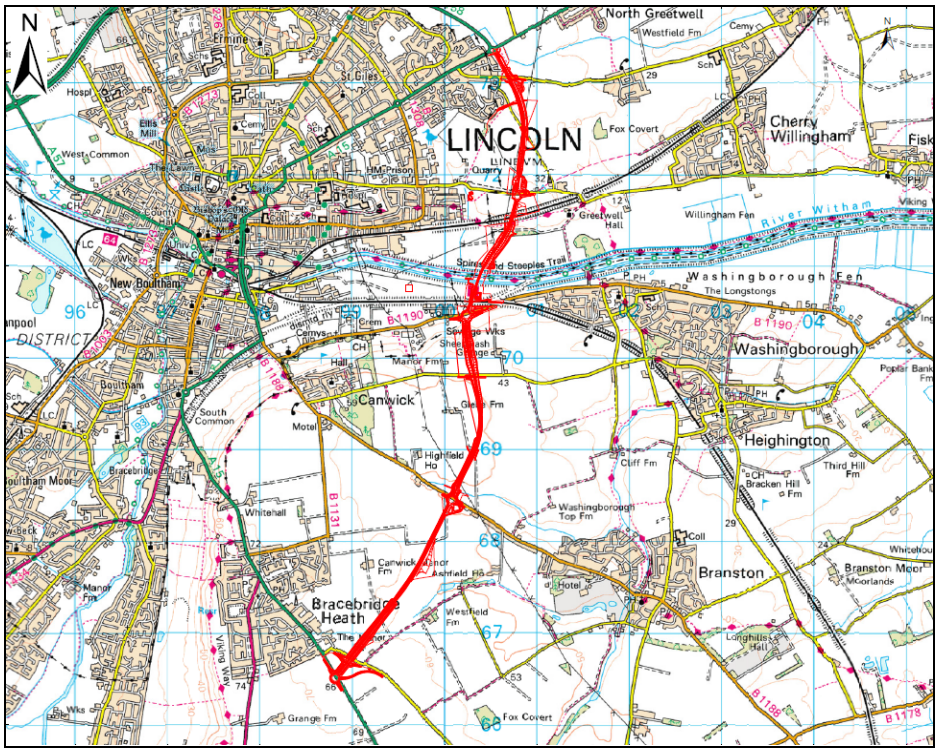


Figure 1, follows the limestone escarpment Lincoln Edge[4] for much of the route, only dipping in the River Witham Valley. Detailed plans are included in Appendix B.

The proposed LEB will provide a new 7.5km single carriageway relief road that will link the junction of the A15 and A158 Wragby Road to the A15 Sleaford Road. The new route will have a design speed of 100kph and a separate 3m wide combined cycle and pedestrian right of way (located on the western side of the carriageway) provided along the full length of the scheme to link up with existing public rights of way.

The proposed bypass will cross the North Delph, the River Witham, South Delph and Canwick Fen Drain with a five span bridge in the River Witham Valley. The Lincoln to Market Rasen railway line will be crossed via an overbridge, LEB will pass underneath the Lincoln to Spalding railway line. A combined cycle footway will be provided along the full length of the route.



Reproduced from Ordnance Survey material with the permission of the Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office. Crown Copyright. OS 100025370.

Figure 1 – Lincoln Eastern Bypass route

2.3 Site Description

2.3.1 Watercourses

The Proposed Scheme is located in the vicinity of the following watercourses

[4] the limestone escarpment that runs roughly north-south through Lincolnshire

- Main Rivers (maintained by the Environment Agency): River Witham and South Delph (also called Sincil Dyke further upstream)
- Non-main rivers: North Delph, Canwick Fen Drain (also known as Soak Dyke)
- Smaller drainage ditches including Reepham Beck, Greetwell Fields Drain, Greetwell Beck, Branston Brook and its tributary and Ashfield Beck.

2.3.2 Geology and Groundwater

The local geology (described in full detail in the Jacobs report) shows Jurassic strata underlying the entire site, comprising primarily limestone with clays. The River Witham has cut through the Lincolnshire Limestone Formation, forming the 'Lincoln Gap'. The proposed bypass crosses the River Witham, which is underlain by alluvium superficial deposits. The majority of the site overlies an outer Groundwater Protection Zone[5].

[5] Defined by a 400 day travel time from a point below the water table. This zone has a minimum radius of 250 or 500 metres around the source, depending on the size of the abstraction. Source: Environment Agency website (2012).

3 Sequential and Exception Tests

3.1 National Planning Policy Framework (NPPF)

The NPPF requires that a sequential approach is adopted to ensure that inappropriate development in areas at risk of flooding is avoided by directing development away from areas at highest risk. If the development cannot be located in an area of lower probability of flooding, an Exception Test may be required.

3.2 Flood Zone Definition

Table 1 below shows the various flood zones as defined in the NPPF. Note that these flood zones refer to the probability of the river and sea flooding, ignoring the presence of defences.

Flood Zone 1	This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding (<0.1%).	Low Probability
Flood Zone 2	This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 probability of river flooding (1% – 0.1%) each year, or between a 1 in 200 and 1 in 1000 probability of sea flooding (0.5% – 0.1%) each year.	Medium Probability
Flood Zone 3a	This zone comprises land assessed as having a 1 in 100 or greater probability of river flooding (>1%) each year, or a 1 in 200 or greater probability of flooding from the sea (>0.5%) each year.	High Probability
Flood Zone 3b	This zone comprises land where water has to flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances but land which would flood with an annual probability of 1 in 20 (5%) or greater in any year, or is designed to flood in an extreme (0.1%) flood, should provide a starting point for consideration.	High Probability

Table 1 – Flood zone definitions

The EA Flood Map included in Appendix C shows areas that could be affected by flooding from main rivers, if there were no flood defences. The Proposed Scheme is located partially within Flood Zones 1, 2 and 3. The Proposed Scheme is not at risk of flooding from the sea.

3.3 Sequential Test

The appropriate uses and Flood Risk Assessment requirements for land in each flood zone is described in the NPPF. Developments are classified according to their 'Flood Risk Vulnerability'. The Proposed Scheme is classified as 'Essential Infrastructure' under the NPPF.

Due to the nature of the development, the proposed road has to cross the Main Rivers and there are no reasonably available routes for such a bypass in lower flood risk zones.

Applying the Sequential Test (see extract from the NPPF shown in Table 2 shows that the majority of the route, which is in Flood Zones 1 and 2, is appropriate. An Exception Test is required for areas that lie in Flood Zone 3.

Flood risk vulnerability classification (see table 2)		Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Flood zone (see table 1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	×	Exception Test required	✓
	Zone 3b functional floodplain	Exception Test required	✓	×	×	×

Key: ✓ Development is appropriate.
× Development should not be permitted.

Table 2 – Sequential Test (extract from NPPF)

3.4 Exception Test

It is necessary for the proposed development to pass the Exception Test where it crosses Flood Zone 3. For the Exception Test to be passed:

- it must be demonstrated that the Proposed Scheme 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 Proposed Scheme 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

The Proposed Scheme was identified as being of key significance by Lincoln Transport Strategy and also the Lincoln Eastern Growth Corridor as noted in the Lincoln Policy Area Strategic Flood Risk Assessment and therefore provides sustainable benefits to the community. All reasonable alternatives have been investigated.

In line with the conclusions of this FRA, the Proposed Scheme will be safe without increasing flooding elsewhere. Thus with submission of this FRA it is demonstrated that the Exception Test is passed.

4 Flood Risk Assessment

4.1 Introduction

The NPPF specifies that flooding from all potential sources is considered. Potential flooding from fluvial, surface water, groundwater and sewers has therefore been assessed.

This section of the report assesses the existing flood risk and the post development flood risk and discusses the potential impacts of climate change in the study area.

4.2 Historic Flooding

There have been a number of significant river flooding events in the proposed development area over the past 100 years. *Lincoln Eastern Bypass Flood Risk Assessment* produced in 2009 contains details of significant fluvial flood events in the study area, as provided by the EA. For this report, the EA has provided the Historic Flood Extent Map for the study area, which is included in Appendix C. This shows the extent of previous recorded flooding in the area, notably March 1947, April 1981 and October 1993.

The March 1947 flood was the most severe flood experienced by the city, causing significant disruption. A comparison of notable flood events between 1872 and 2007 made by the EA suggests that the primary mechanism producing extreme floods in the River Witham catchment is the saturation of the catchment after a period of prolonged rainfall. Most flooding in the catchment occurs in the winter.

4.3 Flooding Sources

4.3.1 Fluvial

Fluvial flooding is the main source of flooding within the study area and the Proposed Scheme traverses several watercourses and/or their catchments (listed in section 2.3.1 of this report).

As part of the 2009 FRA, 2D hydraulic modelling was undertaken to examine the impact of the Proposed Scheme on fluvial flooding in the River Witham, South Delph, North Delph and Canwick Fen Drain. The EA have confirmed that this modelling and its results are still acceptable and are applicable for this Flood Risk Assessment.

The proposed bypass will cross the North Delph, the River Witham, South Delph and Canwick Fen Drain with a five span bridge in the River Witham Valley. The road has been designed to be above the flood levels, including flooding caused by a breach in flood defences, and therefore it will not be at risk of flooding.

As the road will be raised above the floodplain, it will not cause any obstruction to the flow of flood water. Some bridge abutments will be located in the fluvial floodplain, however, these have been designed to have minimal restriction and occupy an insignificant area when compared to the overall area of floodplain. The hydraulic

modelling results are described in the following paragraphs, with full information and supporting maps available in *Lincoln Eastern Bypass Flood Risk Assessment* produced in 2009

The hydraulic modelling results show that there is no difference in the flood extent between the existing scenario and the Proposed Scheme scenario for the 1 in 100 year event. For the 100 year, plus climate change allowance, the flood extent is slightly larger for the proposed scenario than the existing. This is due to backing up on Canwick Fen Drain due to the bridge abutment restricting flow. Flood volumes were assessed and it is recommended that 1,110m^3 of compensation storage is excavated to ensure minimal residual risk. A potential location is south of Canwick Fen Drain upstream of the proposed bypass.

An assessment of a potential breach in flood defences was undertaken by Jacobs in 2009, assuming a 40m wide breach to ground level would occur at the peak of the flood event on either the River Witham north bank or the South Delph south bank. Full details of the hydraulic modelling are contained within the 2009 FRA report, however a summary is provided below.

A comparison of the breach scenario for the 'with bypass' and the existing 'without bypass' situation was carried out for the 100 year event. The results show that the flood extents are similar, but the 'with bypass' flood extent is slightly larger upstream of the Proposed Scheme and slightly smaller downstream. However, the flooding only affects rural land and not buildings/urban areas and so the Proposed Scheme is not considered to have a significant impact on flood risk.

For the Witham North Bank breach scenario, general velocities in the floodplain are less than 1 m/s, however the peak velocity is 6.4 m/s at the flood embankment breach. Flood depths are generally 2 to 3m. For the South Delph South Bank breach scenario, the peak velocity is 3.8 m/s. The peak floodplain depth is between 1m and 2m.

Consultation with the EA indicates that the fluvial defences protecting the study area are in good condition and provide protection against a flood event with a 1% chance of occurring each year (1 in 100 year).

