MOTT MACDONALD

NORTH LINCOLNSHIRE COUNCIL
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Lincolnshire Lakes Area Action Plan

Flood Risk Assessment
AAP Development

8 August 2019

North Lincolnshire Council
358811-MMD-XX-00-RP-C-0024

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Contents

1 Introduction

This document is a strategic Flood Risk Assessment for the Lincolnshire Lakes Area Action Plan (LLAAP). It has been prepared for the purposes of informing future development in the LLAAP about the flood risks principally associated with the River Trent as well as secondary sources such as land drainage and ground water.

It is envisaged that this document will be used to provide guidance to developers wishing to enter in to agreements with North Lincolnshire Council to develop parcels of land within the LLAAP area, without the need to remodel flood risk associated with the River Trent.

In addition, the document will also identify further elements of flood risk, resilience and resistance that will need to be considered on a site-by-site basis in order for each developer to determine suitable development levels and strategies to mitigate flood risk.

This document is issued to support the proposed development of land located to the east of the River Trent near Burringham, North Lincolnshire.

This document should be read in conjunction with other relevant planning documentation.

1.1 Background

The Lincolnshire Lakes Area Action Plan (LLAAP) is a strategic regeneration scheme proposed and endorsed by North Lincolnshire Council on the western fringe of the Scunthorpe urban area. As part of the scheme, it is proposed to develop an area of low lying land beside the River Trent to the west of Scunthorpe. On this basis, one of the key components of the scheme is to deliver a flood management solution that seeks to ensure a safe development, with an appropriate level of flood risk.

Mott MacDonald has been instructed by North Lincolnshire Council to undertake the design of improvements to the existing flood embankment on the right bank of the River Trent. This extends from the M180 motorway crossing for 3.6 km downstream to Keady Bridge in the north.

These works will then enable the development within the existing flood plain of circa 6000 new residential properties.

This Flood Risk Assessment will identify the residual risks that may affect any development in the LLAAP and provide guidance for mitigation of the risk such that the developments are safe for the lifetime of their use and without increasing flood risk elsewhere.

1.2 Site location

The LLAAP area is described in detail in North Lincolnshire Council's Area Action Plan document issued in 2016. It comprises 2063 hectares of land to the west of Scunthorpe.

Its boundaries are Scotter Road to the east, with the town of Scunthorpe beyond, the River Trent to the west, the M180 to the south and, to the north, the B1216 to the River Trent at Neap House.

The full AAP area is shown in Figure 1 below.

This area includes land to the north of the railway line however, this part of the AAP is not contained within the study area for the Flood Risk Assessment. Flood defence works are proposed on the section of the left bank of the River Trent from the M180 over-bridge to the

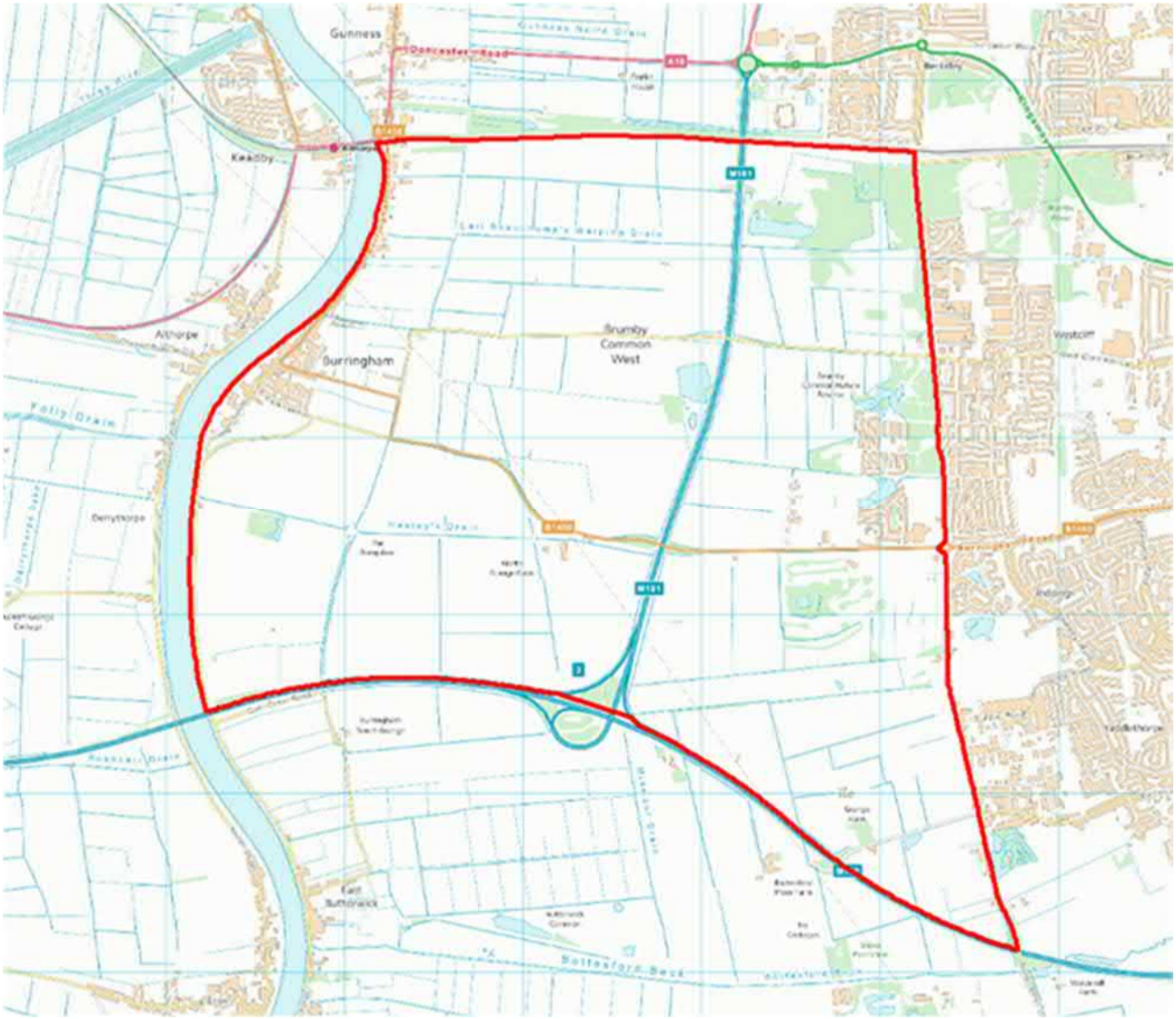
Keadby rail bridge with the railway embankment effectively acting as a boundary to the flood cell for the proposed development area.

This area is noted in Figure 2 and a more detailed plan is included in Appendix A.

Figure 1: Lincolnshire Lakes AAP

Source: North Lincolnshire Council Lincolnshire Lakes AAP 2016

Figure 2: Lincolnshire Lakes AAP Study Area



Source: Contains Ordnance Survey data Crown copyright and database right © 2017

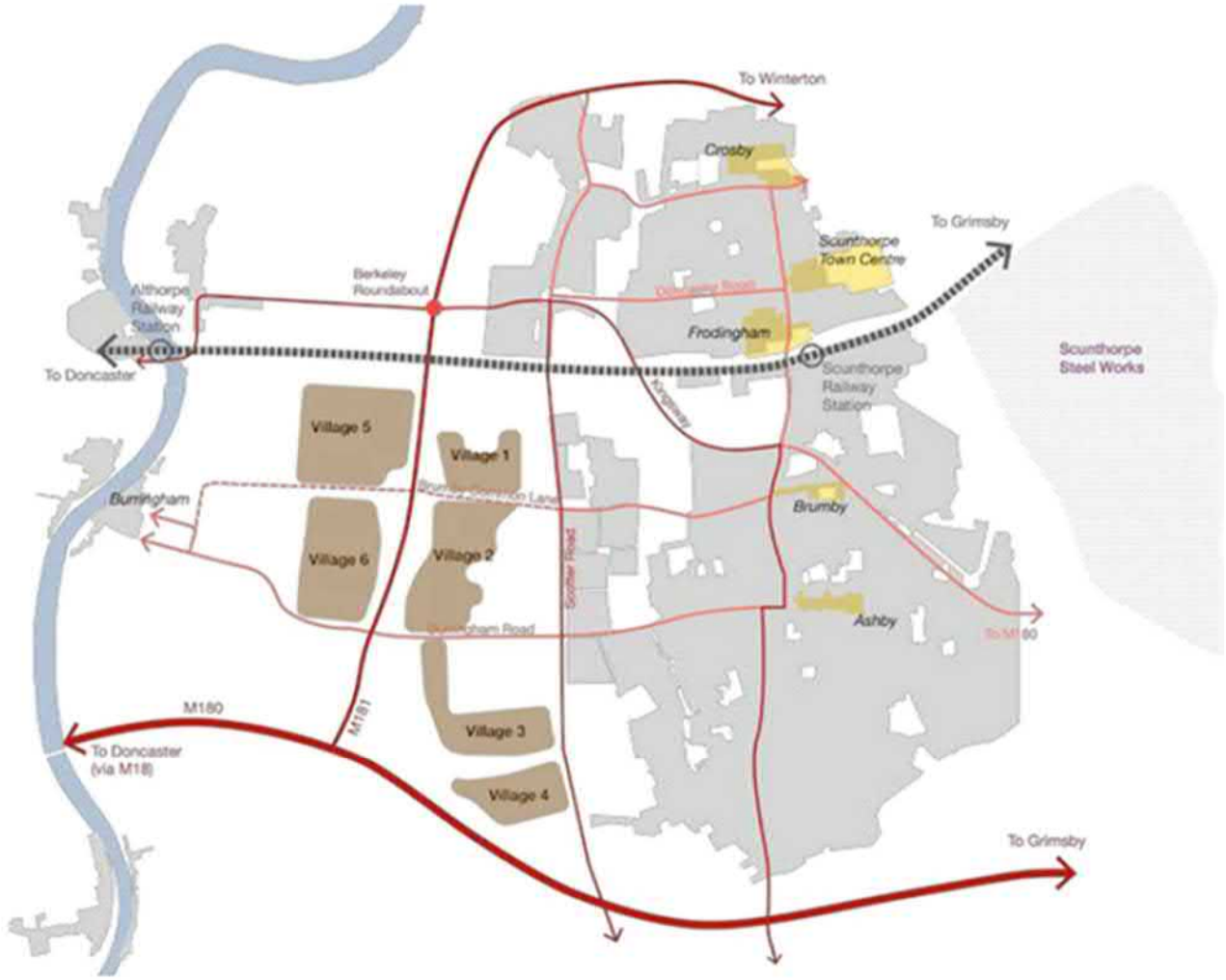
1.3 Residential Development Areas

The locations of the proposed residential development have been initially allocated. There are six main ‘villages’, noted on the plan in Figure 3 below.

These are located either side of the M181 and extend north and south between the M180 and the railway embankment to the north. Access to the developments will be via the M181 with specific new junctions created to facilitate this.

In addition, there is a further allocated development to the south of village 6 between the M180 and M181.

Figure 3: Lincolnshire Lakes Strategic Plan



Source: LL Strategic Design Guide, November 2016

These footprints have been used in all modelling works, the actual constructed footprint may vary but will be discussed in a site-specific FRA for each location.

1.4 Lincolnshire Lakes Flood Defence Scheme

The site is located on the right (eastern) bank of the River Trent and is approximately 3.6km in length, as shown in Figure 4. It runs from the M180 bridge in the north (NGR 483228, 407474) downstream to Keadby Bridge (NGR 484198, 410659). The village of Burringham lies on the right bank of the River Trent in the centre of the study area. Burringham is located approximately 4km west of the edge of Scunthorpe.

Figure 4 indicates the chainage along the length of certain features, for example field boundaries. This is the distance measured in metres along the river bank from the downstream boundary, i.e. the M180. Chainage is depicted as Ch. 200, where the distance from the downstream boundary is 200m.

