West Winch Housing Access Road

Environmental Statement – Appendix 11.1 – Flood Risk Assessment and Drainage Strategy

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Executive Summary

No	Item	Comment
1	Development Description	Housing Access Road & A47 Improvement Works
2	Location	Easting – 521471 Northing – 218830
3	Scale of Development	62 Ha (Red Line), 16.5 Ha proposed Impermeable Area
4	Current Land Use	Agricultural land and existing roads
5	Flood Risk Summary	The site is considered to be at a low or negligible risk from flooding from all sources. A very small area of flood zone 2 has been identified to the north of the site however, this area benefits from flood defences for up to the 1 in 200 year event.
6	Site Level	The high point of the site is towards the centre of the proposed road, just south of Rectory Lane with a level of approximately 20.50mAOD. The low point of the site is located near the northwest corner of site, in the Hardwick Junction with a level of approximately 4.50mAOD. The southern section of the site tends to fall east towards an existing watercourse, the central section of the site tends to fall west toward Puny drain and the northern end falls north towards the Pierpoint drain.

No	Item	Comment
7	Surface Water Drainage	It is proposed to direct surface water via gulley drainage and filter drains to a gravity pipe network prior to discharge to a series of attenuation basins located at the low points of the Site. Surface water will discharge via 7 no. outlets into existing watercourses. The ponds have been designed to accommodate the critical 1 in 100 year + 40% climate change event and discharge will be limited to greenfield rates or 2 ls/ha (whichever is higher) where practicable. Where improvement works are taking place at the Hardwick Junction, discharge is to be directed to the existing drainage network, with any additional impermeable area being attenuated to greenfield or 2 l/s/ha rates.
8	Foul Water Drainage	There is no proposed foul water drainage associated with this development

1 Introduction

1.1 Appointment and Brief

1.1.1 WSP has been appointed by Norfolk County Council (NCC), working in partnership with the Borough Council of Kings Lynn and West Norfolk (BCKLWN), to undertake a Flood Risk Assessment and Drainage Strategy to support a planning application for the proposed West Winch Housing Access Road (WWHAR), mainly to the east of the village of West Winch, near King's Lynn. A Site Location Plan is provided in separate document **Appendix A**.

1.1.2 Development Proposals:

- The WWHAR would provide additional highway capacity to facilitate residential development of up to 4,000 dwellings to the east of West Winch. The WWHAR would be located predominantly to the east of West Winch, in a north-south orientation, between the A47 and A10. The WWHAR scheme also proposes a new roundabout with the A47, dualling of a section of the A47 between the new roundabout and Hardwick interchange, new east-facing slip roads connecting the dualled A47 with Hardwick interchange and minor modifications to the Hardwick interchange itself.
- With respect to the residential development described in 1.1.2 above, WSP has a separate appointment with BCKLWN for high-level masterplanning services to develop supplementary planning documents (SPD) providing more detailed advice and guidance on policies within the King's Lynn & West Norfolk Local Plan, adopted in September 2016. The scope of the SPD appointment does not include the preparation of a Flood Risk Assessment or Drainage Strategy for the proposed residential development.

1.2 Report Scope

1.2.1 The National Planning Policy Framework (NPPF) Section 14 '*Meeting the Challenge of climate change, flooding and coastal change*' requires a planning application to be accompanied by a site-specific FRA. This report sets out the proposed drainage strategy for the scheme including design considerations and constraints that have been applied in order for key consultee's such as the Environment Agency (EA) and NCC, acting as Lead Local Flood Authority, to comment/approve in principle prior to planning submission.

1.2.2 This report is a holistic risk based assessment of potential flooding from possible sources, including fluvial, tidal, groundwater and surface water run-off. It also identifies and examines the residual flood risk to the proposed development and third-party land.

1.2.3 Whilst completing the assessment, consideration has been given to the National Planning Policy Framework (NPPF), Planning Practice Guidance, British Standard 8533:2011, Assessing and Managing Flood Risk in Development, and British Standard 8582:2013 Code of Practice for Surface Water Management for Development Sites.

1.3 Limitations

1.3.1 This report is based on the interpretation and assessment of data provided by third parties. WSP cannot be held responsible for the accuracy of the third-party data and the conclusions and findings of this report may change if the data is amended or updated after the date of consultation.