4.3.2 Surface Water

Surface water flooding can occur as a result of high intensity rainfall falling on saturated land or an impermeable surface. It can also occur if the capacity of drainage systems is exceeded. Surface water flooding has been experienced in Lincoln on a number of occasions. Records of significant surface water flooding events provided by the Environment Agency are presented in the 2009 FRA.

Historically, surface water flooding has not affected the location of the Proposed Scheme, and flood mitigation measures to control the runoff from the Proposed Scheme will ensure that the situation will not change after construction.

4.3.3 *Groundwater*

Groundwater can cause flooding if the water table rises above the ground. There does not appear to be any historical groundwater flooding concerns in the area.

4.3.4 *Sewers*

Many surface water sewers may now be operating beyond their original design capacity as a result of increased surface water from impermeable areas. Anglian Water Service was contacted as part of the 2009 FRA and they highlighted sewerage and surface water drainage infrastructure flooding issues in the Bracebridge Heath and Monks Road to Stamp End areas. The areas highlighted as having historic issues are away from the study area and therefore flooding from sewers is not considered to be a significant risk to the existing site or the proposed bypass.

4.4 Climate Change

Climate change within the UK is likely to result in changes to observed weather patterns. Short duration, high intensity rainfall and more periods of long duration rainfall are expected, in addition to rising sea levels. This will lead to increased risks of flooding.

The United Kingdom Climate Impacts Programme (UKCIP) suggests that winters will become wetter by as much as 20% by the 2050s. The NPPF Technical Guidance contains recommended national precautionary sensitivity ranges for rainfall intensity and peak river flow which can be seen in Table 3.

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	*+5%*	*+10%*	*+20%*	*+30%*
Peak river flow	*+10%*	*+20%*		
Offshore wind speed	*+5%*		*+10%*	
Extreme wave height	*+5%*		*+10%*	

Table 3 – Climate change recommended precautionary sensitivity ranges (Extract from NPPF Technical Guidance)

The potential implications of climate change on flooding in the Lincoln area are summarised below.

Fluvial Flood Risk

Climate change will result in an increase in river flows and levels, meaning that flood defences will provide less protection over time. The extent of flooding is likely to increase in the city in the future.

Surface Water

The Lincoln Integrated Urban Drainage Pilot Study[6] states that 'it is generally accepted that climate change will lead to higher peak rainfall intensities and more frequent storms. Hence urban flood risk will be increased and areas in Lincoln which are currently "critical" will become more so if remedial action is not taken'.

According to the NPPF, developers need to ensure that development does not increase the risk of surface water flooding by controlling surface water runoff from sites, and mitigation measures need to account for climate change allowances in rainfall patterns.

Groundwater

As stated in the 2009 FRA 'The impacts of climate change on groundwater flooding are largely unknown. It is possible that climate change will reduce groundwater levels, thus lowering the risk, or conversely increase groundwater levels, therefore heightening the risk of flooding. Therefore, the Environment Agency has assumed that risks remain similar to the current level and the mechanisms of flooding remain the same'.

4.5 Conclusions

Fluvial flooding is the main source of flood risk in Lincoln, however this risk is currently well managed and a limited number of people are at risk. Consultation with the EA indicates that the fluvial defences protecting the study area are in good condition and provide protection against a flood event with a 1% chance of occurring each year (1 in 100 year). However, when climate change is taken into account, flood defences will provide a lower level of protection.

The proposed bypass has been designed to be well above the floodplain, including flooding resulting from a breach and therefore will not be at risk of flooding. Implementation of the Lincoln Eastern Bypass will not adversely affect fluvial flood risk in the surrounding area.

Flooding from other sources is not considered to be significant at this site and will not be worsened by the proposed bypass.

[6] Lincoln Integrated Urban Drainage Pilot SLD2309 Final Report, Faber Maunsell DEFRA (June 2008)

5 Flood Risk Management

5.1 Introduction

This section describes the detailed proposals for drainage and flood risk management along the Proposed Scheme. The principles adopted during the identification of mitigation measures is one of avoidance if possible, reduction where avoidance cannot be achieved or compensation where reduction cannot be achieved or would not achieve practicable levels of mitigation.

5.2 Natural Catchment Runoff

The proposed intercepting drainage for the natural catchment which the Proposed Scheme crosses, will be provided in the form of ditches and will be kept separate from the highway drainage. The intercepting drainage will convey the natural catchment runoff to the appropriate watercourse, with natural drainage patterns maintained as far as possible. It is considered that pollution control and attenuation measures are not required for the intercepting drainage.

Six watercourses are to be culverted as part of the Proposed Scheme, details of which are included in the 2009 FRA. Proposed culverts have been designed to accommodate flows for a 1 in 100 year return period with an additional 30% increase in design flow for potential climate change.

5.3 Sustainable Drainage Systems (SuDS)

Sustainable Drainage Systems cover the whole range of sustainable approaches to surface drainage management. They are designed to control surface water run off close to where it falls and mimic natural drainage as closely as possible, thus reducing the flood risk to the development area itself and elsewhere.

The EA promote the use of SuDS to attenuate peak flows, produce water quality improvements and environmental enhancements where ground conditions are suitable. Table 4 shows the hierarchy of SuDS options and how these can provide betterment.

	SUDS technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife Benefit
Most Sustainable	**Living roofs**	✔	✔	✔
	Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✔	✔	✔
	Filter strips and swales	✔	✔	✔
	Infiltration devices - soakaways - infiltration trenches and basins	✔	✔	✔
	Permeable surfaces and filter drains - gravelled areas - solid paving blocks - porous paviors	✔	✔	
Least Sustainable	**Tanked systems** - over-sized pipes/tanks - storms cells	✔		

Table 4– The SuDS Hierarchy (Environment Agency 2006)

Management of surface water is a key aspect of the development area. Flood risk in the area will be mitigated through the use of SuDS in the form of attenuation ponds. These will receive and attenuate water draining from the new road, and will be discharged at a controlled rate to ensure that flooding is not increased elsewhere. Well designed and maintained ponds can also offer important aesthetic, amenity and wildlife benefits to developments.

5.4 Proposed Highway Drainage

The highways drainage network has been designed to the following criteria:

- No surcharging in pipes in a 2 year design storm plus 20% increase in rainfall intensity for possible climate change.
- No flooding from the highway drainage system in a 30 year design storm plus 20% increase in rainfall intensity for possible climate change.
- No flooding of properties or from attenuation facilities in a 100 year design storm plus 30% increase in rainfall intensity for possible climate change.

5.4.1 Catchments

The highways drainage for the Proposed Scheme has been divided into five highway drainage catchments (1, 2, A, B, C). Below is a summary of the route of the flow of each catchment. Scheme plans showing the features described are included in Appendix B.

- Catchments 1 and 2 are interlinked.
- Catchment 1 drains the northern section of the road to a low point in the alignment underneath Hawthorn Road, where it is attenuated in ponds and

pumped into Catchment 2.

- Catchment 2 drains from Catchment 1 to Greetwell Road Roundabout where it is attenuated in ponds and discharged into Catchment A at a controlled rate.

- Catchment A drains the highway between Greetwell Road Roundabout and the northern side of the River Witham Bridge into attenuation ponds east of the bypass in the River Witham floodplain. It is attenuated and discharged at a controlled rate into the North Delph.

- Catchment B drains the highway between the River Witham Bridge and the high point in the highways alignment south of Heighington Road. Drainage to the south of Washingborough Road is collected by the initial attenuation ponds south of the Lincoln to Spalding Railway, where it is reintroduced into the Catchment B highway drainage system at a controlled rate. All of the drainage from Catchment B ultimately drains to attenuation ponds to the east of the bypass in the River Witham valley before outfalling at a controlled rate into Canwick Fen Drain.

- Catchment C drains the highway between Catchment B and Sleaford Road Roundabout. The catchment drains to a low point near Lincoln Road Roundabout and into an attenuation pond. It is then discharged into a tributary of Branston Brook at a controlled rate.

5.4.2 Discharges

Without suitable management, there would be an increase in surface water runoff rate and total runoff volume due to the increase in impermeable area. Allowable discharges from the highways drainage network will therefore be limited to the existing greenfield runoff rates. In 2009, Jacobs produced a Drainage Strategy for this scheme[7]. The EA guidance document, Preliminary Rainfall Management for Developments (DEFRA / Environment Agency 2005) was used in the assessment of existing greenfield runoff rates and the calculation of a controlled discharge rate of 2 l/s/ha from the highway drainage.

In addition, the EA guidance document states that long-term storage is to be provided to attenuate the additional volume of runoff from the development compared to the volume that would be contributed from the site in its greenfield state. This volume should ideally be discharged through infiltration or be discharged at a maximum rate of 2 l/s/ha.

Calculations show that the volume of runoff from the proposed development will be four times the site's greenfield runoff rate (pre development). Therefore 75% of the total runoff (additional volume resulting from the development) will need to be stored and discharged at a rate of 2 l/s/ha or less.

[7] Lincoln Eastern Bypass Drainage Strategy Report, Jacobs on behalf of Lincolnshire County Council (2009)

These calculations and discharge figures, which include allowance for climate change, are still appropriate for this development. As the proposed scheme has been changed from a dual carriageway to a single carriageway, these calculations give a conservative estimate of runoff rates.

5.4.3 Attenuation Ponds

The minimum volume capacity of the attenuation ponds are shown in Table 5.

Catchment	Area of Development (ha)	Attenuation Pond Volume Required (m^3)*
1	3.45	2,601
2	4.29	3,302
A	2.7	3,000
B	9.45	Part 1 - 3,918 Part 2 - 2,524
C	9.09	9,048
Note Each attenuation pond contains two cells *Required pond volume is assumed as the 1 in 100 year event + climate change		

Table 5 – Attenuation Pond Volume Details

Pollution control measures will be put in place at all attenuation pond locations comprising a two cell arrangement. Both cells will be lined and cell 1 will include an isolation facility to contain the first flush in case of accidental spillage. Particular attention has been given to the discharge to the Branston Brook tributary due to the proximity of its source and the licensed surface water abstractions located downstream of the discharge point. At this outfall, cell 1 has been designed as a surface flow wetland with the appropriate planting for contaminant removal.

5.5 Flood Risk during Development

Flood Risk also needs to be considered during construction of the Proposed Scheme. Temporary works must be arranged so that they do not adversely affect flood conveyance or flood water levels on any watercourse. In particular, stockpiling of materials should be avoided in floodplain areas close to watercourses. This is unlikely to be an issue since there is ample space available outside the floodplain. The contractor will need to agree temporary works and mitigation measures with the EA.

6 Conclusions

6.1 Sequential and Exception Tests

The NPPF requires that a sequential approach is adopted to ensure that inappropriate development in areas at risk of flooding is avoided by directing development away from areas at highest risk.

The Proposed Scheme is classified as Essential Infrastructure under the NPPF and is partially within Flood Zones 1, 2 and 3. Due to the nature of the development, the proposed road has to cross Main Rivers (and therefore an area of flood risk).