Figure 4: Indicative River Flood Defence Site Location Plan

Source: Contains data from Bing - Copyright (c) 2009 Microsoft Corporation

During the feasibility stage, the Lincolnshire Lakes Flood Management and Drainage Strategy report[1] was prepared for North Lincolnshire Council. This report gave a broad assessment of flood risks to the LLAAP development site, potential measures to mitigate flood risk and recommendations for drainage requirements and was intended to inform the final option masterplan for Lincolnshire Lakes. The report presented three broad options; flood defence improvements, the construction of secondary defences, and raising the footprint of the development site. All options assume the retention of the existing embankment.

1.5 Purpose of this report

The United Kingdom Government has placed increasing priority on the need to take full account of the risks associated with flooding at all stages of the planning and development process, to reduce future damage to property and loss of life. The Planning Policy Guidance – Technical Guidance (PPG-TG) identifies how flooding is dealt with in the drafting of planning policy and the consideration of planning applications.

The purpose of this report is to assist our Client, North Lincolnshire Council and the Local Planning Authority (also North Lincolnshire Council) to make an informed decision on the flood risks associated with the proposed residential development scheme.

[1] URS (2014) Lincolnshire Lakes Flood Management and Drainage Strategy

Local Planning Authorities have the powers to control development in accordance with the guidelines contained in PPG-TG, and are expected to apply a risk-based approach to development with the Sequential Test. This sets out a sequential characterisation of flood risk in terms of annual probability of river, tidal and coastal flooding.

Mott MacDonald has been appointed to identify and evaluate flood risk associated with the residential development and to identify mitigation measures that will make the developments safe for the lifetime of their use while not increasing flood risk elsewhere.

The FRA will discuss mitigation options for each development area for all identified sources of flood risk.

1.6 Resources and References

In compiling this assessment various additional texts have been used and are referred to throughout to support this document.

The FRA will include reference to the following documents comprising both publicly available guidance documents and technical documents prepared as part of this planning application.

1. Planning Practice Guidance – Technical Guidance (PPG-TG)[2]
2. Environment Agency Flood Risk Standing Advice for England[3]
3. Adapting to Climate Change: Guidance for Risk Management Authorities[4]
4. Hydraulic Modelling Report – 358811-MMD_00-XX-RP-0019 – Mott MacDonald;
5. Flood Defence FRA – 358811-MMD_00-XX-RP-0020 – Mott MacDonald;
6. AAP Development Drainage Strategy – 358811-MMD_00-XX-RP-0021 – Mott MacDonald;
7. Land Drainage Modelling Report – 358811-MMD_00-XX-RP-0023 – Mott MacDonald;
8. Ground Water Flood Risk Assessment – 358811/WCD/WAM/01/A.

1.7 Extent of Liability

Mott MacDonald will follow accepted procedure in providing the services but given the residual risk associated with any prediction and the variability that can be experienced in flood conditions, Mott MacDonald accepts no liability for and gives no warranty against actual flooding of property (Client's or third party) or the consequences of flooding in relation to the performances of the service.

Allowance for the effects of climate change will be made in accordance with government recommendations in place and statistical data available at the time of writing this report. These recommendations may become more onerous and the statistical data may be revised in the future; we will not make any estimate of what changes may result from this. Please be aware that this and other issues over which the consultant has no control, may affect future flood risk at your development and require you to undertake further work for which we accept no liability.

[2] http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/

[3] https://www.gov.uk/flood-risk-assessment-local-planning-authorities

[4] https://www.gov.uk/government/publications/adapting-to-climate-change-for-risk-management-authorities

2 Scheme Description

2.1 Options Considered

Previous reports have identified areas within the flood plain that would be suitable for residential development, these are shown in Figure 3. The viability of each of these areas remains subject to the form and extent of the separately issued flood defence scheme and therefore only the footprint of the development areas has been identified to date.

This FRA will help to identify the remaining criteria for the proposed residential and infrastructure development in each area.

2.2 Mitigation Selection

2.2.1 Defence Level

The proposed flood levels in the flood plain area are dictated by the adopted flood defence scheme on the right bank of the River Trent between the M180 bridge and Keadby Rail Bridge.

This is dealt with in more detail in the specific FRA reference RP-0020 but, in summary, a sheet pile wall will be installed with a managed overflow area to locally control levels in the channel. The residential development areas will be protected by the defences but will need to be safe during extreme overtopping and breach events.

The estimated flood level for the overtopping and breach scenarios has been evaluated in RP-0020 and is reported herein. It is a requirement for each site-specific development FRA that the ultimate level of each mitigation solution is determined.

2.2.2 Proposed Standard of Protection

The proposed flood defence works along the River Trent aim to reduce the risk of breach between M180 and Keadby Bridge to improve the safety of the Lincolnshire Lakes development. The flood defence strengthening works contribute to reducing residual flood risk in this area and to assist the new development to comply with the National Planning Policy Framework requirements for flood risk mitigation.

The standard of protection for each development area will need to take into consideration the current defence levels of the hard defences along the River Trent and current climate change guidance[5].

The minimum requirement for each development area will be the relevant 0.5%AEP+Climate Change Tidal or Fluvial event.

2.2.3 Surface Water Management

The scale of the development will generate significant new impermeable areas within the flood plain and if left unmitigated will generate commensurate increases in runoff.

The Lincolnshire Lakes scheme provides an opportunity for the application of a fully sustainable drainage system (SuDS) to mitigate this flood risk at source. This approach is endorsed in the more detailed separately issued AAP Development Drainage Strategy (RP-0021). This

[5] Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities

describes a SuDS based approach that promotes the use of the most sustainable drainage systems as the principle means of surface water management.

2.2.4 Land Drainage

The whole AAP area is dominated by an artificial ditch drainage system, maintained in the most part by the local Internal Drainage Board (IDB) with some riparian sections.

The development of the residential schemes and any associated land raising will inevitably impact on the operation, connectivity and performance of this system. These impacts have been identified and evaluated in the separately issued Land Drainage Modelling Report (RP-0023) and the AAP Development Drainage Strategy (RP-0021).

The development of the residential areas will require the modification of approximately 6.3km of ditches and possibly the installation of 180m of culvert, should land raising be carried out across the area.

3 Flood Risk Methodology

3.1 Introduction

The FRA will demonstrate the modelled flood levels in proximity to each development area based on a variety of storm scenarios.

In addition to this, to deliver the proposed footprint of each of the villages, the impact of the development on the local existing sources of flood risk will be evaluated.

Finally, as part of the protection of the development themselves from flood risk, the management of surface water generated within the sites will be discussed.

The impacts of the works have been assessed in relation to specific categories summarised thus:

1. Settlements / Property – this is the residential element of the development villages and will typically receive the highest level of protection;
2. Key Infrastructure – critical parts of infrastructure needed to develop each village such as gas governors, electrical sub-stations etc will need to be assessed and mitigation provided to ensure the develops remain habitable during extreme events;
3. Leisure and Commercial – Less Vulnerable type development can tolerate some residual flood risk and some may be located in areas not suitable for residential development, this may include commercial, industrial and leisure type developments with commensurate flood resilient construction;
4. Ancillary infrastructure – This covers other pieces of infrastructure that may be affected but which is water-compatible (ditches, watercourses or agricultural land) or is Less Vulnerable (car parks, roads).

3.2 Strategic Approach

In order for the developers in the LLAAP are to have flexibility in their approach to the management of flood risk within each village, this document enables site specific assessment of residual flood risk based on factors within the developer's influence.

Those elements that are not able to be influenced by the developer such as the performance of the new flood defences, the current modelling uncertainty assessment and the application of climate change, will be specified with the assessment.

The assessment of the final flood risk in each area will be the responsibility of each developer and will be a function of the prescribed flood levels noted in this report, plus evaluated residual flood risks specific to the development type and layouts in each area.

All scenarios modelled assume that the LLAAP are is fully developed when assessing site specific flood level.

4 Source of Flood Risk

4.1 Fluvial and Tidal Flood Risk – Including Breach and Overtopping Scenarios

Tidal and Fluvial sources are recognised as the most significant flood risk to the proposed development and this is acknowledged in previous studies and North Lincolnshire Council guidance.

The initial guidance on flood risk is given in the core documents:

- Lincolnshire Lakes – Flood Risk Strategy Way Forward and;
- the second part from the LLAAP Policy F1 documents

The general guidance is summarised below:

- The developments must be safe for the events up to an including the 0.5%AEP plus an allowance for climate change event (UE) whilst being checked for performance and resilience to flooding for 0.1%AEP plus climate change events.
- In order to meet the minimum acceptable flood risk standards, the minimum floor level of proposed **More Vulnerable** residential development should be set no lower than the 0.5% AEP plus climate change flood level, plus a 300mm freeboard allowance.
- Minimum floor levels for the proposed new development should also be checked against updated flood levels for the 0.1% AEP plus climate change event in order to:
  - Provide the means to ensure decision makers are aware of the residual risks;
  - Identify where resilience and resistance measures should be considered;
  - Help developers and North Lincolnshire Council develop suitable Integrated Flood Evacuation Plans.
- **Less Vulnerable** development should aim to provide finished floor levels equivalent to the 0.5%AEP plus climate change, where this is not possible lower finished floor levels may be permitted where it can be demonstrated that:
  - The building structure can tolerate the proposed flooding depth;
  - The modelled velocities and flood depths are below the 'Danger for Some' classification noted in the DEFRA technical report FD2321/TR1 (e.g. depth <0.25m and velocity <0.5m/s);
  - Suitable flood resilience is built into the fabric of the building;
  - Suitable flood evacuation and business continuity plans are produced.
- In addition to this, as the area is protected by flood defences both currently and in the future, it is necessary to assess the impact of failure of those defences on all development, new and old, within the flood envelope.

The flood scenarios noted above have been modelled.

Reference is made to the separately issued Hydraulic Modelling Report reference 358811-MMD-00-XX-RP-C-0019 which has more detailed flood modelling outputs. The FRA has a summary of the outputs for comparison.

It is noted that two scenarios are considered, one Short-term, up to 2050 and the second Long-term to 2115. As part of the managed adaptive approach, endorsed by the Environment

Agency, further interventions within the catchment, may act to modify flood risk in this area. The Long-term scenario models a ‘to-be-agreed catchment-wide’ flood mitigation option and so should be considered as illustrative at this stage.

The proposed defences are designed to significantly reduce the risk of overtopping in the residential parts of Burringham and further east to the village development areas.

However, the critical scenarios for the villages are the breach scenarios, which need to be tested for all flood defences using the 0.5% (1 in 200-year) and 0.1% AEP (1 in-1000 year) events. It should be noted that the change from soft-defence to hard-defence in this case will reduce the volume of water spilling in to the flood plain as the width and duration of the assumed breach is reduced. However, the flood plain will still receive flow from the Trent and it will be necessary to consider the impact of this when setting the level of the proposed residential development.