2 Policy Context

2.1 National Planning Policy Framework (NPPF)

2.1.1 The National Planning Policy Framework (NPPF) was published in March 2012 (last updated in September 2023) with the aim of protecting the environment and to promote sustainable growth. There is an overarching

presumption in favour of sustainable development that should be the basis of every plan and every decision.

2.1.2 The following paragraphs/policies within the NPPF are considered relevant to this assessment:

- Paragraph 159: Requires that “Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future) Where development is necessary in such areas, the development should be made
- safe for its lifetime without increasing flood risk elsewhere.”;
- Paragraph 162: Explains that “The aim of the sequential test is to steer new development to areas with the lowest risk of flooding from any source.”; and
- Paragraph 167: Explains that “When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere […];
- Paragraph 169: Recommends that “Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:
    - a) take account of advice from the lead local flood authority;
    - b) have appropriate proposed minimum operational standards;
    - c) have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and
    - d) where possible, provide multifunctional benefits.”.

2.2 Technical Guidance to the National Planning Policy Framework

2.2.1 The NPPF Technical Guidance includes Flood Zone definitions and flood risk vulnerability classifications for different land uses.

2.2.2 The assessment of flood risk is based on the definitions in Table 1 of the Technical Guidance of the NPPF. As summarised in Table 2-1 below:

Table 2-1 – Flood zone definitions

Flood Zone	Definition
Flood Zone 1	▪ As that which has a "Low Probability" of flooding. The definition provided in Table 1 is: *"This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%)."*
Flood Zone 2	▪ As that which has a "Medium Probability" of flooding. The definition provided in Table 1 is: *"This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year."*
Flood Zone 3a	▪ As that which has a "High Probability" of flooding. The definition provided in Table 1 is: *"This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year."*
Flood Zone 3b	▪ As "the functional floodplain". The definition provided in Table 1 is: *"This zone comprises land where water has to flow or be stored in times of flood."*

2.2.3 Included within the "Policy aims" of Table 1 for Flood Zone 3a is reference to flood storage. This is not required in Flood Zone 2 but for Flood Zone 3a it is *stated as follows:*

"In this zone, developers and local authorities should seek opportunities to:

- *Create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage."*

2.2.4 The Environment Agency will often refer to this as "*flood compensation storage*" and require that the existing flood storage in the development area is maintained on a "*level-for-level"* basis. Typically, they will ask for evidence that the volume available for flooding is the same at every 200mm vertical slice post-development as it was pre-development up to the level of the 1 in 100 year flood, i.e. the extent of Flood Zone 3a.

2.2.5 The NPPF classifies the Flood Risk Vulnerability of various land uses in Table 2 (reproduced below). The More Vulnerable Classification encompasses usages such as hospitals and buildings used for dwellings. Less Vulnerable applies to buildings used for general industry, storage and distribution.

Table 2-2 – Flood risk vulnerability classification

Classification	**Development Type**
Essential Infrastructure	▪ Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. ▪ Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including infrastructure for electricity supply including generation, storage and distribution systems; and water treatment works that need to remain operational in times of flood. ▪ Wind turbines. ▪ Solar farms

Classification	Development Type
Highly Vulnerable	▪ Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational during flooding. ▪ Emergency dispersal points. ▪ Basement dwellings. ▪ Caravans, mobile homes and park homes intended for permanent residential use. ▪ Installations requiring hazardous substances consent (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as “essential infrastructure”)
More Vulnerable	▪ Hospitals. ▪ Residential institutions such as residential care homes, children’s homes, social services homes, prisons and hostels. ▪ Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. ▪ Non–residential uses for health services, nurseries and educational establishments. ▪ Landfill and sites used for waste management facilities for hazardous waste. ▪ Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.