The Proposed Scheme was identified as being of key significance by Lincoln Transport Strategy and the Lincoln Eastern Growth Corridor and therefore provides sustainable benefits to the community. All reasonable alternatives have been investigated, however there are no reasonably available routes for a city bypass in lower flood risk zones. With submission of this FRA, it is demonstrated that the Sequential and Exception Tests are passed.

6.2 Flood Risk

Fluvial flooding is the main source of flood risk in Lincoln, however this risk is currently well managed and a limited number of people are at risk. Consultation with the EA indicates that the fluvial defences protecting the study area are in good condition and provide protection against a flood event with a 1% chance of occurring each year (1 in 100 year). However, when climate change is taken into account, flood defences will provide a lower level of protection.

As the road will be raised above the floodplain, it will not cause any obstruction in the floodplain, however, some bridge abutments will be located in the fluvial floodplain. Hydraulic modelling carried out in 2009 showed that there is no increase in fluvial flood risk with the bypass for the 1 in 100 year event. For the 100 year plus climate change scenario, the flood extent is slightly larger for the proposed scenario due to the bridge abutment restricting flow. Flood volumes were assessed and it is recommended that 1,110m^3 of compensation storage is provided on the southern floodplain to ensure minimal residual risk.

The model was also used to estimate the extent, depth and velocity of flooding which would arise from a breach in defences. The road has been designed to be above the floodplain, including flooding caused by a breach in defences, and therefore it will not be at risk of flooding. There remains a flood risk from failure of fluvial flood defences, however, the flooding only affects rural land and not buildings / urban areas and is not worsened by the Proposed Scheme.

The six watercourses that are to be culverted as part of the Proposed Scheme are to be designed with a sufficient capacity to accommodate the 1 in 100 year event with climate change flows.

The proposed road surface water drainage will discharge to attenuation ponds. The attenuation ponds will store excess runoff caused by the development and outfall into adjacent watercourses at a controlled rate, limiting discharge to the existing greenfield runoff rate of 2 l/s/ha. The highways drainage network has been designed so that there will be no increase in risk of flooding to properties or from attenuation facilities in a 100 year design storm plus 30% increase in rainfall intensity for possible climate change. These measures mean that there will be no increase in flood risk caused by the development.

In terms of flood risk during construction, temporary works must be arranged so that they do not adversely affect flood conveyance or flood water levels on any watercourses. The contractor will need to agree temporary works and mitigation measures with the EA.

Flood risk from other sources including surface water and groundwater is not significant at this site and the existing situation will not be worsened by the proposed bypass.

In summary, the findings of the Flood Risk Assessment show that provided mitigation measures are employed, the proposed Lincoln Eastern Bypass will be safe and will not increase flood risk to the surrounding area.

7 Appendices

Appendix A	Site location maps (from Lincoln Eastern Bypass Flood Risk Assessment, Jacobs (2009)
Appendix B	Lincoln Eastern Bypass Plans
Appendix C	Environment Agency Data

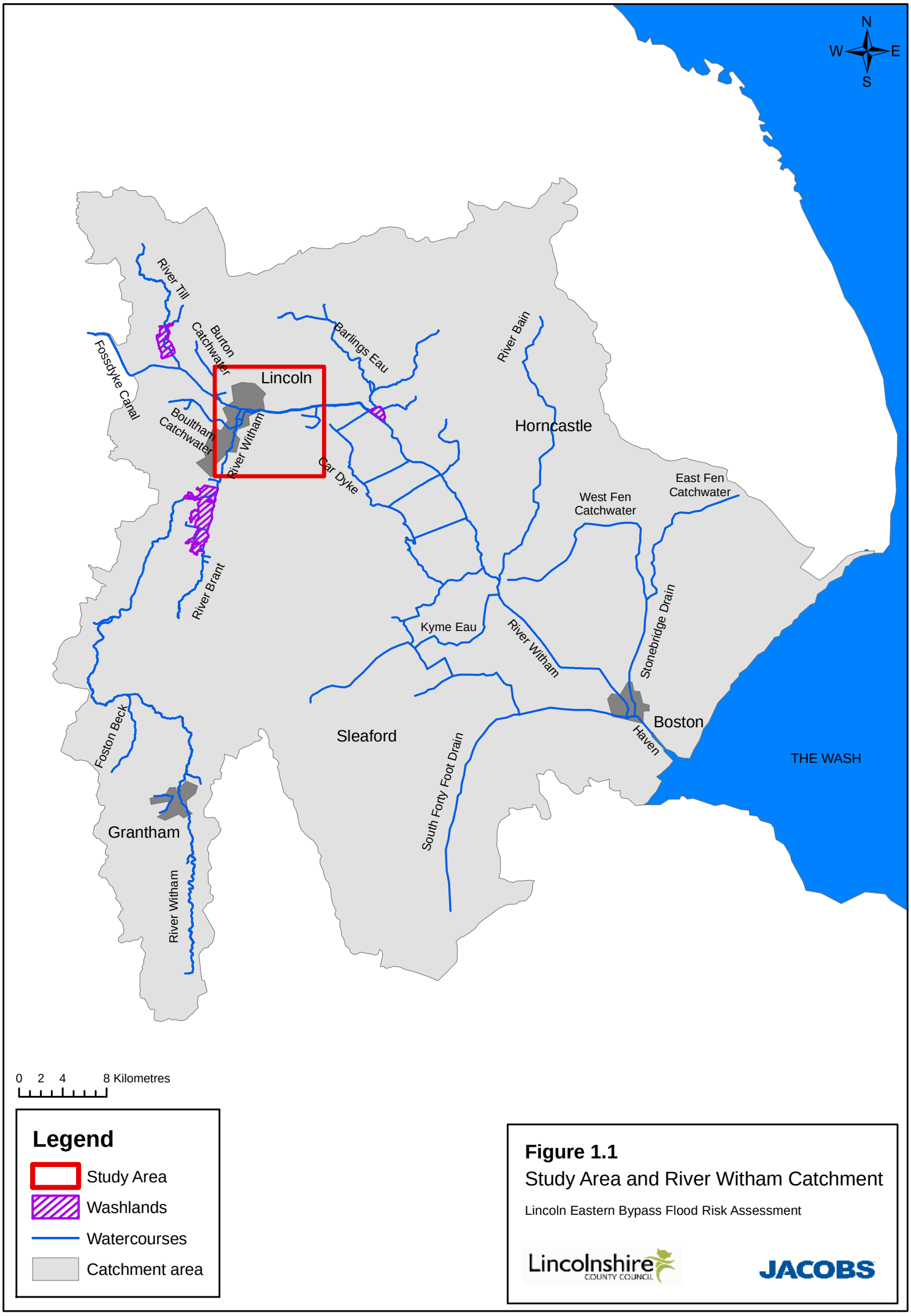


Figure 1.1

Study Area and River Witham Catchment

Lincoln Eastern Bypass Flood Risk Assessment

Lincolnshire County Council

JACOBS

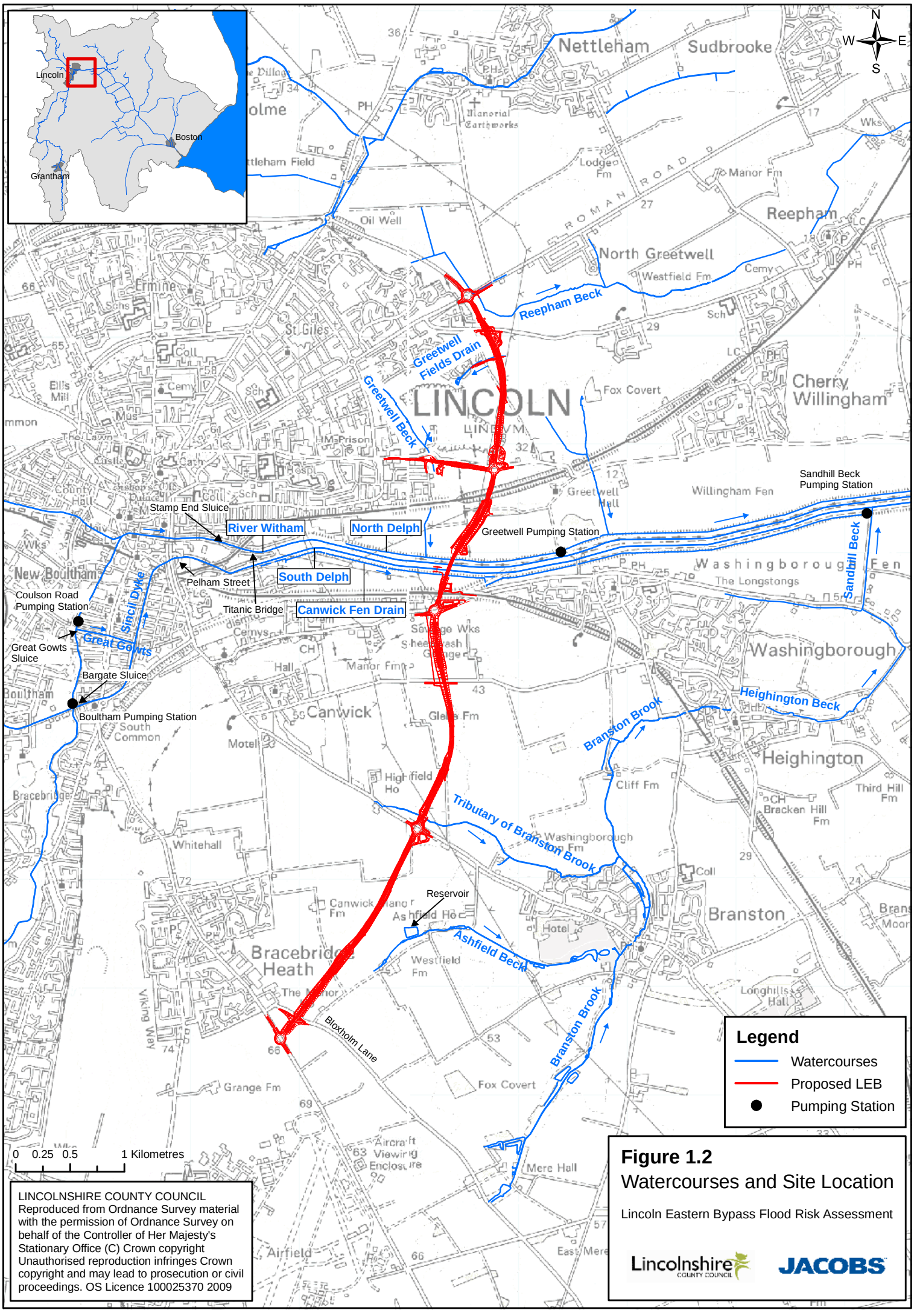
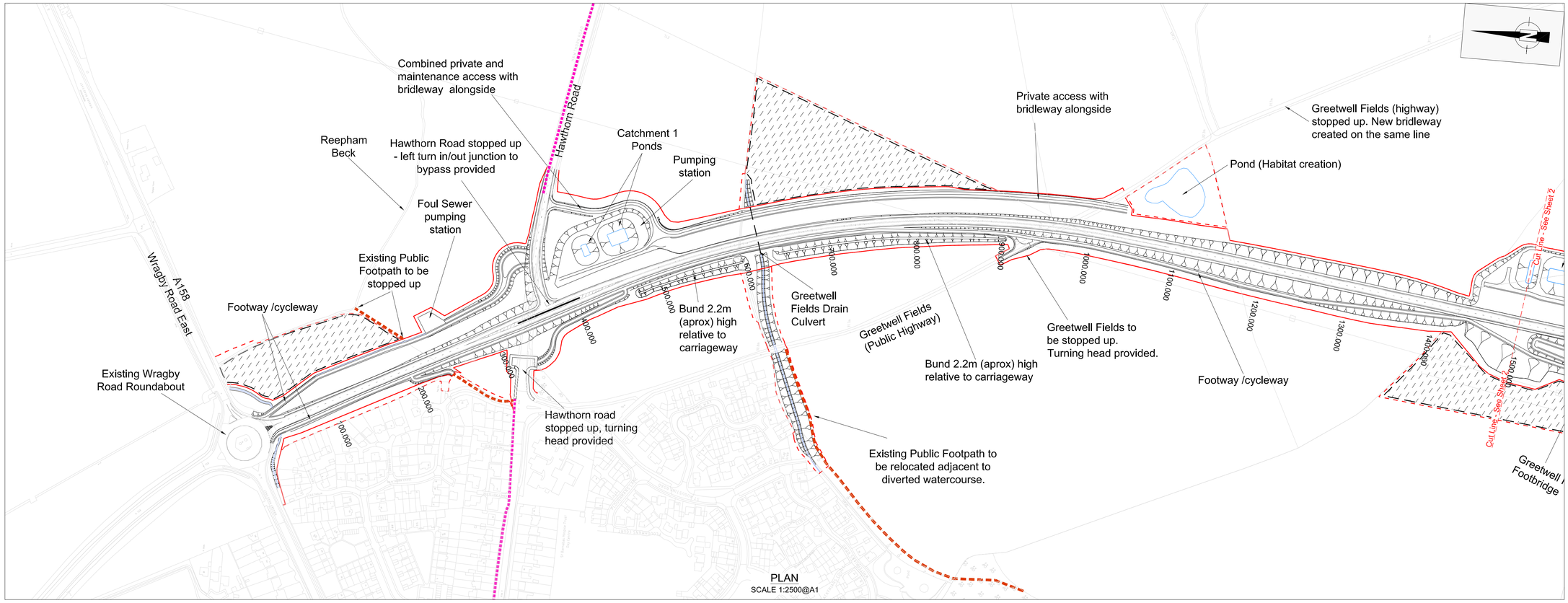