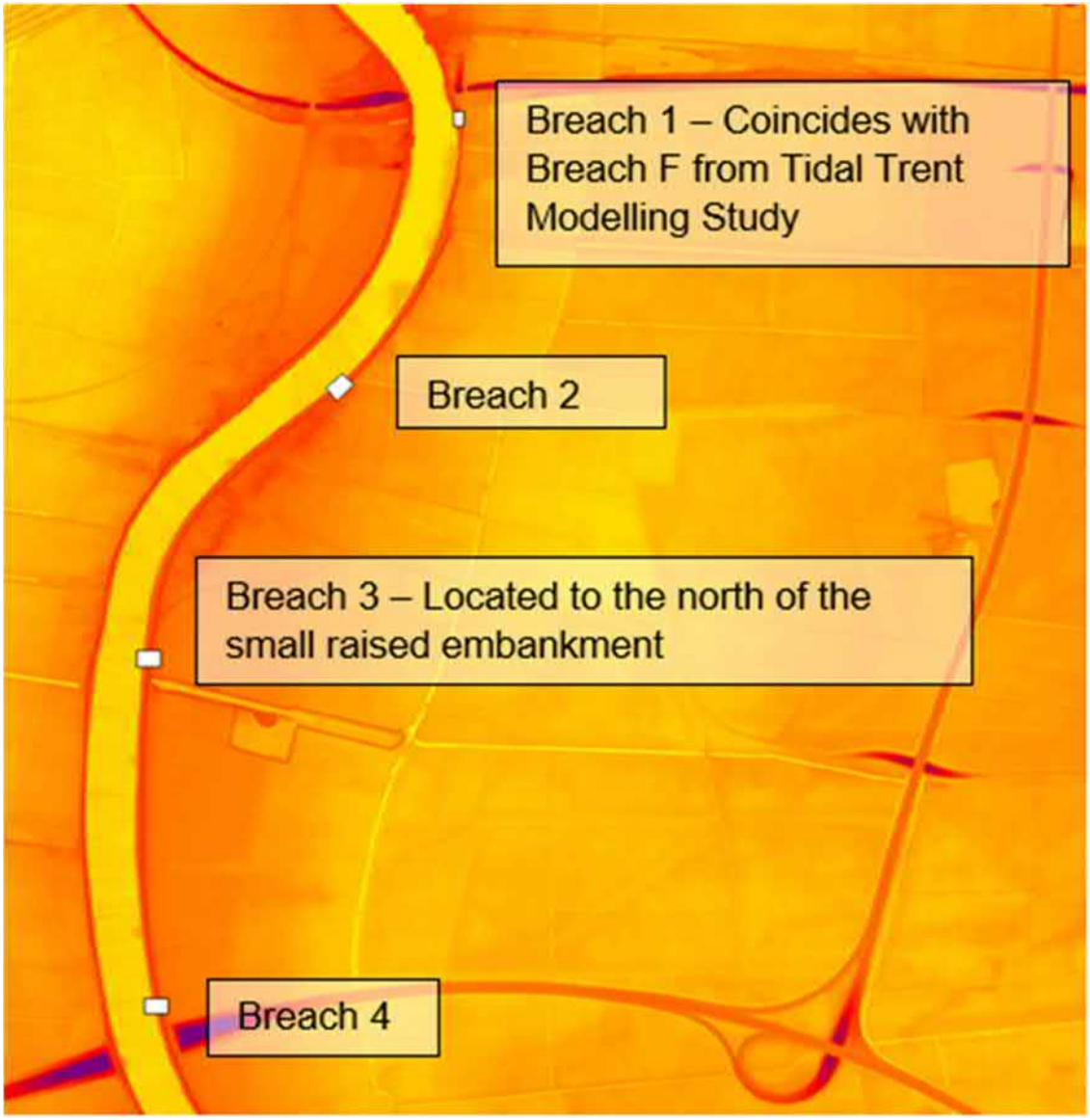
Outputs from the critical storm events and scenarios noted above are summarised in Table 1 below. It is noted that H++ events have been included as advisory levels, in order to gauge the magnitude of the change between the Higher Central and H++ events.

4.1.1 Breach Scenarios

Reference is made to the approved hydraulic modelling report (358811-MMD-00-XX-RP-C-0019 - LLakes_Hydraulic Modelling Report) which defines in detail the breach modelling scenarios.

In summary, 4 locations were selected where either weakness in the existing defence is identified or where maximum risk to the residential part of Burringham was possible. These are shown on the illustration in Figure 5.

Figure 5: Breach Locations



Source: Mott MacDonald 358811-MMD-00-XX-RP-C-0019 - LLakes_Hydraulic Modelling Report

Table 1 - Peak flood levels adjacent to the development platforms for short and long-term mitigation scenarios

Design Epoch	Scenario	Climate Change Projection	Fluvial Annual Exceedance Probability (%)	Tidal Annual Exceedance Probability (%)	Breach	Peak flood level adjacent to development platforms (mAOD)						
						Village 5 - North-West	Village 1 - North-East	Village 6 - Central West	Village 2 - Central East (North Burringham Road)	Village 3 - Central East (South Burringham Road)	Village 7 - South-West	Village 4 - South-East
Overtopping												
2015	Short Term Mitigation	Present Day	50%	0.50%	No Flooding							
2040	Short Term Mitigation	Higher Central (Fluvial), Upper End (Tidal)	0.50%	20%	No Flooding							
			0.10%	20%		2.97	4.46	3.70	4.50	4.51	3.23	4.52
		H++ (Fluvial and Tidal)	0.50%	20%	No Flooding							
			0.10%	20%		5.64	5.63	5.64	5.65	5.68	5.65	5.67
2050	Short Term Mitigation	Upper End (Fluvial and Tidal)	50%	3.33%	No Flooding							
			50%	0.50%	No Flooding							
			50%	0.10%	No Flooding							
		H++ (Fluvial and Tidal)	50%	0.50%	No Flooding							
			50%	0.10%	No Flooding							
2115	Short Term Mitigation	Upper End (Fluvial and Tidal)	50%	0.50%		2.88	N/A	2.21	N/A	N/A	2.21	N/A
			0.50%	20%	No Flooding							
	Long Term Mitigation	Higher Central (Fluvial), Upper End (Tidal)	0.50%	20%	No Flooding							
			0.10%	20%		5.28	5.28	5.29	5.31	5.30	5.30	5.30
		Upper End (Fluvial and Tidal)	50%	0.50%		2.87	N/A	2.15	N/A	N/A	2.15	N/A
			50%	0.10%		2.89	N/A	2.23	N/A	N/A	2.23	N/A
			0.50%	20%	No Flooding							
		H++ (Fluvial and Tidal)	50%	0.50%		4.48	4.44	4.46	4.43	4.26	4.45	4.26
			50%	0.10%		4.50	4.46	4.48	4.45	4.28	4.47	4.27
			0.50%	20%		5.10	5.10	5.10	5.10	5.10	5.10	5.10
			0.10%	20%		6.28	6.26	6.31	6.30	6.35	6.34	6.38

Design Epoch	Scenario	Climate Change Projection	Fluvial Annual Exceedance Probability (%)	Tidal Annual Exceedance Probability (%)	Breach	Peak flood level adjacent to development platforms (mAOD)						
						Village 5 - North-West	Village 1 - North-East	Village 6 - Central West	Village 2 - Central East (North Burringham Road)	Village 3 - Central East (South Burringham Road)	Village 7 - South-West	Village 4 - South-East
Breach Models												
2040	Short Term Mitigation	Higher Central (Fluvial), Upper End (Tidal)	0.50%	20%	BR1	2.29	N/A	1.90	N/A	N/A	1.90	N/A
			0.10%	20%	BR1	4.41	4.45	4.41	4.48	4.50	4.41	4.51
		H++ (Fluvial and Tidal)	0.50%	20%	BR1	2.31	N/A	1.99	N/A	N/A	1.99	N/A
2050	Short Term Mitigation	Upper End (Fluvial and Tidal)	50%	0.50%	BR1	2.43	N/A	2.12	N/A	N/A	2.12	N/A
			50%	0.50%	BR2	No Flooding						
			50%	0.50%	BR3	1.22	N/A	1.22	N/A	N/A	N/A	N/A
			50%	0.50%	BR4	No Flooding						
			50%	0.10%	BR1	2.43	N/A	2.13	N/A	N/A	2.13	N/A
		H++ (Fluvial and Tidal)	50%	0.50%	BR1	2.44	N/A	2.19	N/A	N/A	2.12	N/A
2115	Short Term Mitigation	Upper End (Fluvial and Tidal)	50%	0.50%	BR1	3.27	3.15	3.27	3.03	1.93	3.27	1.90
			0.50%	20%	BR1	2.57	N/A	2.57	2.52	N/A	2.57	N/A

Source: Mott MacDonald report reference 358811-MMD-00-XX-RP-C-0019

Village 1

Overtopping

The peak flood level noted adjacent to Village 1 for the overtopping scenario is **5.28mAOD** for the 2115 epoch (T005_2115_UE_F1000_2115_UE_OT_LT_MIT_V04_V26). This is as a result of the secondary flow mechanism behind the flood defences generated by spills from the channel upstream of the site.

Breach

The peak flood level noted for the breach event is **3.15mAOD** for the 2115 epoch at breach location 1. (T0200_2115_UE_F0002_2115_UE_BR1_ST_MIT_V23_V26)

Village 2

Overtopping

The peak flood level noted adjacent to Village 2 for the overtopping scenario is **5.31mAOD** for the 2115 epoch (T005_2115_UE_F1000_2115_UE_OT_LT_MIT_V04_V26). This is as a result of the secondary flow mechanism behind the flood defences generated by spills from the channel upstream of the site.

Breach

The peak flood level noted for the breach event is **3.03mAOD** for the 2115 epoch at breach location 1. (T0005_2115_UE_F0200_2115_UE_BR1_ST_MIT_V23_V26)

Village 3

Overtopping

The peak flood level noted adjacent to Village 3 for the overtopping scenario is **5.30mAOD** for the 2115 epoch (T005_2115_UE_F1000_2115_UE_OT_LT_MIT_V04_V26). This is as a result of the secondary flow mechanism behind the flood defences generated by spills from the channel upstream of the site.

Breach

The peak flood level noted for the breach event is **1.93mAOD** for the 2115 epoch at breach location 1. (T0200_2115_UE_F0002_2115_UE_BR1_ST_MIT_V23_V26)

Village 4

Overtopping

The peak flood level noted adjacent to Village 4 for the overtopping scenario is **5.30mAOD** for the 2115 epoch (T005_2115_UE_F1000_2115_UE_OT_LT_MIT_V04_V26). This is as a result of the secondary flow mechanism behind the flood defences generated by spills from the channel upstream of the site.

Breach

The peak flood level noted for the breach event is **1.90mAOD** for the 2115 epoch at breach location 1. (T0200_2115_UE_F0002_2115_UE_BR1_ST_MIT_V23_V26)

Village 5

Overtopping

The peak flood level noted adjacent to Village 5 for the overtopping scenario is **5.28mAOD** for the 2115 epoch (T005_2115_UE_F1000_2115_UE_OT_LT_MIT_V04_V26). This is as a result of the secondary flow mechanism behind the flood defences generated by spills from the channel upstream of the site.

Breach

The peak flood level noted for the breach event is **3.27mAOD** for the 2115 epoch at breach location 1. (T0200_2115_UE_F0002_2115_UE_BR1_ST_MIT_V23_V26)

Village 6

Overtopping

The peak flood level noted adjacent to Village 6 for the overtopping scenario is **5.29mAOD** for the 2115 epoch (T005_2115_UE_F1000_2115_UE_OT_LT_MIT_V04_V26This is as a result of the secondary flow mechanism behind the flood defences generated by spills from the channel upstream of the site.

Breach

The peak flood level noted for the breach event is **3.27mAOD** for the 2115 epoch at breach location 1. (T0200_2115_UE_F0002_2115_UE_BR1_ST_MIT_V23_V26)

Village 7

Overtopping

The peak flood level noted adjacent to Village 7 for the overtopping scenario is **5.30mAOD** for the 2115 epoch (T005_2115_UE_F1000_2115_UE_OT_LT_MIT_V04_V26). This is as a result of the secondary flow mechanism behind the flood defences generated by spills from the channel upstream of the site.

Breach

The peak flood level noted for the breach event is **3.27mAOD** for the 2115 epoch at breach location 1. (T0200_2115_UE_F0002_2115_UE_BR1_ST_MIT_V23_V26)

The above figures should be used to determine appropriate mitigation levels for all types of development within the site area, that is to say, the vulnerability and resilience to inundation of each type should be considered to determine appropriate residual protection.