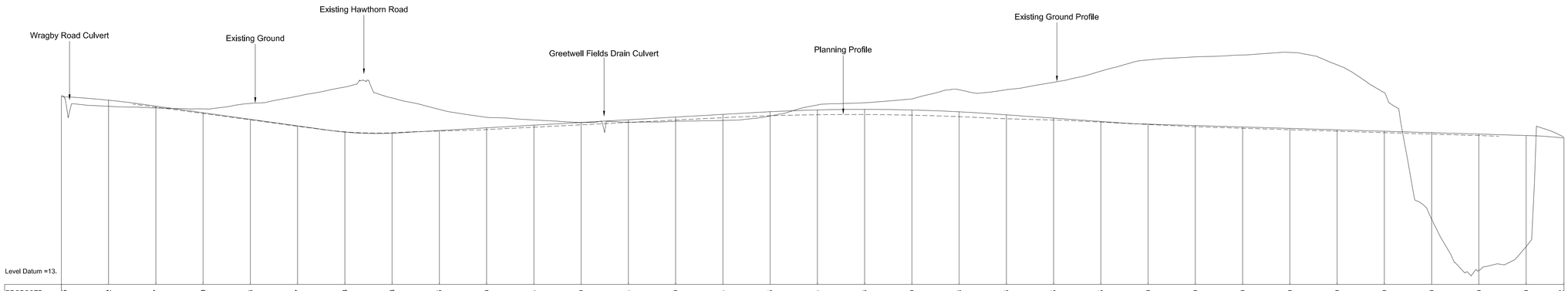
Figure 1.2
Watercourses and Site Location

Lincoln Eastern Bypass Flood Risk Assessment

Lincolnshire COUNTY COUNCIL JACOBS



PLAN
SCALE 1:2500@A1



Level Datum =13.

Chainage	PROPOSED LEVELS	EXISTING GROUND LEVELS	PLANNING SCHEME LEVELS	Gradient	Horizontal	Vertical
0.	32.865	32.964	33.171			
50.	32.472	31.824	32.500	-0.766	straight L=365.988m	L=87.687m R=-10000.m
100.	31.847	31.660	31.828	-1.251		
150.	31.150	31.550	31.157	-1.393		
200.	30.454	32.133	30.485	-1.393		L=194.639m G=-1.393
250.	29.757	32.895	29.814	-1.393		
300.	29.103	33.865	29.224	-1.308		
350.	28.983	32.711	29.126	-0.240	transition L=69.979m	R=3700 L=72.616m
400.	29.265	31.499	29.451	0.563		
450.	29.550	30.666	29.832	0.570		
500.	29.834	30.382	30.084	0.570		
550.	30.119	30.107	30.336	0.570		
600.	30.404	30.149	30.598	0.570		
650.	30.689	30.248	30.840	0.570		
700.	30.974	30.333	31.091	0.570	R=1050.m L=569.966m	G=0.570 L=382.842m
750.	31.255	30.808	31.291	0.562		
800.	31.444	31.969	31.401	0.379		
850.	31.506	32.203	31.422	0.122		
900.	31.439	32.604	31.354	-0.134		
950.	31.243	33.570	31.197	-0.390		
1000.	30.925	33.583	30.938	-0.636	transition L=69.979m	L=247.591m R=-19500.m
1050.	30.575	34.363	30.535	-0.700		L=141.022m G=-0.700
1100.	30.225	35.547	30.247	-0.700		
1150.	29.940	36.730	29.997	-0.570	straight L=514.117m	R=3700 L=14.8
1200.	29.790	37.058	29.755	-0.300		
1250.	29.640	37.250	29.600	-0.300		
1300.	29.490	37.520	29.446	-0.300		L=413.408m G=-0.300
1350.	29.340	36.207	29.291	-0.300		
1400.	29.190	33.268	29.137	-0.300		
1450.	29.040	19.504	28.992	-0.300		
1500.	28.890	14.471	28.828	-0.300		
1550.	28.740	16.989	28.673	-0.300		L=35.4 R=4225
1590.	28.472	28.587	28.543	-0.671		

LONGITUDINAL SECTION
HORIZONTAL SCALE 1:2500@A1, VERTICAL SCALE 1:250@A1

X-Refs & Blocks used in this Drawing

NOTES:

Key

- Existing Public Footpath
- Existing Cycleway
- Indicative location of site compound / construction area
- Indicative location of topsoil storage area
- Proposed Highway Boundary
- Works Boundary

WORK IN PROGRESS

LIVE WORKING DRAWING CURRENTLY UNDER AMENDMENT AND SUBJECT TO UNRECORDED CHANGES PRIOR TO APPROVAL.
DO NOT ISSUE THIS DRAWING

Revision:	Description:	Drawn By:	CAD By:	Approved By:	Approval Date
A	First issue	OM	OM	MB	07/09/2012

Amendment Details

Drawing 1st Approval
1st Approval by: M.Bradshaw
Date: 07/09/2012

Drawn/Designed by:	CAD Drawing Creation Created By:	Date:
O.Makarov	O.Makarov	07/09/2012

Scale@A1: 1:2500 for Plan; 1:250 for Profile

Lincolnshire COUNTY COUNCIL
Highways Alliance
TECHNICAL SERVICES PARTNERSHIP
WITHAM PARK HOUSE,
WITHAM PARK,
WATERSIDE SOUTH
LINCOLN LN5 7JN
Customer Service Centre : (01522) 782070

mouchel

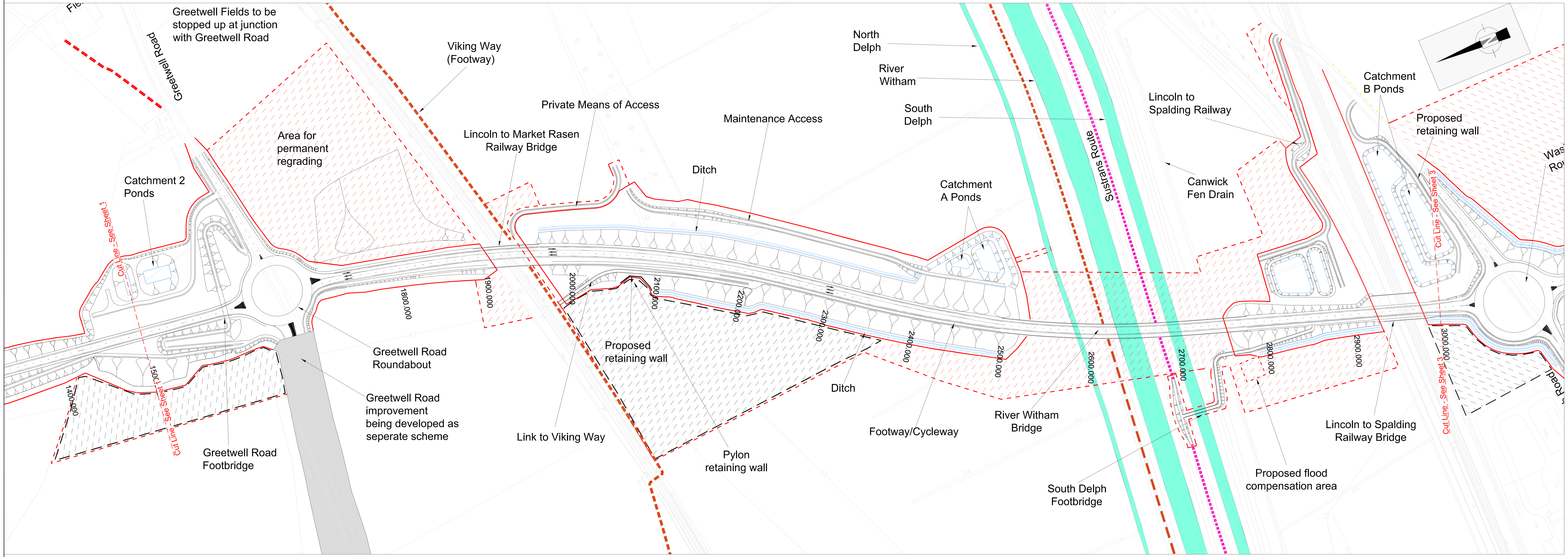
B/1030171/100/023
Paper Size Drawing Number