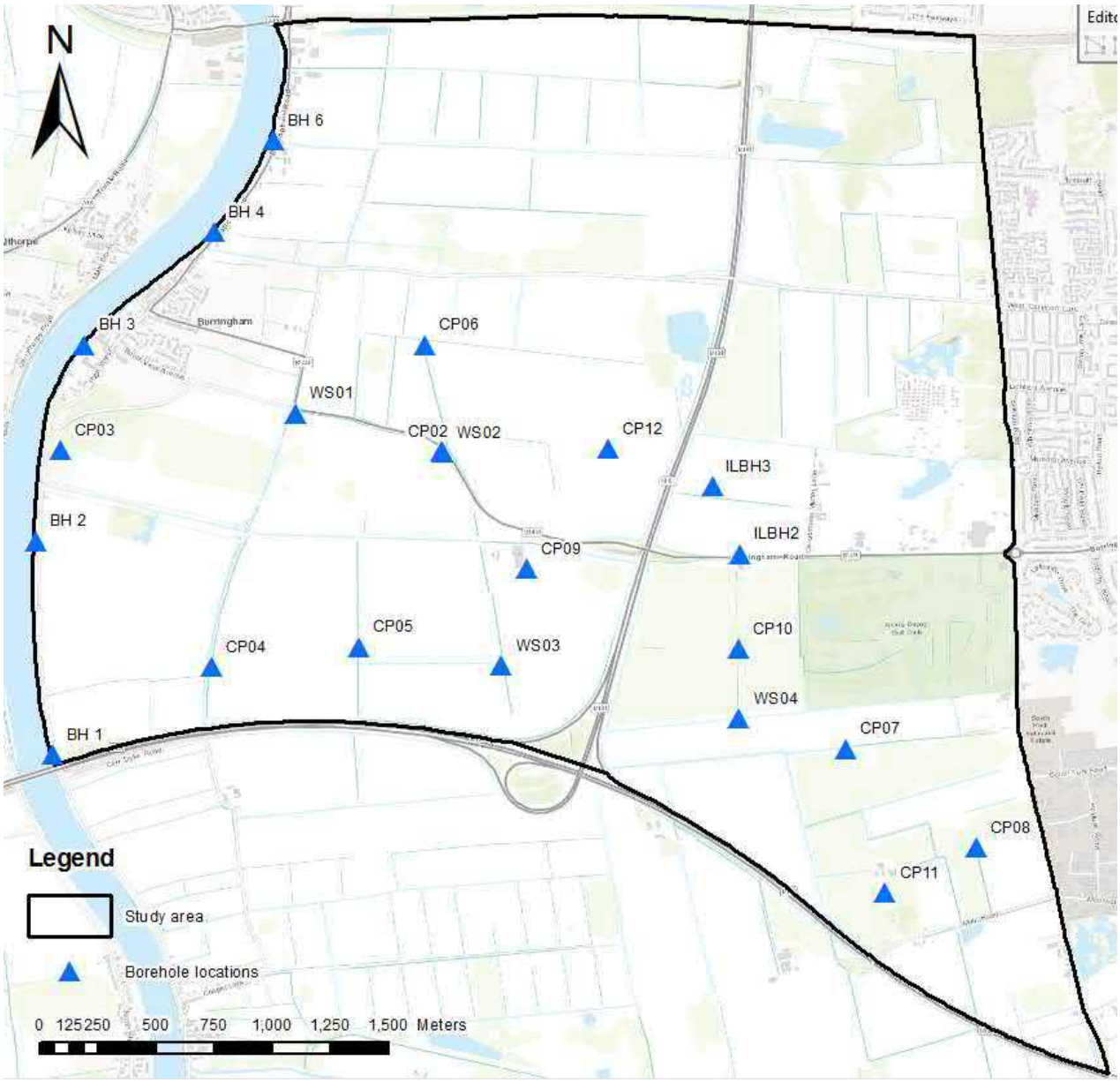
4.2 Ground Water

4.2.1 Ground Water – External to platforms

Reference is made to a separately issued ground water flood risk assessment prepared by Mott MacDonald during the option phase of the LLAAP scheme. The report is reference 358811/WCD/WAM/01/A and was issued on the 17th January 2017.

The report uses data based on readings from a network of 29 ground water monitoring stations installed between 2015 and 2016. Figure 6 shows these indicative locations.

Figure 6: Groundwater monitoring points



Source: Mott MacDonald 2016, Esri, HERE, Delorne, Intermap, increment P corp, GEBCO, USGS, FAO, NPS, NRCAN, Geobase, IGN, Kadaster NL, Ordnance Survey, METI, ©OpenStreetMap contributors and the GIS user community

In addition to the ground water monitoring, the Environment Agency supplied River Trent level data to correlate the river level at the time of the ground water recordings. The ground water FRA explains in detail the relationship between the local groundwater regime and the River Trent and concludes, in section 5.1.1 that:

The proposed sheet pile wall is expected to restrict groundwater flow between the River Trent and the alluvium. The available groundwater level data for the site indicates that groundwater levels are typically below the elevation of the water in the River Trent and suggest that the River Trent loses water to the surrounding alluvium. It is not anticipated that this situation will change

substantially even during periods of high groundwater recharge, given the relative elevation of the ground, water levels in the IDB drainage network and water levels in the River Trent.

The development of the villages and the likely elevation above the flood plain required for flood mitigation will isolate the platforms from any impacts in the change of the ground water regime locally. As the relative ground water level is controlled by the IDB drainage system, the maintenance of connectivity of the ditch system will be required to ensure that this management is retained.

4.2.2 Ground Water – Internal to platforms

The post-development village areas will include areas of open space that would not normally be drained. The engineered nature of the material placement would tend to preclude the 'natural' infiltration of rainfall in these areas. This is more so in the case where cohesive materials are used as engineered fill.

To avoid issues with surface inundation or ponding it will be necessary to provide a drainage system for these non-developed areas.

4.3 Surface Water Management

The development of the AAP villages will introduce significant areas of new impermeable surface. This will generate a commensurate increase in the rate of runoff from rainfall. If left unmitigated this would comprise a flood risk to both the development itself and the surrounding area.

For example, the anticipated greenfield runoff in this area for 1ha using the ICoP SuDS method for the Q_{bar} and Q_{100} events is 1.5l/s and 3.9l/s. In comparison, runoff from a similar impermeable area for a 2-year 30-minute event (23.54mm/hr) would be in the region of 65l/s.

In addition to this, the response of the catchment would be significantly altered post-development with runoff from impermeable areas having a time of concentration in the order of 4-8 minutes, whereas the greenfield system may be measured in hours.

The combination of the two elements means that traditional piped systems would create a flood risk that will require extensive mitigation.

4.4 Land Drainage

The impact of land drainage on the redevelopment areas themselves is discussed in 4.2.2 and will need to be mitigated as part of the platform development.

The impact of the development on land drainage surrounding the villages is discussed in detail in the separately issued Lincolnshire Lakes Platform Development Drainage Strategy (358811-MMD-XX-00-RP-C-0021) which notes that the current planned village footprints will require the modification of approximately 6.3km of ditches and possibly the installation of 180m of culvert to maintain connectivity through the area.

The footprints of the developments will also displace floodwater from the current scenario and with the improvements in channel connectivity this flood water is typically moved to the west.

4.5 Adopted Drainage

The areas proposed for the village locations are mainly undeveloped agricultural land and so are not served by adopted drainage assets. Asset plans from Seven Trent Water (STW) have been obtained as part of the Land Drainage Modelling (358811-MMD-XX-00-RP-C-0023) which

show that the existing adopted surface water systems outfall to the land drainage system in three locations to the east of the proposed developments to the east of the M181.

Flows from these systems are accommodated within the land drainage network and so flood risk from this source should be considered to be similar.

4.6 Highway Drainage

The carriageways of the M180 and M181 are noted, from Highways England asset records, to be positively drained to the ditch networks through this area.

No formal records exist for the Local Authority controlled carriageways; however, site observations indicate that drainage is typically either over-the-edge to adjacent ditches or kerb and gullies with outfalls to adjacent ditches.

The M180 and M181 are to be retained, albeit with new junctions on the M181 to enable vehicle access to the development areas.

The remaining existing carriageways will be unaffected by the proposed development. There may be some ancillary works on them to improve signage etc. but it is not anticipated that the existing drainage regime is modified.

In general, the existing highways sit slightly higher than adjacent land level to enable drainage and protect from residual flood risk. In the post-development scenario, it is likely that the development areas will be set higher than the existing roads to provide increased flood protection.

4.7 Reservoir Flooding

The site is noted to be within the catchment of a theoretical reservoir flooding event. However, it is not located in close proximity to the source or within an identified rapid inundation zone.

As such the site and the proposed development platforms are not considered to be at risk from reservoir failure.

5 Flood Risk Assessment and Mitigation

The flood risk at a specific point in the active flood area is ultimately a combination of factors, principally comprising the modelled local flood level but with various other additional risks or mitigation measures required for consideration. When evaluated as a whole these will provide a site-specific flood level.

Each of these elements are discussed below, some are physical factors related to the development of the local dynamic flood level while others are factors directly related to the type and method of development.

Any proposed development should consider each of the factors below and evaluate each applicable one to determine the proposed flood level and freeboard required.

5.1 Fluvial and Tidal Flood Risk – including breach scenarios

This is the major risk to the development in this area.

As noted previously the developments should be safe for 0.5% AEP events plus 30% climate change with consideration for the 0.1%AEP overtopping events. The outputs for each Village have been evaluated and are listed in Section 4.1.

Table 2: Summary of Maximum Estimated Flood Levels for 2115 Epoch events

Village Reference	0.5% AEP Over Topping Flood Level – 2115 Epoch mAOD	0.1% AEP Overtopping Flood Level – 2115 Epoch mAOD	0.5% Breach Flood Level – 2115 Epoch mAOD
1	No Flooding	5.28	3.15
2	No Flooding	5.31	3.03
3	No Flooding	5.30	1.93
4	No Flooding	5.30	1.90
5	2.87	5.28	3.27
6	2.15	5.29	3.27
7	2.15	5.30	3.27

Source: Mott MacDonald 2018 - 358811-MMD-XX-00-RP-C-0019 Table 22

The above figures should be used to determine appropriate mitigation levels for all types of development within the site area (More and Less Vulnerable uses), that is to say that the vulnerability and resilience to inundation of each type should be considered to determine appropriate residual protection noting that resilience for Less Vulnerable development is a function of the specific building use and proposed operation that should be determined on a site-by-site basis.

The determination of the suitable flood protection levels for the platforms and subsequently for the development located therein, needs to consider more than just the flood level adjacent. Below are additional requirements that will need to be factored in to determine finished levels for various elements within the development area.

The use of land raising for mitigation will provide a long-term option, however, the engineered materials placed on such a large scale will result in settlement over time. The type of fill and placement method are the key criteria to determining estimated long-term settlement and this

change in finished levels over time will need to be evaluated and mitigated in the design of each platform.

5.1.1 Freeboard

The selection of the required amount of freeboard is a combination of the uncertainty in the estimation of future climate change and the subsequent impact on rainfall rates, limitations in the modelling software and the data used to create the model and the sensitivity of the receptors.

For the LLAAP local guidance based on local advice from Environment Agency / North Lincolnshire Council is that 300mm of freeboard should be applied across the Lincolnshire Lakes development for 0.5%AEP+CC events.

It should be noted that as freeboard is a function of uncertainty and sensitivity, this advice may be revised in future either as uncertainty is modulated by new evidence, calibration or sensitivity changes.

General guidance is taken from the current Environment Agency document Fluvial Freeboard Guidance note published in 2000 (reference W187) for the physical process that needs to be considered in the evaluation of freeboard. Further to this, the recent issued Environment Agency document Accounting for Residual Uncertainty: Updating the Freeboard Guidance[6] provides a more nuanced approach to determining modelling and residual uncertainties and so this has been adopted for this element of the freeboard assessment.

Developers are encouraged to engage with the Environment Agency and North Lincolnshire Council to determine the current status of the freeboard requirement for their developments prior to submitting site specific flood risk assessments. Particular attention is drawn to the use of the Humber 2013 tidal surge water levels, these are still to be finalised and may impact the outputs herein.

5.1.1.1 Drainage

The provision of surface drainage systems will permit the use of much shallower falls on drainage conveyance components in comparison to a piped system. However, some fall is required, initially to drain land or development to conveyance assets and then within those assets to attenuation features and outfalls.

Gradients for surface systems are typically in the range of 1v:200h to 1v:500h while pipes systems will be 1v:150h to 1v:300h.

Therefore, parts of the drained catchment located more remotely from the proposed outfalls will require increased levels to provide sufficient conveyance capacity. With the outfall level constrained by gravity discharge to the adjacent land drainage system the upstream end may need to be elevated significantly to accommodate this.

5.1.2 Sensitivity of Receptors

Different parts of the developments will have different sensitivity to flooding.

The application of the freeboard determined above should be relative to the status of the receptor considered:

[6] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/623421/Accounting_for_residual_uncertainty___an_update_to_the_fluvial_freeboard_guide_-_report.pdf

5.1.2.1 More sensitive

Such as residential development and critical infrastructure. No tolerance of flooding, full application of freeboard.

5.1.2.2 Less sensitive

Such as Public Open Spaces accessed by public, rear gardens. Tolerant of limited flooding determined by risk to public, suitable proportion of freeboard applied with resilience to full level of freeboard.

5.1.2.3 Non-sensitive

Levels set to the predicted adjacent flood level or potentially lower for landscaped areas would be appropriate provided that the areas can be easily recovered and rehabilitated after an extreme event and can be drained adequately during normal operation.

5.2 Ground Water

5.2.1 Ground Water – External to platforms

The maintenance of the existing land drainage regime within the flood plain is the principal means of mitigating flood risk from this source.

The Land Drainage Modelling report identifies where modification is required and concludes that should these be implemented then the flood risk can be managed locally without impact on property or infrastructure. There may be a change in the location of surface flooding as a result of extreme events such as pump failure, but this would be a very low probability event and with suitable maintenance this could be mitigated.

5.2.2 Ground Water – Internal to platforms

Management of water falling on to the non-developed areas of the development platform will need to be considered. There are various options to facilitate this and the solution for each platform may use one or all of these. All the systems would need to discharge to the surrounding land drainage systems and given the preferred drainage strategy for the developed areas would comprise numerous small flow rate outfalls rather than fewer, larger outfalls.

5.2.2.1 Combined Land and Development Drainage

The platform drainage systems may be combined to provide a system which collects, conveys and attenuates runoff from all surfaces within the platform boundary.

The two systems would have significantly different runoff profiles which should assist in limiting the increase in attenuation required by adding runoff from undeveloped areas.

Combining the systems would lead to oversizing of attenuation and conveyance features in some places but would avoid the need for a secondary drainage system and would support a SuDS based scheme by replicating the response of natural drainage systems.

5.2.2.2 Secondary Land Drainage

The provision of a separate land drainage system within the platforms and separate to the drainage system for the developed areas is viable, this is much the same as the existing developed areas of Burringham. It should be utilised in conjunction with land morphology below.

5.2.2.3 Land Morphology

Construction of the platform areas enables manipulation of the final levels to suit exactly the requirements of the development. As such the provision of land morphology that will encourage runoff from the undeveloped areas away from sensitive areas and ultimately in to the land drainage system at the base of the platform can be achieved.

This may be limited to land on the periphery of the development platforms where access to the existing land drainage is more easily achievable or alternatively the land drainage can be combined with the outfalls from the developed area drainage systems after the local flow control and attenuation features.

5.2.2.4 Drainage Blanket

A more engineered option would be the construction of a drainage layer within the platform build up. This would comprise a more permeable material such as a DoT Type 3 or open graded material. This would need to be able to be compacted to form the platform.

The drainage layer can then be used as an infiltration layer across the site with surface land drainage connected in to the drainage layer using soakaway type systems. The drainage layer would then be intercepted on the boundary of the platform and discharged to the adjacent land drainage feature at the toe.

5.3 Surface Water Management

Reference is made to the separately issued report 358811-MMD-XX-00-RP-C-0021 - AAP Drainage Strategy. This identifies a SuDS based approach to the delivery of the development drainage.

This would seek to replicate a source control type system with surface management of runoff rather than an infrastructure-based option comprising large diameter pipework and fewer, larger attenuation features.

Furthermore, the use of shallow surface systems will maximise opportunities for habitat creation and bio-diversity improvements as well as water quality improvements whilst minimising excavations.

Runoff from the development areas shall be limited to IDB drainage rates of 1.4l/s/ha, this is the equivalent of the Q_{bar} rate which means that for all events above the 1 in 1-year the proposed development runoff will be at a lower rate than the current undeveloped scenario.

The Land Drainage Modelling report identifies that the existing pumped IDB system is capable of handling the predicted runoff from the whole AAP and therefore a development drainage strategy that complies with the guidance in the AAP Drainage Strategy will adequately mitigate flood risk.

It is necessary for the drainage systems to operate during 1%AEP+CC event which will limit the depth of outfalls to the adjacent land drainage system. As the defences to the River Trent provide protection in excess of the 1%AEP event the performance of the drainage system will not be affected by these extreme events.

5.4 Land Drainage

The mitigation options for the land drainage are the same as for the management of ground water (Section 5.2) as the two are effectively part of the same system locally.

The Land Drainage Modelling report (358811-MMD-XX-00-RP-C-0023) demonstrates that the existing pumped land drainage system is suitable for the proposed future inputs from the post-development scenario.

In consideration of the above, the development of the villages will not increase flood risk within the land drainage system.

5.5 Adopted Drainage

The sites are not currently served by adopted drainage however, as part of the development adopted drainage will be installed.

These systems should comply with the requirements of Sewers for Adoption 7th edition and so will not pose a flood risk to the new development.

5.6 Highway Drainage

The drainage systems for the existing carriageways will not be affected by the development and so will not impact on the development site.

The provision of the new junctions from the M181 and the development access roads will require new drainage. All systems should be designed to comply with Local Highway Authority guidance and where possible should use SuDS based systems.

The development of new drainage to this standard will ensure that the roads and junctions do not pose a flood risk to either the development or adjacent sites.

6 Conclusions and Recommendations

This assessment concludes that the proposed areas allocated for residential development as part of the LLAAP can be safely developed if the outputs from the hydraulic modelling are used and the guidance noted within this and referenced documents is applied.

The proposed residential development areas will be impacted by residual risks associated with overtopping and breach of the new defences along the River Trent for events up to the 2115 epoch. Modelled outputs from these scenarios have been presented for each of the villages and this will need to be accommodated within the development of each area.

Each village will need to apply the relevant freeboard assessment to determine the applicable minimum finished flood levels or formation levels for all assessed receptor vulnerability classifications and demonstrate how this has been calculated in each case, as outlined in Section 5.

The development of the proposed mitigation options, most likely land raising, will itself impact on flood risk associated with the existing managed land drainage system in this area.

The required modifications to this system to accommodate the proposed development footprints should present an opportunity to enhance the natural form of the drainage system and, where manageable, provide improved habitat creation, bio-diversity and Water Framework Directive objectives.

Within the development areas, surface water management will be required to mitigate any potential flood risk generated by the increase in impermeable area in each village. This should follow the source control principles noted in CIRIA SuDS Manual (C753) and in keeping with the green village aim of the AAP development should be based around green/blue infrastructure surface management of water and should apply SuDS principles by default. This will not only achieve mitigation of flood risk but will also maximise opportunities for habitat creation, bio-diversity enhancement, water quality improvements and community engagement and wellbeing.

In summary, while the proposed development in this area is significant, the scale will enable the incorporation of modern engineering principles that will mitigate flood risk while yielding significant opportunities for environmental enhancements over and above the current status of the agricultural landform to generate overall improvements in flood risk, bio-diversity and amenity post-development.

6.1 Guidance for Developers and Applicants

Developers and Applicants may use the outputs from the flood modelling in this FRA for preliminary design of development level flood mitigation in addition to the assessment of freeboard to be applied. The outputs in the FRA represent the best available data at the time of publishing.

Developers and Applicants must provide their own assessment of flood risk specific to their development area using the flood information noted herein but also using new or additional information that may become available such as future changes to climate change allowance guidance and/or updated modelling (such as the Humber Strategy) which may supersede the details within this FRA.

Site specific FRA’s shall use the same design critical events as noted herein.

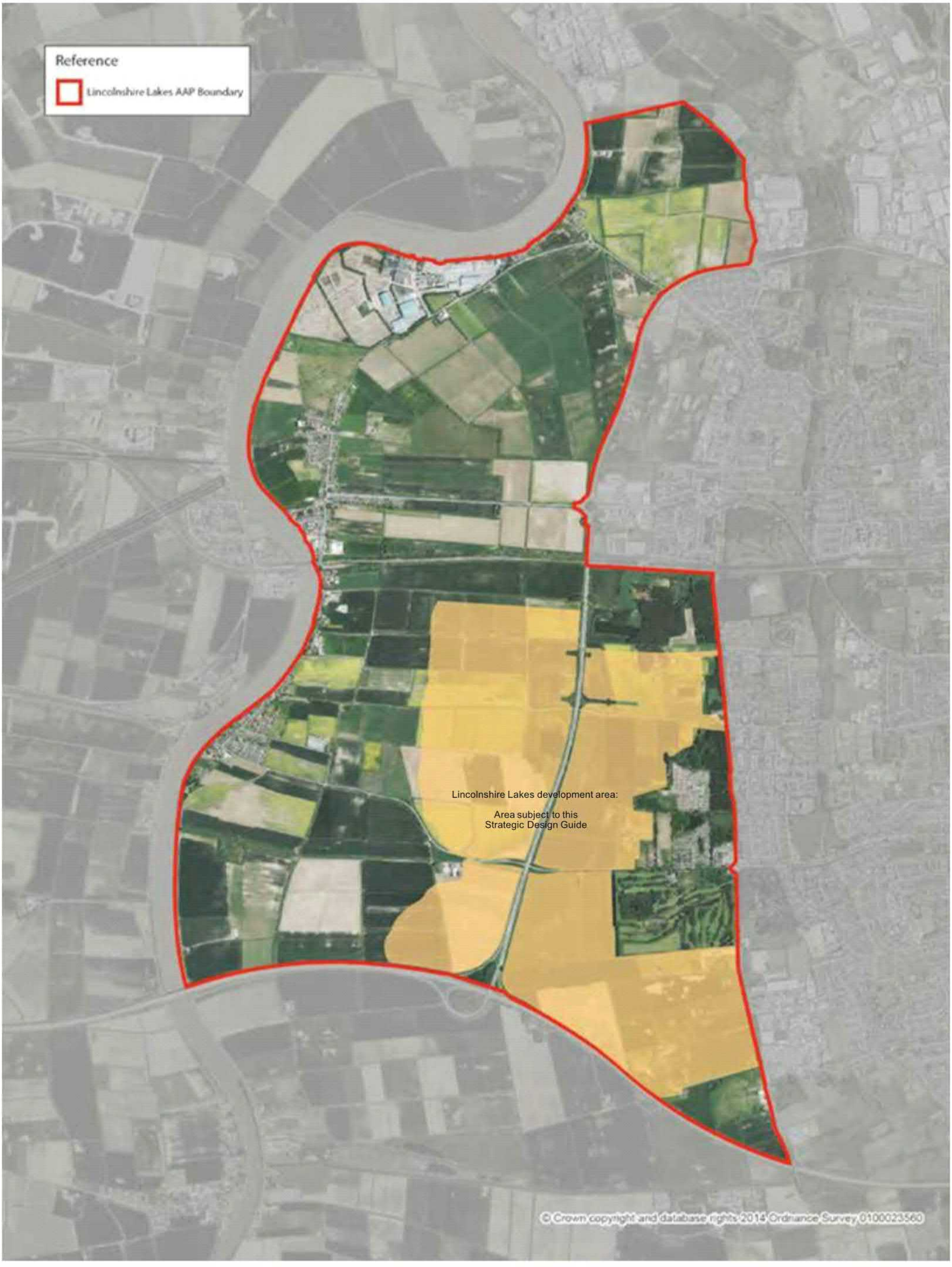
For site specific modelling, Developers or Applicants should contact the Environment Agency and North Lincolnshire Council prior to starting a site-specific FRA in order to discuss this.

This would include agreeing any additional modelling/modifications to the existing model that may be needed.

Any FRA will need to propose an evidence-based mitigation scheme that includes, but is not limited to, platform levels, freeboard, resilience measures and an integrated flood excavation plan.