Rev.A
Revision

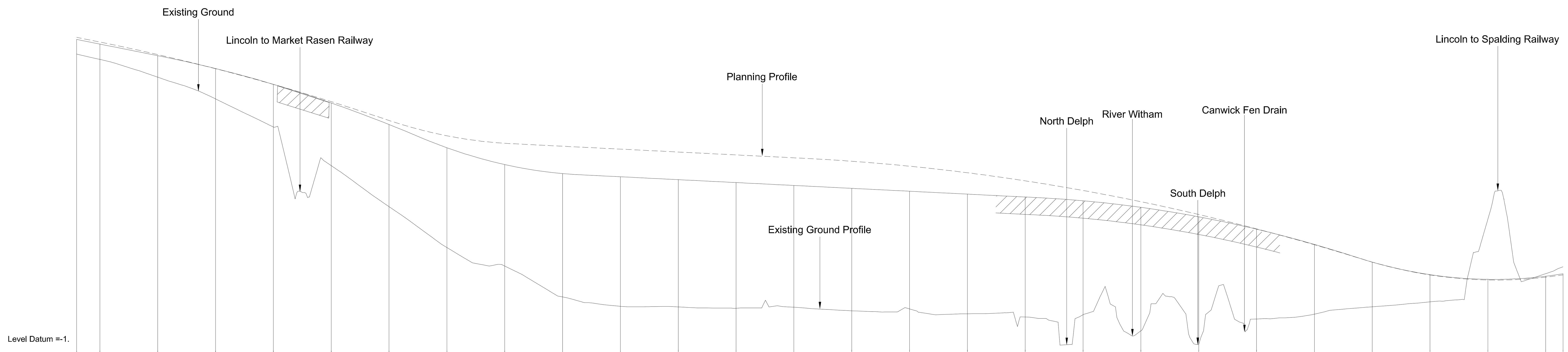
Project: Lincoln Eastern Bypass

Description:

MAIN CARRIAGEWAY
Plan & Profile (Sheet 1 of 5)



PLAN
SCALE 1:2500@A1



Chainage	PROPOSED LEVELS	EXISTING GROUND LEVELS	PLANNING SCHEME LEVELS	Gradient
	26.286	25.027	26.464	
1750.	25.884	24.558	26.063	-2.
1800.	24.884	23.024	24.979	-2.
1850.	23.770	21.146	23.758	-2.227
1900.	22.407	18.716	22.401	-2.726
1950.	20.794	15.377	20.909	-3.226
2000.	18.931	11.832	19.283	-3.726
2050.	16.926	8.301	17.958	-4.011
2100.	15.472	6.697	17.308	-2.908
2150.	14.693	4.029	17.056	-1.557
2200.	14.416	3.221	16.806	-0.554
2250.	14.166	3.168	16.556	-0.500
2300.	13.916	3.049	16.306	-0.500
2350.	13.666	3.138	16.056	-0.500
2400.	13.416	2.827	15.759	-0.500
2450.	13.166	2.993	15.330	-0.500
2500.	12.916	2.575	14.765	-0.500
2550.	12.666	2.293	14.066	-0.500
2600.	12.342	2.499	13.231	-0.649
2650.	11.774	1.099	12.261	-1.136
2700.	10.956	-0.064	11.155 11.155	-1.636
2750.	9.888	2.120	9.915	-2.136
2800.	8.570	2.539	8.540	-2.636
2850.	7.042	3.178	7.039	-3.056
2900.	5.958	3.603	5.928	-2.167
2950.	5.551	10.751	5.492	-0.815
3000.	5.819	6.042	5.732	0.536
3015.	6.028	6.638	5.939	1.397

Horizontal: straight L; transition L=120.922m; R=1020.m L=306.412m; transition L=120.922m; transition L=120.922m; R=-1020.m L=211.487m; transition L=120.922m; staright L=278.893m

Vertical: L=72.498m G=-2.00; L=223.519m R=-10000.m; R=3700.m L=138.202m; L=397.296m G=-0.500; L=273.912m R=-10000.m; R=3700.m L=175.346m

LONGITUDINAL SECTION
HORIZONTAL SCALE 1:2500@A1, VERTICAL SCALE 1:250@A1

X-Refs & Blocks used in this Drawing

NOTES:

Key
- Existing Public Footpath
- Existing Cycleway
- Indicative location of site compound / construction area
- Indicative location of topsoil storage area
- Proposed Highway Boundary
- Works Boundary

WORK IN PROGRESS

LIVE WORKING DRAWING CURRENTLY UNDER AMENDMENT AND SUBJECT TO UNRECORDED CHANGES PRIOR TO APPROVAL. DO NOT ISSUE THIS DRAWING

Revision	Description	Drawn By	CAD By	Approved By	Approval Date
A	First issue	OM	OM	MB	13/04/2011

Amendment Details

Drawing 1st Approval
1st Approval by: M.Bradshaw | Date: 07/09/2012

Drawn/Designed by: O.Makarov
CAD Drawing Creation — Created By: O.Makarov — Date: 07/09/2012

Scale@A1: 1:2500 for Plan; 1:250 for Profile

Lincolnshire COUNTY COUNCIL
Highways Alliance
mouchel

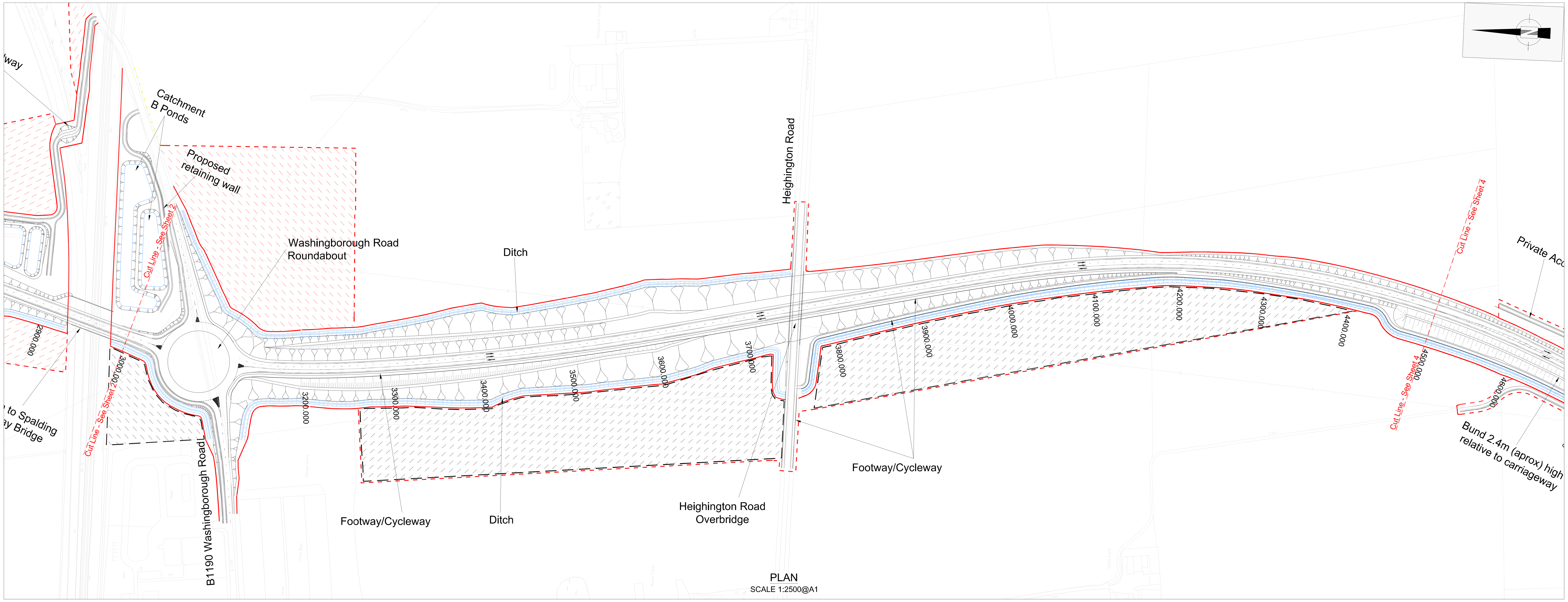
TECHNICAL SERVICES PARTNERSHIP
WITHAM PARK HOUSE,
WITHAM PARK,
WATERSIDE SOUTH
LINCOLN LN5 7JN
Customer Service Centre: (01522) 782070

B/1030171/100/024 — Rev.A
Paper Size — Drawing Number — Revision

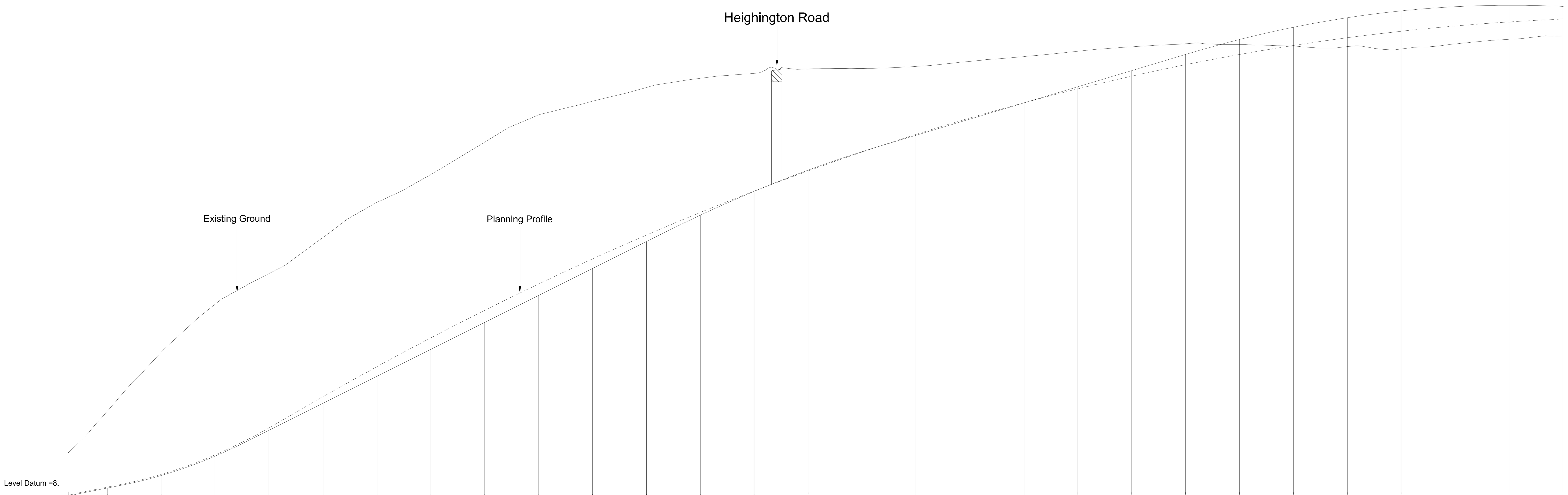
Project: Lincoln Eastern Bypass

Description:

MAIN CARRIAGEWAY
Plan & Profile (Sheet 2 of 5)



PLAN
SCALE 1:2500@A1



PROPOSED LEVELS	8.211	8.935	10.096	11.900	14.306	16.806	19.306	21.806	24.306	26.806	29.306	31.806	34.255	36.470
EXISTING GROUND LEVELS	12.211	16.069	21.541	25.994	28.839	32.184	35.438	38.026	41.030	43.565	44.826	46.103	46.953	47.415
PLANNING SCHEME LEVELS	8.262	9.021	10.194	12.016	14.514	17.407	20.195	22.868	25.425	27.868	30.196	32.409	34.507	36.490
Gradient		2.00	2.322	3.609	4.811	5.00	5.00	5.00	5.00	5.00	5.00	5.00	4.898	4.431
Chainage	3113.	3150.	3200.	3250.	3300.	3350.	3400.	3450.	3500.	3550.	3600.	3650.	3700.	3750.

PROPOSED LEVELS	38.435	40.151	41.667	43.167	44.667	46.168	47.668	49.168	50.553	51.689	52.575	53.210	53.596	53.732	53.618
EXISTING GROUND LEVELS	47.821	47.869	48.058	48.527	48.970	49.466	49.876	50.157	50.095	49.953	49.892	49.675	50.144	50.573	50.872
PLANNING SCHEME LEVELS	38.358	40.111	41.750	43.273	44.681	45.975	47.153	48.217	49.165	49.999	50.717	51.321	51.810	52.184	52.443
Gradient	3.931	3.431	3.033	3.00	3.00	3.00	3.00	3.00	2.771	2.271	1.772	1.272	0.772	0.272	-0.228
Chainage	3800.	3850.	3900.	3950.	4000.	4050.	4100.	4150.	4200.	4250.	4300.	4350.	4400.	4450.	4500.

Horizontal: R=-1020.m L=108.477m | transition L=78.096m | R=-2880.m L=310.405m | straight L=324.058m | transition L=120.922m | R=1020.m L=564.762m

Vertical: G=2.00 L=51.0 | R=3700.m L=111.m | G=5.00 L=391.614m | L=199.982m R=-10000.m | G=3.00 L=284.057m | L=348.260m R=-10001.680m

LONGITUDINAL SECTION
HORIZONTAL SCALE 1:2500@A1, VERTICAL SCALE 1:250@A1

X-Refs & Blocks used in this Drawing

NOTES:
Key
- Existing Public Footpath
- Existing Cycleway
- Indicative location of site compound / construction area
- Indicative location of topsoil storage area
- Proposed Highway Boundary
- Works Boundary

WORK IN PROGRESS

LIVE WORKING DRAWING CURRENTLY UNDER AMENDMENT AND SUBJECT TO UNRECORDED CHANGES PRIOR TO APPROVAL. DO NOT ISSUE THIS DRAWING

Revision	Description	Drawn By	CAD By	Approved By	Approval Date
A	First issue	OM	OM	MB	13/04/2011

Amendment Details

Drawing 1st Approval
1st Approval by: M.Bradshaw Date: 07/09/2012

Drawn/Designed by: O.Makarov
CAD Drawing Creation — Created By: O.Makarov Date: 07/09/2012

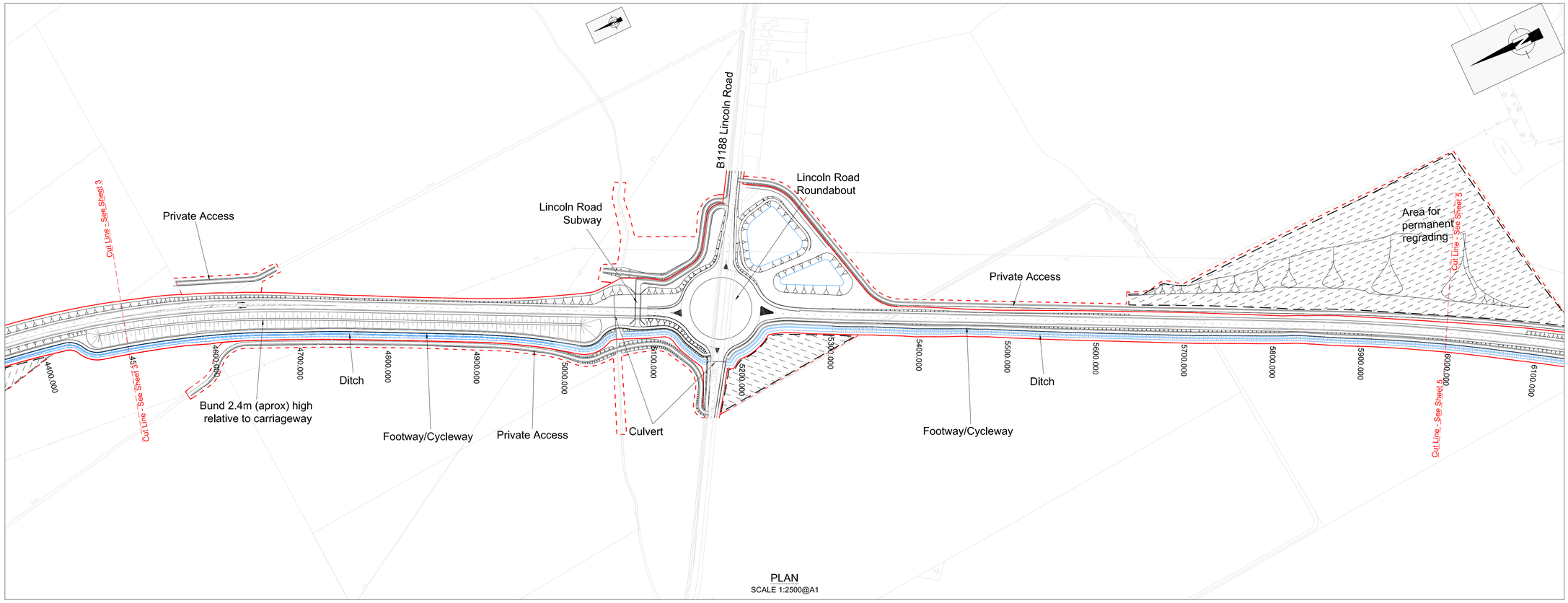
Scale@A1: 1:2500 for Plan; 1:250 for Profile

Lincolnshire COUNTY COUNCIL
Highways Alliance
mouchel

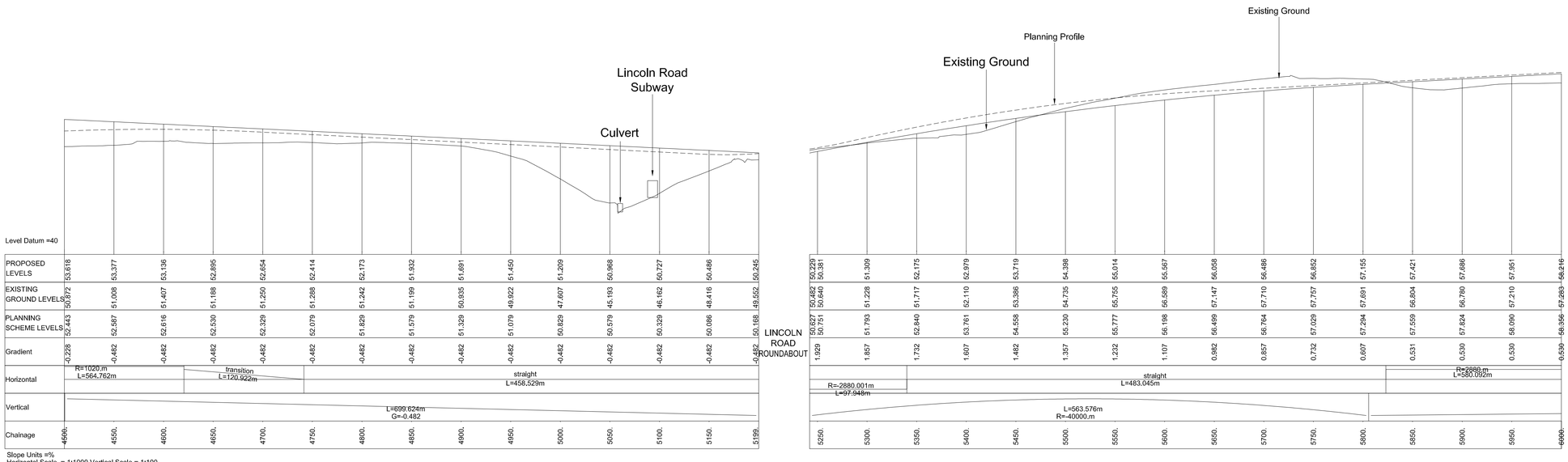
TECHNICAL SERVICES PARTNERSHIP
WITHAM PARK HOUSE,
WITHAM PARK,
WATERSIDE SOUTH
LINCOLN LN5 7JN
Customer Service Centre : (01522) 782070

B/1030171/100/025 — Paper Size, Drawing Number
Rev.A — Revision

Project: Lincoln Eastern Bypass
Description:
MAIN CARRIAGEWAY
Plan & Profile (Sheet 3 of 5)



PLAN
SCALE 1:2500@A1



Slope Units =%
Horizontal Scale = 1:1000,Vertical Scale = 1:100

LONGITUDINAL SECTION
HORIZONTAL SCALE 1:2500@A1, VERTICAL SCALE 1:250@A1

X-Refs & Blocks used in this Drawing

NOTES:

Key

- Existing Public Footpath
- Existing Cycleway
- Indicative location of site compound / construction area
- Indicative location of topsoil storage area
- Proposed Highway Boundary
- Works Boundary

WORK IN PROGRESS

LIVE WORKING DRAWING CURRENTLY UNDER AMENDMENT AND SUBJECT TO UNRECORDED CHANGES PRIOR TO APPROVAL.
DO NOT ISSUE THIS DRAWING

Revision:	Description:	Drawn By:	CAD By:	Approved By:	Approval Date
A	First issue	OM	OM	MB	13/04/2011

Amendment Details

Drawing 1st Approval

1st Approval by: M.Bradshaw | Date: 07/09/2012

Drawn/Designed by:	CAD Drawing Creation Created By:	Date:
O.Makarov	O.Makarov	07/09/2012

Scale@A1: 1:2500 for Plan; 1:250 for Profile

Lincolnshire COUNTY COUNCIL
Highways Alliance
TECHNICAL SERVICES PARTNERSHIP
WITHAM PARK HOUSE,
WITHAM PARK,
WATERSIDE SOUTH
LINCOLN LN5 7JN
Customer Service Centre : (01522) 782070