Appendices

A. Lincolnshire Lakes Area Action Plan Extents


Reference
Lincolnshire Lakes AAP Boundary
Lincolnshire Lakes development area:
Area subject to this
Strategic Design Guide
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B. Flood Defence Scheme Phasing Drawing

B.1 MMD-358811-C-DR-00-XX-6310 – Scheme Phasing and Extents

B.2 MMD-358811-C-DR-00-XX-6311 to 6318– Extents of Proposed Works Sheet 1 to 8

Notes

1. To be read in conjunction with other Contract Documents.

Key to symbols

- Phase 1 of the Works (green)
- Phase 2 of the Works (red)
- Phase 3 of the Works (blue)

Reference drawings

MMD-358811-C-DR-00-XX-6311 - Extent of Proposed Works, Sheet 1 of 8
MMD-358811-C-DR-00-XX-6312 - Extent of Proposed Works, Sheet 2 of 8
MMD-358811-C-DR-00-XX-6313 - Extent of Proposed Works, Sheet 3 of 8
MMD-358811-C-DR-00-XX-6314 - Extent of Proposed Works, Sheet 4 of 8
MMD-358811-C-DR-00-XX-6315 - Extent of Proposed Works, Sheet 5 of 8
MMD-358811-C-DR-00-XX-6316 - Extent of Proposed Works, Sheet 6 of 8
MMD-358811-C-DR-00-XX-6317 - Extent of Proposed Works, Sheet 7 of 8
MMD-358811-C-DR-00-XX-6318 - Extent of Proposed Works, Sheet 8 of 8

Rev	Date	Drawn	Description	Ch'k'd	App'd
P2	16/11/17	KM	Revised proposals at RB6	FB	LG
P1	27/10/17	KM	For Information	FB	LG

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Title

Lincolnshire Lakes Flood Defence Scheme Phasing Drawing

Designed	R Spence	RS	Eng check	F Buskevicius	FB
Drawn	K Montagu	KM	Coordination	V King	VK
Dwg check	F Buskevicius	FB	Approved	L Geddes	LG

Scale	Status	Rev
1:5000	INF	P2

Drawing Number
MMD-358811-C-DR-00-XX-6310

1:5000 0 250m 500m

Schedule of Third-Party Interventions				
Phase	Intervention	River Ch. start	River Ch. end	Req. height
2	LB1	4055	4555	6.32
2	LB2	6215	6355	6.18
2	LB3	6704	6895	6.17
2	LB4	7095	7295	6.17
2	LB5	7346	7534	6.28
1	MO1	N/A	N/A	1.5
2	LB6	7614	7677	6.3
2	LB8	8073	8173	6.3
2	LB9	9114	9964	6.29
2	LB10	10129	10391	6.26
2	LB11	10391	10639	6.22
2	LB12	14273	14613	6.2
2	RB1	14654	14734	6.25
2	RB2a	15514	15674	6.33
2	RB2b	15674	15834	6.2
2	RB3a	15954	16234	6.26
2	RB3b	16243	16434	6.15
2	RB4a	18313	18533	6.28
2	RB4b	18533	18773	6.17
2	RB5	19215	19435	6.3
2	RB6	N/A	N/A	3.3

Ch. 14613m
Phase 2 Embankment works
LB12
Ch. 14273m
River Trent
Phase 2 Property Level Protection
RB6

Notes

1. To be read in conjunction with other Contract Documents.
2. Flood defence height based on EA survey data.
3. Phase 1 Works to be completed prior to commencement of Phase 2 works.
4. All approvals and consents to be in place prior to start of work.

Key to symbols

- Phase 1 New sheet pile walls and embankment protection
- Phase 1 Existing wall works
- Phase 2 New flood walls
- Phase 2 Embankment works
- Phase 2 Existing wall works
- Phase 3 New sheet pile walls and embankment protection
- Managed overflow area
- Site Chainage 10800

RESIDUAL HEALTH & SAFETY RISK ASSESSMENT

Wherever possible, risk is designed-out of this proposal during the design process. Where this is not possible, the risk will be minimised and any residual significant risk will be noted and indicated by the symbol.

Reference drawings / documents

MMD-358811-C-DR-00-XX-6312 - Extent of Proposed Works, Sheet 2 of 8
MMD-358811-C-DR-00-XX-6313 - Extent of Proposed Works, Sheet 3 of 8
MMD-358811-C-DR-00-XX-6314 - Extent of Proposed Works, Sheet 4 of 8
MMD-358811-C-DR-00-XX-6315 - Extent of Proposed Works, Sheet 5 of 8
MMD-358811-C-DR-00-XX-6316 - Extent of Proposed Works, Sheet 6 of 8
MMD-358811-C-DR-00-XX-6317 - Extent of Proposed Works, Sheet 7 of 8
MMD-358811-C-DR-00-XX-6318 - Extent of Proposed Works, Sheet 8 of 8

MMD-358811-C-DR-00-XX-6201 - Embankment Protection, General Arrangement
MMD-358811-C-DR-00-XX-6202 - Embankment Protection, Sections

Rev	Date	Drawn	Description	Ch'k'd	App'd
C1	02/02/2018	KM	Construction Issue	FB	LG

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Title
Lincolnshire Lakes
Flood Defence Scheme
Extents of Proposed Works
Sheet 1 of 8

Designed	M Wild	MW	Eng check	F Buskevicius	FB
Drawn	K Montagu	KM	Coordination	V King	VK
Dwg check	F Buskevicius	FB	Approved	L Geddes	LG

Scale at A1	Status	Rev	Security
1:2500	CON	C1	STD

Drawing Number
MMD-358811-C-DR-00-XX-6311

1:2500 0 125m 250m

P:\Sheffield\358811 Lincolnshire Lakes\Drawings\Internally produced\08 Detailed Design Drawings\MMD-358811-C-DR-00-XX-6311-6318 Extents of Proposed Works.dwg Feb 2, 2018 - 11:03AM BUS62542

Schedule of Third-Party Interventions				
Phase	Intervention	River Ch. start	River Ch. end	Req. height
2	LB1	4055	4555	6.32
2	LB2	6215	6355	6.18
2	LB3	6704	6895	6.17
2	LB4	7095	7295	6.17
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2	LB11	10391	10639	6.22
2	LB12	14273	14613	6.2
2	RB1	14654	14734	6.25
2	RB2a	15514	15674	6.33
2	RB2b	15674	15834	6.2
2	RB3a	15954	16234	6.26
2	RB3b	16243	16434	6.15
2	RB4a	18313	18533	6.28
2	RB4b	18533	18773	6.17
2	RB5	19215	19435	6.3
2	RB6	N/A	N/A	3.3

Keadby Power Station

North Keadby

Ch. 10639m

LB11

Phase 2 Embankment works

Works adjacent to SSE Keadby Power Station

Ch. 10391m

LB10

Phase 2 Existing wall works

Ch. 10129m

Ch. 9964m

River Trent

Restricted access to works. Landowner permissions will be required in advance of works

Phase 2 Embankment works LB9

South Keadby

SSSI north of Keadby Bridge

MMD-358811-C-DR-00-XX-6313

Ch. 9144m

Keadby Bridge

0 1:2500 125m 250m

Ordnance Survey Data supplied by North Lincolnshire Council,© Crown copyright and database rights 2015 Ordinance Survey 0100023560

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Notes

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4. All approvals and consents to be in place prior to start of work.

Key to symbols

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- Phase 1 Existing wall works
- Phase 2 New flood walls
- Phase 2 Embankment works
- Phase 2 Existing wall works
- Phase 3 New sheet pile walls and embankment protection
- Managed overflow area
- Site Chainage (10800)

RESIDUAL ENVIRONMENTAL RISK ASSESSMENT

RESIDUAL HEALTH & SAFETY RISK ASSESSMENT

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Reference drawings / documents

MMD-358811-C-DR-00-XX-6311 - Extent of Proposed Works, Sheet 1 of 8
MMD-358811-C-DR-00-XX-6313 - Extent of Proposed Works, Sheet 3 of 8
MMD-358811-C-DR-00-XX-6314 - Extent of Proposed Works, Sheet 4 of 8
MMD-358811-C-DR-00-XX-6315 - Extent of Proposed Works, Sheet 5 of 8
MMD-358811-C-DR-00-XX-6316 - Extent of Proposed Works, Sheet 6 of 8
MMD-358811-C-DR-00-XX-6317 - Extent of Proposed Works, Sheet 7 of 8
MMD-358811-C-DR-00-XX-6318 - Extent of Proposed Works, Sheet 8 of 8

MMD-358811-C-DR-00-XX-6201 - Embankment Protection, General Arrangement
MMD-358811-C-DR-00-XX-6202 - Embankment Protection, Sections

Rev	Date	Drawn	Description	Ch'k'd	App'd
C1	02/02/2018	KM	Construction Issue	FB	LG

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Title
Lincolnshire Lakes Flood Defence Scheme Extents of Proposed Works Sheet 2 of 8

Designed	M Wild	MW	Eng check	F Buskevicius	FB
Drawn	K Montagu	KM	Coordination	V King	VK
Dwg check	F Buskevicius	FB	Approved	L Geddes	LG

Scale at A1	Status	Rev	Security
1:2500	CON	C1	STD

Drawing Number
MMD-358811-C-DR-00-XX-6312

Schedule of Third-Party Interventions				
Phase	Intervention	River Ch. start	River Ch. end	Req. height
2	LB1	4055	4555	6.32
2	LB2	6215	6355	6.18
2	LB3	6704	6895	6.17
2	LB4	7095	7295	6.17
2	LB5	7346	7534	6.28
1	MO1	N/A	N/A	1.5
2	LB6	7614	7677	6.3
2	LB8	8073	8173	6.3
2	LB9	9114	9964	6.29
2	LB10	10129	10391	6.26
2	LB11	10391	10639	6.22
2	LB12	14273	14613	6.2
2	RB1	14654	14734	6.25
2	RB2a	15514	15674	6.33
2	RB2b	15674	15834	6.2
2	RB3a	15954	16234	6.26
2	RB3b	16243	16434	6.15
2	RB4a	18313	18533	6.28
2	RB4b	18533	18773	6.17
2	RB5	19215	19435	6.3
2	RB6	N/A	N/A	3.3

MMD-358811-C-DR-00-XX-6312

Ch. 23862m

Ch. 9144m

Keadby Bridge

Listed structure

Existing stone buttress (old bridge abutment)

Phase 1 New sheet pile wall

New sheet pile walls to be constructed adjacent to existing walls

Primary School

Ch. 23548m

Phase 1 Existing wall works

Ch. 23352m

River Trent

North Burringham

Overhead services

Phase 1 New sheet pile walls

Ch. 8173m

LB8

Ch. 8073m

Phase 2 Embankment works

MMD-358811-C-DR-00-XX-6314

Althorpe

Structure sensitive to vibrations

Ch. 22457m

Ch. 7677m

LB6

Ch. 7614m

Phase 2 Embankment works

Phase 1 New sheet pile walls

Burringham Village

Underground BT cables under the line of the flood defence

Ch. 7534m

1:2500 0 125m 250m

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Notes

1. To be read in conjunction with other Contract Documents.
2. Flood defence height based on EA survey data.
3. Phase 1 Works to be completed prior to commencement of Phase 2 works.
4. All approvals and consents to be in place prior to start of work.

Key to symbols

- Phase 1 New sheet pile walls and embankment protection
- Phase 1 Existing wall works
- Phase 2 New flood walls
- Phase 2 Embankment works
- Phase 2 Existing wall works
- Phase 3 New sheet pile walls and embankment protection
- Managed overflow area
- Site Chainage 10800

RESIDUAL HEALTH & SAFETY RISK ASSESSMENT

Wherever possible, risk is designed-out of this proposal during the design process. Where this is not possible, the risk will be minimised and any residual significant risk will be noted and indicated by the symbol.

Reference drawings / documents

MMD-358811-C-DR-00-XX-6311 - Extent of Proposed Works, Sheet 1 of 8
MMD-358811-C-DR-00-XX-6312 - Extent of Proposed Works, Sheet 2 of 8
MMD-358811-C-DR-00-XX-6314 - Extent of Proposed Works, Sheet 4 of 8
MMD-358811-C-DR-00-XX-6315 - Extent of Proposed Works, Sheet 5 of 8
MMD-358811-C-DR-00-XX-6316 - Extent of Proposed Works, Sheet 6 of 8
MMD-358811-C-DR-00-XX-6317 - Extent of Proposed Works, Sheet 7 of 8
MMD-358811-C-DR-00-XX-6318 - Extent of Proposed Works, Sheet 8 of 8

MMD-358811-C-DR-00-XX-6201 - Embankment Protection, General Arrangement
MMD-358811-C-DR-00-XX-6202 - Embankment Protection, Sections

Rev	Date	Drawn	Description	Ch'k'd	App'd
C1	02/02/2018	KM	Construction Issue	FB	LG

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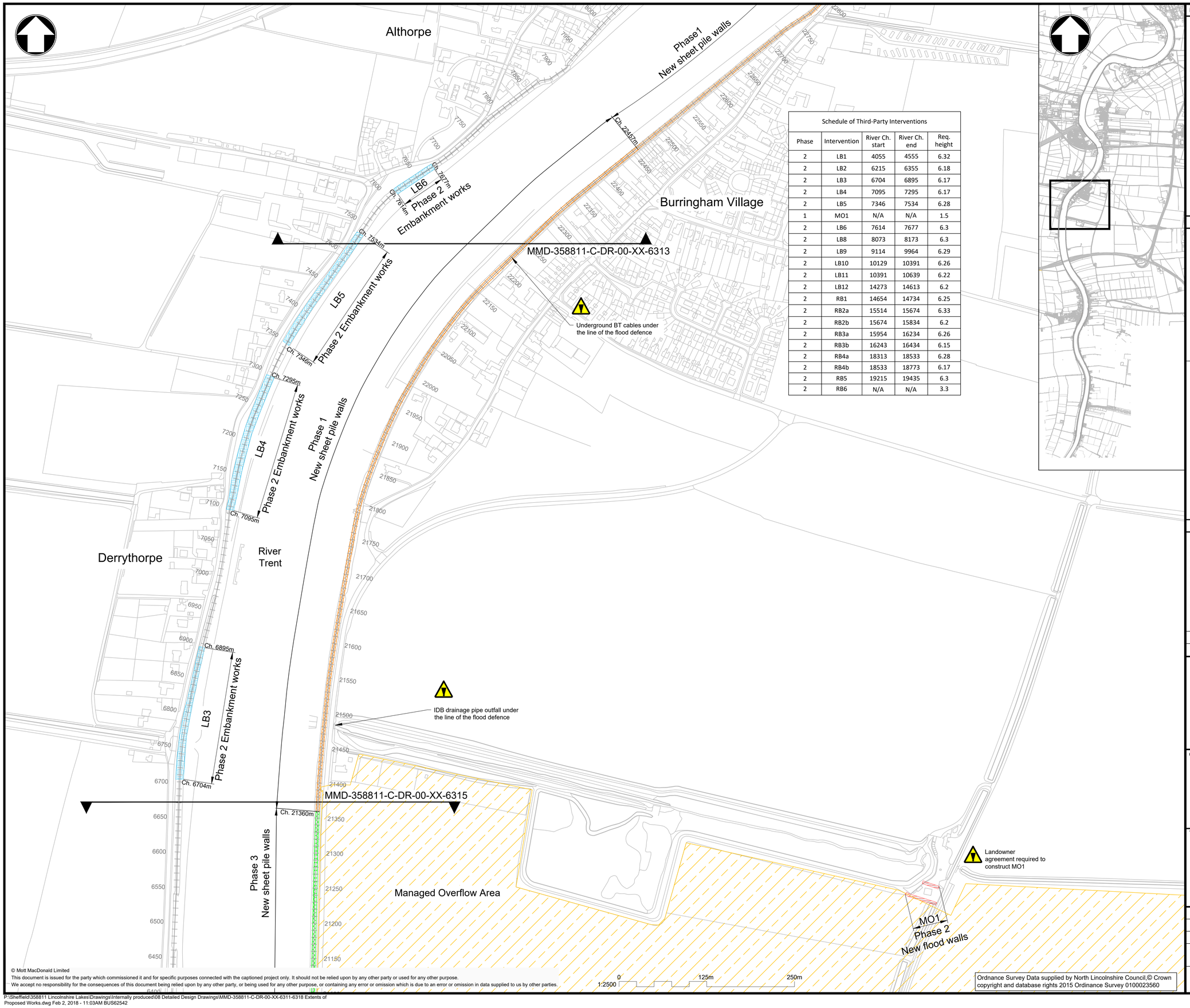
NORTH LINCOLNSHIRE COUNCIL

Title
Lincolnshire Lakes Flood Defence Scheme Extents of Proposed Works Sheet 3 of 8

Designed	M Wild	MW	Eng check	F Buskevicius	FB
Drawn	K Montagu	KM	Coordination	V King	VK
Dwg check	F Buskevicius	FB	Approved	L Geddes	LG

Scale at A1	Status	Rev	Security
1:2500	CON	C1	STD

Drawing Number
MMD-358811-C-DR-00-XX-6313



Schedule of Third-Party Interventions				
Phase	Intervention	River Ch. start	River Ch. end	Req. height
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2	LB8	8073	8173	6.3
2	LB9	9114	9964	6.29
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2	RB4a	18313	18533	6.28
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2	RB5	19215	19435	6.3
2	RB6	N/A	N/A	3.3

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- Phase 2 Embankment works
- Phase 2 Existing wall works
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- Site Chainage 10800

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MMD-358811-C-DR-00-XX-6318 - Extent of Proposed Works, Sheet 8 of 8

MMD-358811-C-DR-00-XX-6201 - Embankment Protection, General Arrangement
MMD-358811-C-DR-00-XX-6202 - Embankment Protection, Sections

Rev	Date	Drawn	Description	Ch'k'd	App'd
C1	02/02/2018	KM	Construction Issue	FB	LG

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Title
Lincolnshire Lakes
Flood Defence Scheme
Extents of Proposed Works
Sheet 4 of 8

Designed	M Wild	MW	Eng check	F Buskevicius	FB
Drawn	K Montagu	KM	Coordination	V King	VK
Dwg check	F Buskevicius	FB	Approved	L Geddes	LG

Scale at A1	Status	Rev	Security
1:2500	CON	C1	STD

Drawing Number
MMD-358811-C-DR-00-XX-6314

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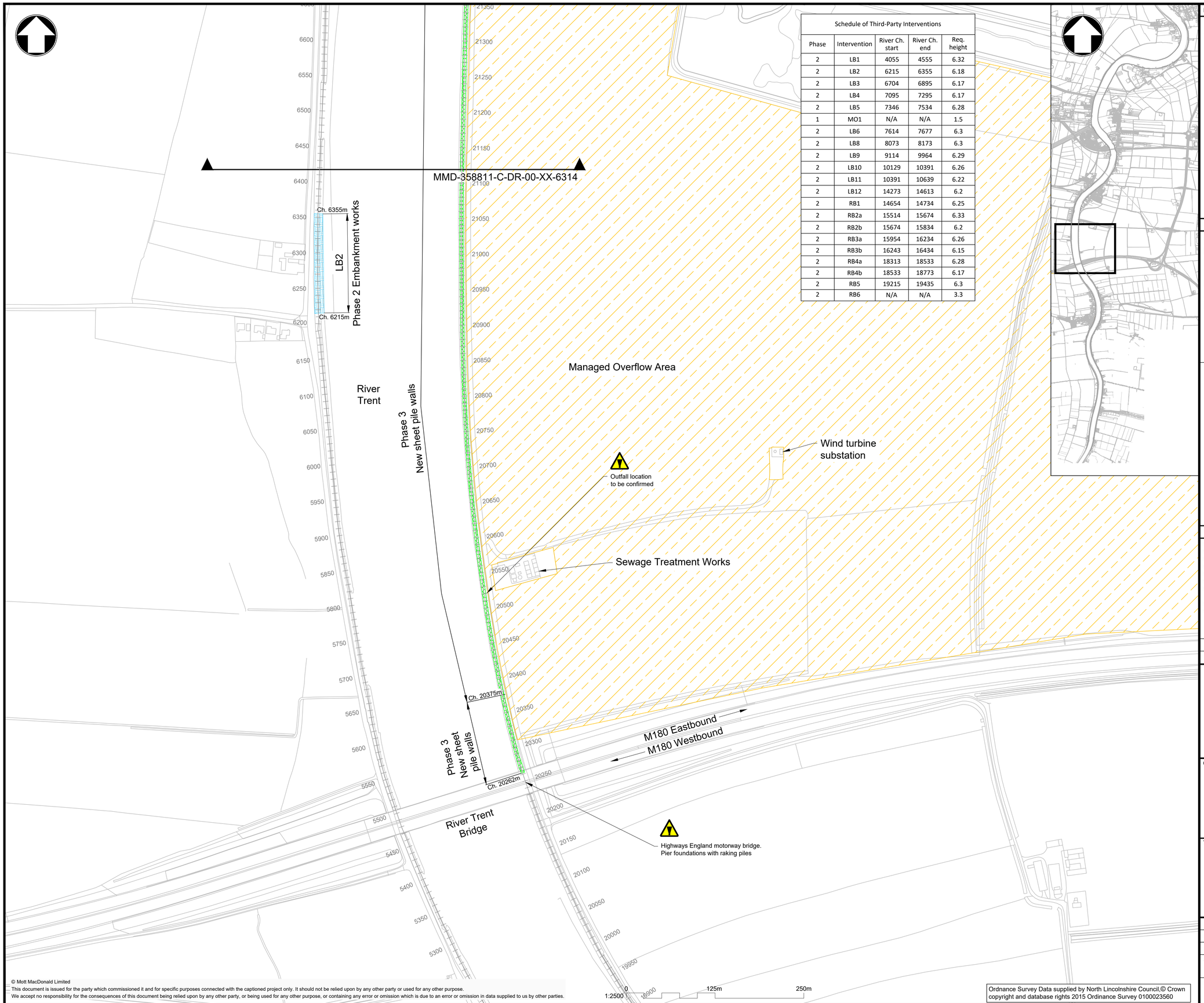

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2	RB3b	16243	16434	6.15
2	RB4a	18313	18533	6.28
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- Phase 1 Existing wall works
- Phase 2 New flood walls
- Phase 2 Embankment works
- Phase 2 Existing wall works
- Phase 3 New sheet pile walls and embankment protection
- Managed overflow area
- Site Chainage 10800

RESIDUAL HEALTH & SAFETY RISK ASSESSMENT

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Reference drawings / documents

MMD-358811-C-DR-00-XX-6311 - Extent of Proposed Works, Sheet 1 of 8
MMD-358811-C-DR-00-XX-6312 - Extent of Proposed Works, Sheet 2 of 8
MMD-358811-C-DR-00-XX-6313 - Extent of Proposed Works, Sheet 3 of 8
MMD-358811-C-DR-00-XX-6314 - Extent of Proposed Works, Sheet 4 of 8
MMD-358811-C-DR-00-XX-6316 - Extent of Proposed Works, Sheet 6 of 8
MMD-358811-C-DR-00-XX-6317 - Extent of Proposed Works, Sheet 7 of 8
MMD-358811-C-DR-00-XX-6318 - Extent of Proposed Works, Sheet 8 of 8

MMD-358811-C-DR-00-XX-6201 - Embankment Protection, General Arrangement
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Rev	Date	Drawn	Description	Ch'k'd	App'd
C1	02/02/2018	KM	Construction Issue	FB	LG

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NORTH LINCOLNSHIRE COUNCIL

Title
Lincolnshire Lakes Flood Defence Scheme Extents of Proposed Works Sheet 5 of 8

Designed	M Wild	MW	Eng check	F Buskevicius	FB
Drawn	K Montagu	KM	Coordination	V King	VK
Dwg check	F Buskevicius	FB	Approved	L Geddes	LG