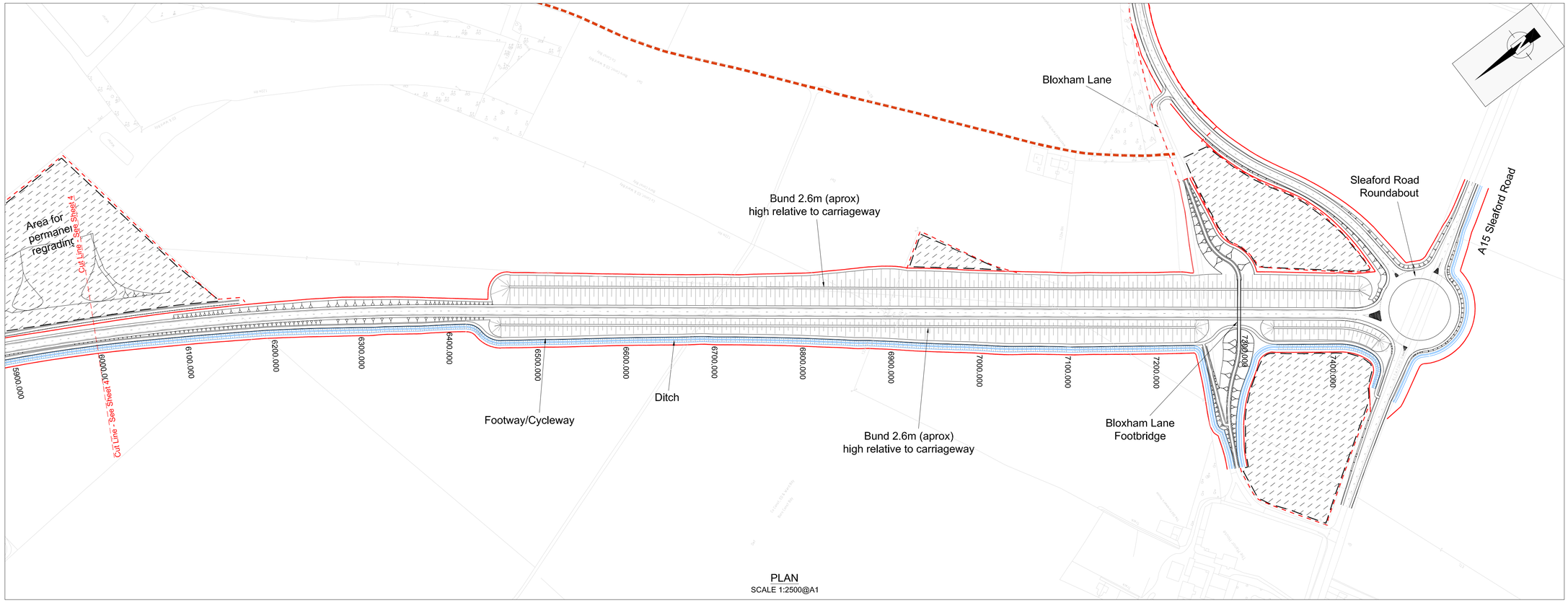
mouchel

B/1030171/100/026 (Paper Size / Drawing Number) | Rev.A (Revision)

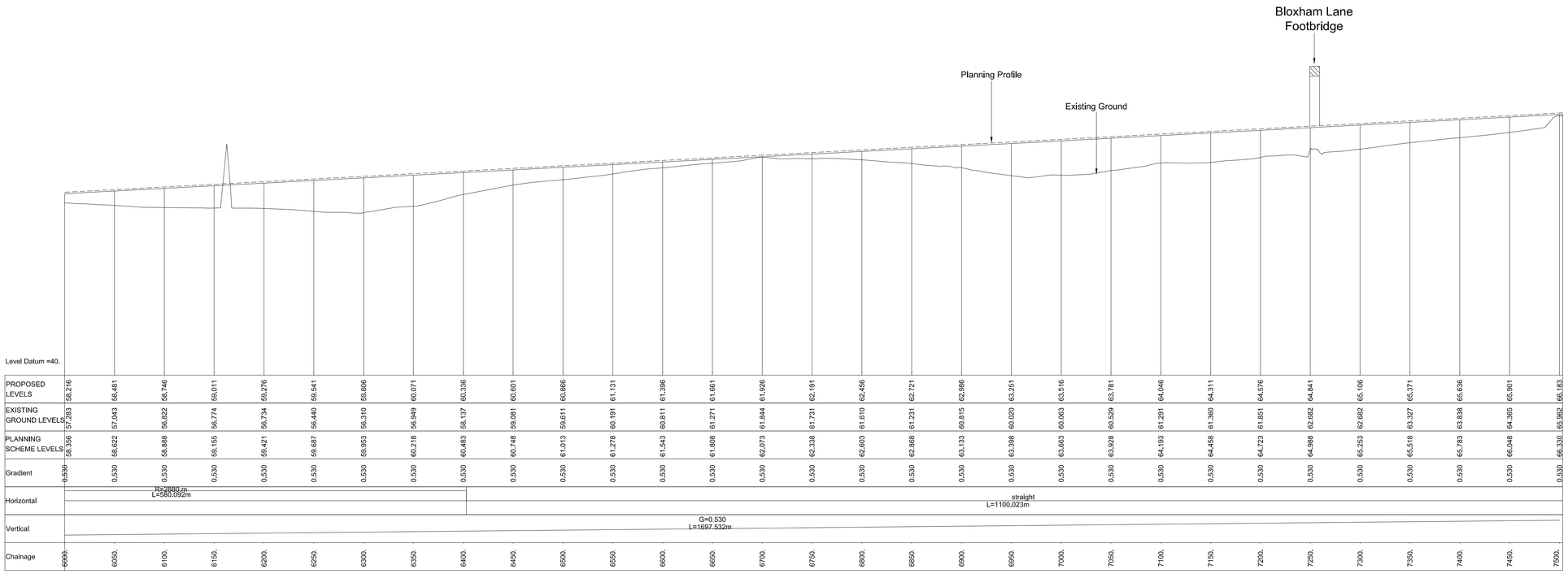
Project: Lincoln Eastern Bypass

Description:

MAIN CARRIAGEWAY
Plan & Profile (Sheet 4 of 5)



PLAN
SCALE 1:2500@A1



LONGITUDINAL SECTION
HORIZONTAL SCALE 1:2500@A1, VERTICAL SCALE 1:250@A1

X-Refs & Blocks used in this Drawing

NOTES:

Key

- Existing Public Footpath
- Existing Cycleway
- Indicative location of site compound / construction area
- Indicative location of topsoil storage area
- Proposed Highway Boundary
- Works Boundary

WORK IN PROGRESS

LIVE WORKING DRAWING CURRENTLY UNDER AMENDMENT AND SUBJECT TO UNRECORDED CHANGES PRIOR TO APPROVAL.
DO NOT ISSUE THIS DRAWING

Revision:	Description:	Drawn By:	CAD By:	Approved By:	Approval Date
A	First Issue	OM	OM	MB	13/04/2011

Amendment Details

Drawing 1st Approval

1st Approval by: M.Bradshaw | Date: 07/09/2012

Drawn/Designed by:	CAD Drawing Creation Created By:	Date:
O.Makarov	O.Makarov	07/09/2012

Scale@A1: 1:2500 for Plan; 1:250 for Profile

Lincolnshire COUNTY COUNCIL
Highways Alliance
TECHNICAL SERVICES PARTNERSHIP
WITHAM PARK HOUSE,
WITHAM PARK,
WATERSIDE SOUTH
LINCOLN LN5 7JN
Customer Service Centre : (01522) 782070
mouchel

B/1030171/100/027 (Paper Size / Drawing Number) | Rev.A (Revision)

Project: Lincoln Eastern Bypass

Description:

MAIN CARRIAGEWAY
Plan & Profile (Sheet 5 of 5)

Dear Hilary
<hilary.hampton@mouchel.com>

Our ref: CCN-2012- 32819
Your ref:

Date: 2 November 2012

Dear Hilary

Basic Flood Risk Assessment Data Request for Lincoln Eastern Bypass.

Thank you for your request of September 2012 to use Environment Agency data, Product 3, in the development of the Flood Risk Assessment (FRA) for the above site. The information is attached.

If you have requested this information to help inform a development proposal, then you should note the detail in the attached advisory text on the use of Environment Agency Information for Flood Risk Assessments / Flood Consequence Assessments.

Flood Map
The attached map includes the current Flood Map for your area. The Flood Map indicates the area at risk of flooding, **assuming no flood defences exist**, for a flood event with a 0.5% chance of occurring in any year for flooding from the sea, or a 1% chance of occurring for fluvial (river) flooding. It also shows the extent of the Extreme Flood Outline which represents the extent of a flood event with a 0.1% chance of occurring in any year, or the highest recorded historic extent if greater.

The Flood Map only indicates the extent and likelihood of flooding from rivers or the sea. It should also be remembered that flooding may occur from other sources such as surface water sewers, road drainage, etc.

Fluvial Flood Levels
The fluvial flood levels for the model nodes shown on the attached map are set out in the table below. They are measured in metres above Ordnance Datum Newlyn (mODN).

Contd…/

Waterside House, Waterside North, Lincoln, LN2 5HA
Customer services line: 03708 506 506
Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

			Annual Exceedance Probability - Maximum Water Levels (mODN)				
Node Label	Easting	Northing	4% (1 in 25)	1% (1 in 100)	1% (1 in 100) inc Climate Change	0.1% (1 in 1000)	0.1% (1 in 1000) inc Climate Change
LWC_49000	499422	371040	4.63	4.70	4.76	4.88	4.94
LWC_47472	500958	370865	4.59	4.66	4.72	4.84	4.91
LWC_46000	502414	371114	4.57	4.63	4.69	4.81	4.88
SO_49000	499405	370990	4.63	4.70	4.76	4.88	4.95
SO_47472	500967	370812	4.59	4.65	4.72	4.84	4.90
SO_46000	502413	371058	4.56	4.63	4.69	4.81	4.88

These levels are taken from the Lower Witham Flood Map Improvements Model (October 2009) and are the most up-to-date currently available. We aim to review our models on a regular basis, so if you are using these levels more than twelve months from the date of this letter, please contact us again to check that they are still valid.

Please note that these levels are “in-channel” levels and therefore may not represent the flood level on the floodplain, particularly where the channel is embanked or has raised defences.

Fluvial Defence Information
The fluvial defences protecting this site consist of earth embankments and upstream flood storage reservoirs. They are in good / fair condition and provide protection against a flood event with a 20% chance of occurring in any year (1 in 5). We inspect these defences regularly to ensure that any potential defects are identified early.

Historic Flood Extent Map
A copy of the Historic Flood Extent Map for your area is enclosed. This shows the extent of previous recorded flooding in your area, notably March 1947, April 1981 and October 1993. It is possible that other flooding may have occurred that we do not have records for, and other organisations, such as the Local Authority or Internal Drainage Boards, may have records.

Land Drainage
The information provided is limited to flood risk from the sea and rivers with catchment areas greater than 3km^2. The property is in an area of extensive land drainage which may pose an additional risk of flooding. Further information should be sought from the Witham First Internal Drainage Board (tel: 01522 697123) and the Witham Third Internal Drainage Board (tel: 01522 697123)

Climate Change
Climate change will increase flood risk due to overtopping of defences. Please contact our Development & Flood Risk Team to discuss how this risk should be considered within your Flood Risk Assessment.

This information is provided subject to the enclosed notice, which you should read.

If you have any queries or would like to discuss the content of this letter further please contact Iain Drury using the telephone/email details below. Please quote our

CCN reference number in all correspondence where data is referenced, including the Flood Risk Assessment.