Scale at A1	Status	Rev	Security
1:2500	CON	C1	STD

Drawing Number
MMD-358811-C-DR-00-XX-6315

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Schedule of Third-Party Interventions				
Phase	Intervention	River Ch. start	River Ch. end	Req. height
2	LB1	4055	4555	6.32
2	LB2	6215	6355	6.18
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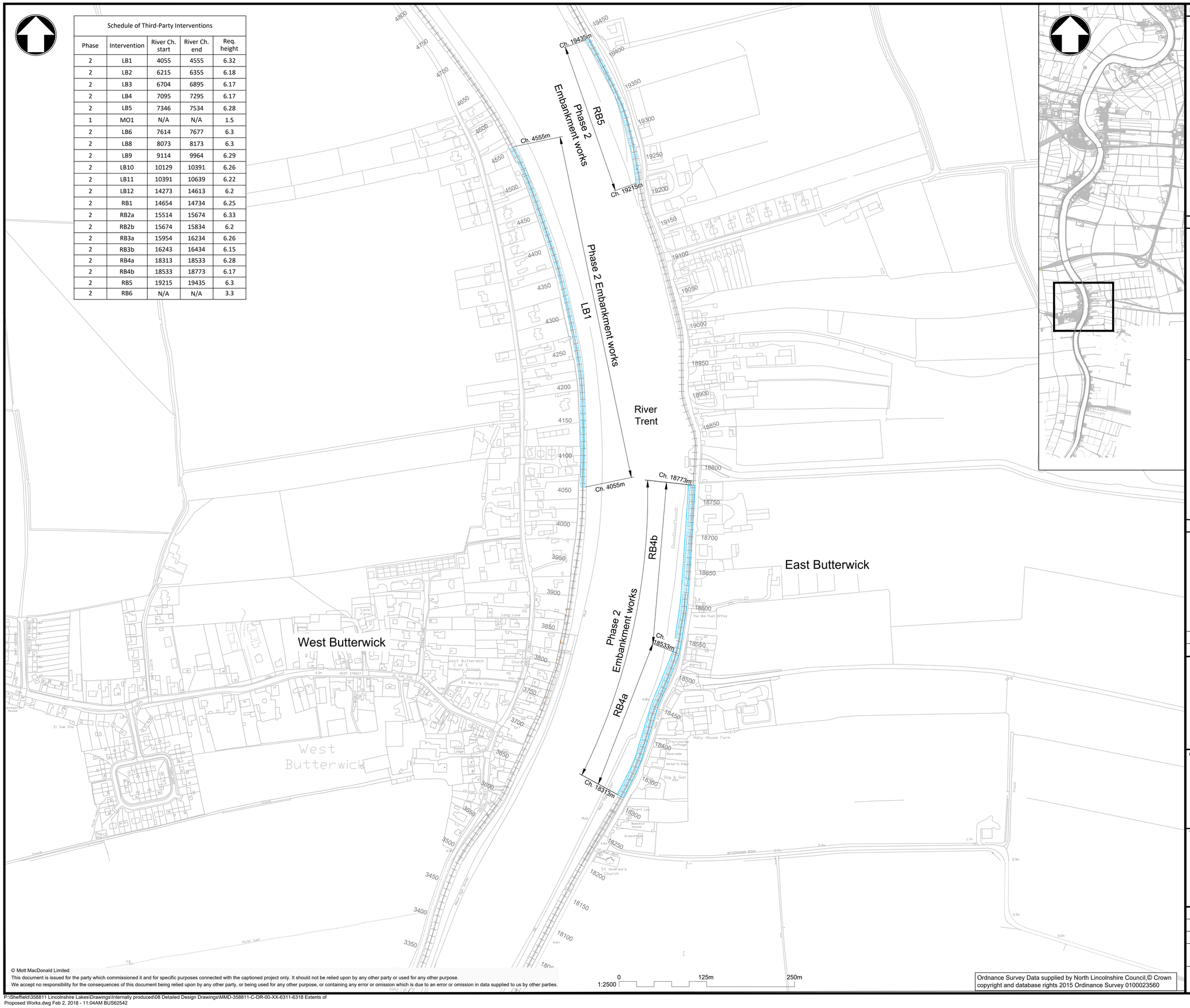

Notes

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- Phase 1 Existing wall works
- Phase 2 New flood walls
- Phase 2 Embankment works
- Phase 2 Existing wall works
- Phase 3 New sheet pile walls and embankment protection
- Managed overflow area
- Site Chainage 10800

RESIDUAL HEALTH & SAFETY RISK ASSESSMENT

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Reference drawings / documents

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MMD-358811-C-DR-00-XX-6312 - Extent of Proposed Works, Sheet 2 of 8
MMD-358811-C-DR-00-XX-6313 - Extent of Proposed Works, Sheet 3 of 8
MMD-358811-C-DR-00-XX-6314 - Extent of Proposed Works, Sheet 4 of 8
MMD-358811-C-DR-00-XX-6315 - Extent of Proposed Works, Sheet 5 of 8
MMD-358811-C-DR-00-XX-6317 - Extent of Proposed Works, Sheet 7 of 8
MMD-358811-C-DR-00-XX-6318 - Extent of Proposed Works, Sheet 8 of 8

MMD-358811-C-DR-00-XX-6201 - Embankment Protection, General Arrangement
MMD-358811-C-DR-00-XX-6202 - Embankment Protection, Sections

Rev	Date	Drawn	Description	Ch'k'd	App'd
C1	02/02/2018	KM	Construction Issue	FB	LG

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NORTH LINCOLNSHIRE COUNCIL

Title
Lincolnshire Lakes Flood Defence Scheme Extents of Proposed Works Sheet 6 of 8

Designed	M Wild	MW	Eng check	F Buskevicius	FB
Drawn	K Montagu	KM	Coordination	V King	VK
Dwg check	V King	FB	Approved	L Geddes	LG

Scale at A1	Status	Rev	Security
1:2500	CON	C1	STD

Drawing Number
MMD-358811-C-DR-00-XX-6316

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1:2500

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Schedule of Third-Party Interventions				
Phase	Intervention	River Ch. start	River Ch. end	Req. height
2	LB1	4055	4555	6.32
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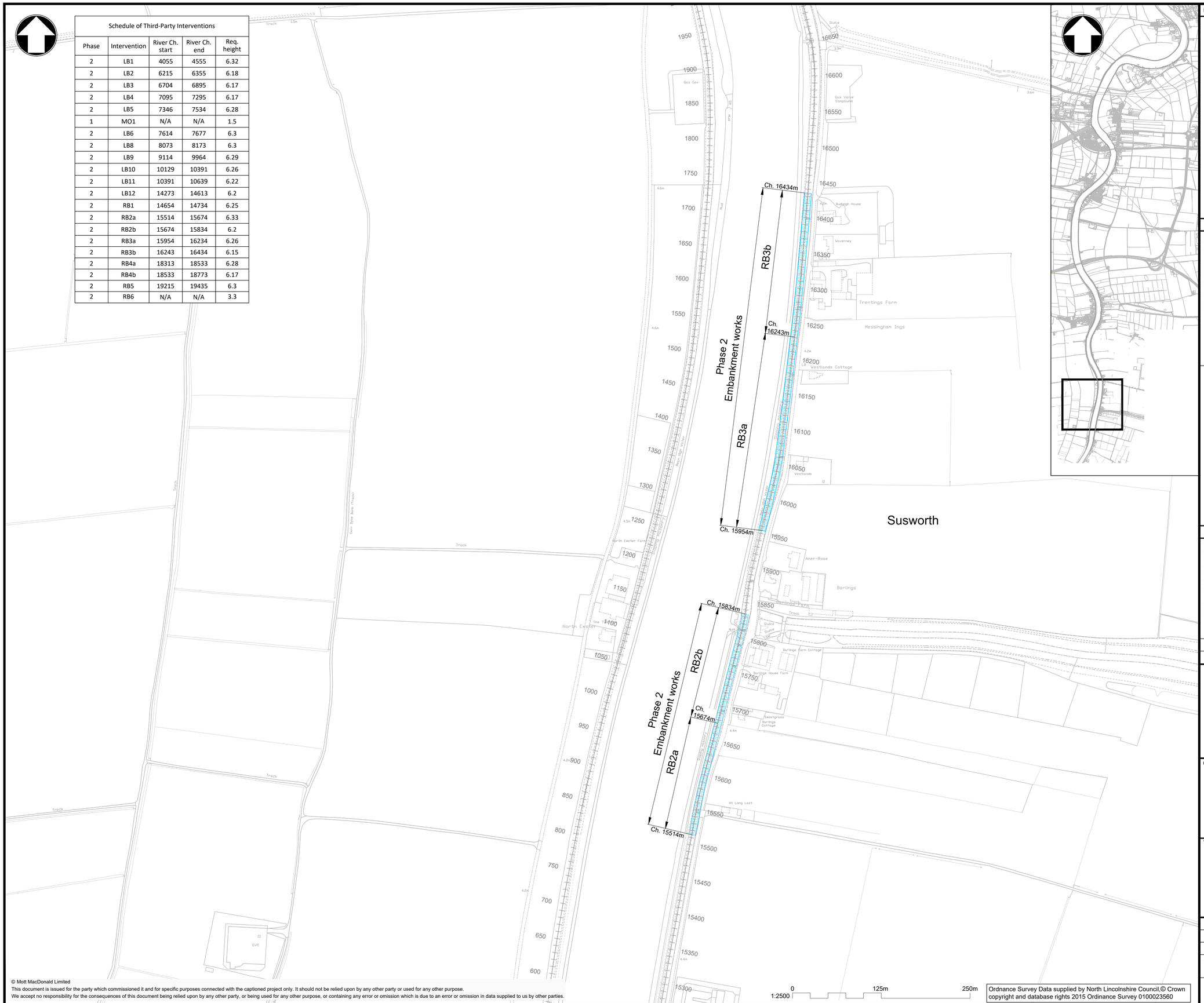

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Notes

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RESIDUAL HEALTH & SAFETY RISK ASSESSMENT
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Reference drawings / documents

MMD-358811-C-DR-00-XX-6311 - Extent of Proposed Works, Sheet 1 of 8
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MMD-358811-C-DR-00-XX-6313 - Extent of Proposed Works, Sheet 3 of 8
MMD-358811-C-DR-00-XX-6314 - Extent of Proposed Works, Sheet 4 of 8
MMD-358811-C-DR-00-XX-6315 - Extent of Proposed Works, Sheet 5 of 8
MMD-358811-C-DR-00-XX-6316 - Extent of Proposed Works, Sheet 6 of 8
MMD-358811-C-DR-00-XX-6318 - Extent of Proposed Works, Sheet 8 of 8

MMD-358811-C-DR-00-XX-6201 - Embankment Protection, General Arrangement
MMD-358811-C-DR-00-XX-6202 - Embankment Protection, Sections

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NORTH LINCOLNSHIRE COUNCIL

Title
Lincolnshire Lakes Flood Defence Scheme Extents of Proposed Works Sheet 7 of 8

Designed	M Wild	MW	Eng check	F Buskevicius	FB
Drawn	K Montagu	KM	Coordination	V King	VK
Dwg check	F Buskevicius	FB	Approved	L Geddes	LG

Scale at A1	Status	Rev	Security
1:2500	CON	C1	STD

Drawing Number
MMD-358811-C-DR-00-XX-6317

Schedule of Third-Party Interventions				
Phase	Intervention	River Ch. start	River Ch. end	Req. height
2	LB1	4055	4555	6.32
2	LB2	6215	6355	6.18
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NORTH LINCOLNSHIRE COUNCIL

Title

Lincolnshire Lakes
Flood Defence Scheme
Extents of Proposed Works
Sheet 8 of 8

Designed	M Wild	MW	Eng check	F Buskevicius	FB
Drawn	K Montagu	KM	Coordination	V King	VK
Dwg check	F Buskevicius	FB	Approved	L Geddes	LG

Scale at A1	Status	Rev	Security
1:2500	CON	C1	STD

Drawing Number

MMD-358811-C-DR-00-XX-6318

1:2500 0 125m 250m

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