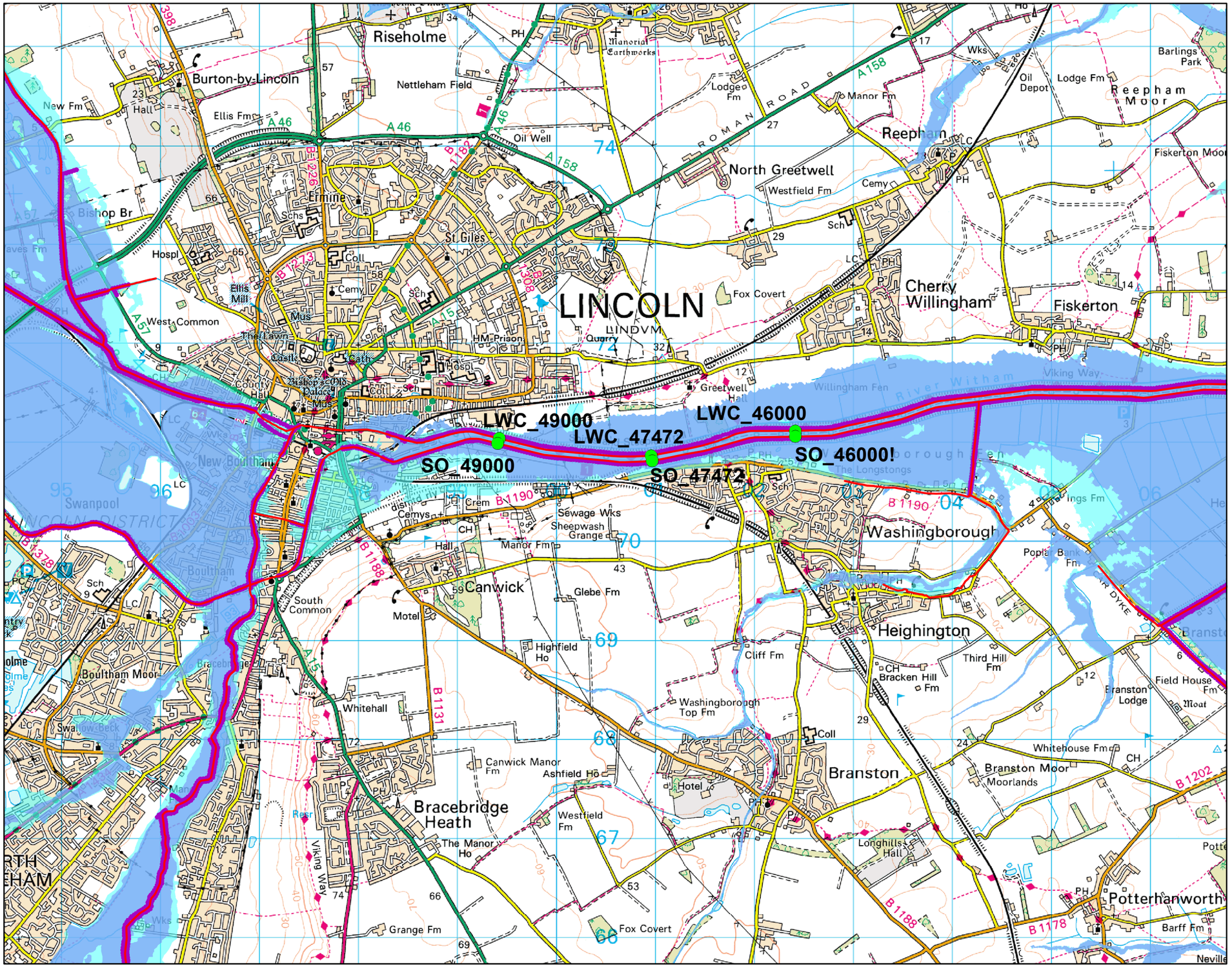
Yours sincerely

FOR John Ray
Coastal Partnerships & Strategic Overview Team Leader

Direct dial 01522 785011
Direct fax 01522 785018
Direct e-mail iain.drury@environment-agency.gov.uk

Enc.
FRA Advisory Text
Basic FRA Map
Historic Flood Extent Map
Standard Notice

Basic FRA Map centred on TF 00597 70582 - created September 2012 [Ref: CCN-2012-32819]



Environment Agency

Scale 1:40,000

N
W E
S

Model_Nodes

Main River

Dark blue shows the area that could be affected by flooding, either from rivers or the sea, if there were no flood defences. This area could be flooded:

- from the sea by a flood that has a 0.5% (1 in 200) or greater chance of happening each year.

- or from a river by a flood that has a 1% (1 in 100) or greater chance of happening each year.

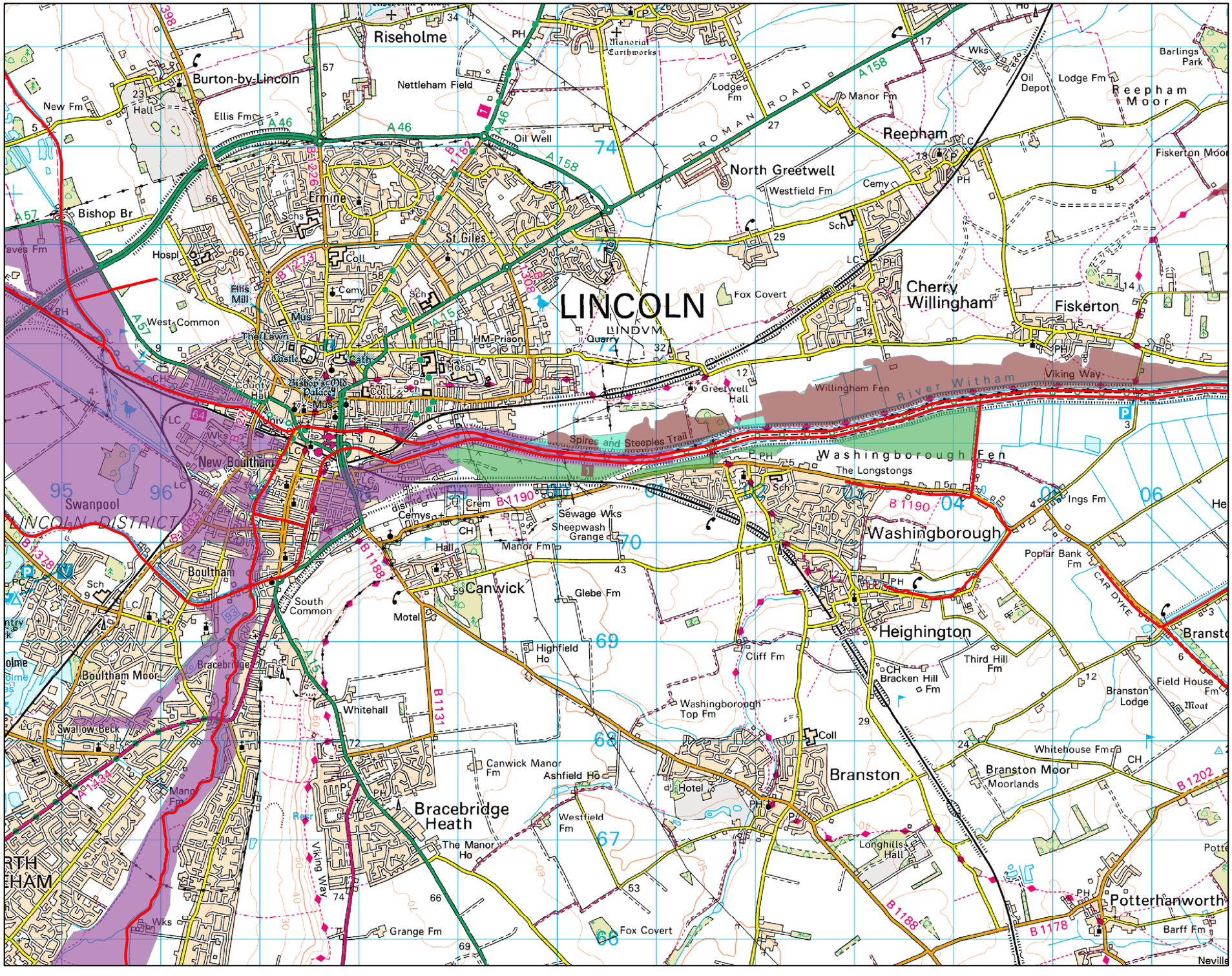
Light blue shows the extent of the Extreme Flood Outline, which represents the extent of a flood event with a 0.1% chance of occurring in any year, or the highest recorded historic extent if greater.

These two colours show the extent of the natural floodplain if there were no flood defences or certain other manmade structures and channel improvements. Sites outside the two extents, but behind raised defences, may be affected by flooding if the defences are overtopped or fail.

Produced by Partnerships and Strategic Overview Team

Historic Flood Extent Map

Map centred on TF 00597 70582 - created September 2012 [Ref: CCN-2012-32819]



Environment Agency

Scale 1:40,000

N
W E
S

Main River

Historic Flood Event

- April 1981 on the Barlings Eau System
- April 1981 on the South Delph d/s of Lincoln
- March 1947 on the River Witham in Lincoln
- October 1993 on the Barlings Eau

Please refer to the attached datasheet for more information

Produced by Partnerships and Strategic Overview Team

Hilary Hampton

From: Coe, Steven [steven.coe@environment-agency.gov.uk]
Sent: 09 November 2012 13:46
To: Hilary Hampton
Subject: RE: LEB Jacobs 2009 Hydraulic Modelling Report

Hillary

Having now looked through the Hydraulic Modelling Report from April 2009 I can now advise the following:

The modelling work can be considered to be fit for purpose with the following points to be made aware of:

- The river levels and flows that were used in the report are very similar to the revised levels that we now have available.
- The downstream model boundary is only 250m downstream of the breach and the location of the bypass structure which may be exaggerating the impact on the flood extents.
- The flood extent for the 1% annual probability event is smaller than for some of our own modelling work. However as the report is aiming to assess the impact of the bypass the different to the report and our own modelling is immaterial.

As the report is to be included in a new application it needs to be accompanied by a statement that refers to the points which have been raised above. This will help to bring the report up to date for consideration with the new planning application.

If you have any questions in relation to this please get in touch.

Regards

Steven Coe
Flood and Coastal Risk Management Officer
Partnerships and Strategic Overview Team (Lincolnshire)

Environment Agency
* Guy Gibson Hall, Manby Park, Louth, LN11 8UR
(01522 785343
(7 50 5343 (internal)
8 steven.coe@environment-agency.gov.uk

From: Hilary Hampton [mailto:Hilary.Hampton@mouchel.com]
Sent: 23 October 2012 13:54
To: Coe, Steven
Subject: LEB Jacobs 2009 Hydraulic Modelling Report
Importance: High

Dear Steve,

Please find attached the report we have been discussing in terms of it's validity for use in supporting

the 2012 LEB scheme.

We would be grateful if confirmation can be provided that this modelling is suitable for use for the 2012 scheme.

Kind regards,

Hilary

Hilary Hampton
Flooding Engineer
Flooding, Coastal and Drainage Team

Mouchel, 37-39 Perrymount Road, Haywards Heath, West Sussex RH16 3BN

T: +44 (0) 1444 472374
M: +44 (0) 7787 923541
www.mouchel.com

Our Services include:
Acoustics, Air Quality, Coastal Engineering and management, Contaminated land assessment and remediation, Drainage assessments and design, Ecology, Environmental Assessment and Management, Flood Risk Management, Geospatial Systems, Geotechnical Engineering, Heritage, Human Health Risk Assessment, Hydrogeology, and Groundwater Engineering, Hydrology, Hydraulic Modelling, Hydrometrics and Water Environment Monitoring, Land and Engineering Survey, Land Services, Landscape and Urban Design, Maritime Engineering, Sustainability, Waste, Water and wastewater treatment

Agency at www.environment-agency.gov.uk