Classification	Development Type
Less Vulnerable	▪ Police, ambulance and fire stations which are not required to be operational during flooding. ▪ Buildings used for shops, financial, professional and other services, restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non–residential institutions not included in “more vulnerable”, and assembly and leisure. ▪ Land and buildings used for agriculture and forestry. ▪ Waste treatment (except landfill and hazardous waste facilities). ▪ Minerals working and processing (except for sand and gravel working). ▪ Water treatment works which do not need to remain operational during times of flood. ▪ Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place). ▪ Car Parks

Classification	Development Type
Water-compatible development	▪ Flood control infrastructure. ▪ Water transmission infrastructure and pumping stations. ▪ Sewage transmission infrastructure and pumping stations. ▪ Sand and gravel working. ▪ Docks, marinas and wharves. ▪ Navigation facilities. ▪ Ministry of Defence installations. ▪ Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. ▪ Water-based recreation (excluding sleeping accommodation). ▪ Lifeguard and coastguard stations. ▪ Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. ▪ Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

2.2.6 The overall aim is to steer new development to Flood Zone 1. Where there are no reasonably available sites within Flood Zone 1, local planning authorities allocating land in local plans or determining planning applications for development at any particular location should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2, applying the Exception Test if required (see table below). Following review of Table 2.2: Flood Risk Vulnerability Classification the proposed development would be classified as Essential Infrastructure/More Vulnerable.

Table 2-3 – Flood risk vulnerability and flood zone 'compatibility

Flood Zone	Essential Infrastructure Classification	Water Compatible Classification	Highly Vulnerable Classification	More Vulnerable Classification	Less Vulnerable Classification
Zone 1	Development is appropriate	Development is appropriate	Development is appropriate	Development is appropriate	Development is appropriate
Zone 2	Development is appropriate	Development is appropriate	Exception Test Required	Development is appropriate	Development is appropriate
Zone 3a	Exception Test Required	Development is appropriate	Development should not be permitted	Exception Test Required	Development is appropriate
Zone 3b	Exception Test Required	Development is appropriate	Development should not be permitted	Development should not be permitted	Development should not be permitted

2.3 Norfolk County Council – Preliminary Flood Risk Assessment (PFRA) 2011

2.3.1 This report gives an overview of local flood risk in Norfolk based on a review of historic records of flooding and data derived from modelling of potential future flooding. It has been prepared by Norfolk County Council as part of a submission to meet the requirements of the Flood Risk Regulations (2009). The Regulations together with the related Flood Risk Management Act 2010 identify Norfolk County Council as Lead Local Flood Authority (LLFA) and require the council to develop a Preliminary Flood Risk Assessment (of sources of local flood risk - surface water, ordinary watercourses and groundwater) and subsequently a strategy for the management of local flood risk.

2.3.2 Records were reviewed that had been collated from a range of sources including water companies, district councils, the Highways Agency and local authorities. They showed that flooding has occurred in Norfolk from a range of sources, at various times and at locations across the county. However, as there has been no standardised methodology for recording information about

flooding it is not possible to map flood extents or determine the consequences of the majority of the past events.

2.3.3 Data provided by the Environment Agency, produced to a national methodology determined by Defra, was used to assess future flood risk and for the review and identification of Flood Risk areas.

2.3.4 The PFRA is a high-level screening exercise and must therefore consider floods which have significant harmful consequences for human health, economic activity, the environment and cultural heritage. The PFRA identifies such areas and if they are considered to be nationally significant, as defined by Defra, they are highlighted as 'Flood Risk Areas'. Flood Risk Areas warrant further examination and management through the production of flood risk and flood hazard maps and flood risk management plans.

2.3.5 The aim of this PFRA is to develop a strategic assessment of local flood risk across Norfolk based on information from past floods and modelling of the potential impact of future flooding. The process will inform the development of a strategy for the management of local flood risk.

- Records of historic flooding from surface runoff, groundwater and ordinary watercourses will be collated and assessed to help with understanding past forms of flooding.
- Data sources that will help with mapping potential future flood risk will be identified.
- A PFRA report which satisfies the requirements of the Flood Risk Regulations 2009 will be produced.
- The national assessment of indicative Flood Risk Areas will be reviewed and if applicable additions and amendments will be suggested and justified in the light of local circumstances.

2.3.6 The Local Flood Risk Management Strategy should collate and consolidate information from the PFRA and the Strategic Flood Risk Assessments (SFRA)

to cover flood risks from all sources of flooding and establish a methodology for managing the risks within the partnership framework.

2.4 King's Lynn and West Norfolk Strategic Flood Risk Assessment (SFRA) 2018

2.4.1 In 2018 a Strategic Flood Risk Assessment (SFRA) was undertaken by JBA Consulting. The document fulfils the Level 1 SFRA requirements, replacing an earlier SFRA published in 2008.

2.4.2 Additionally, since 2008 there have been a number of flood events in the UK which have changed the way in which flood risk is managed and regulated. Whilst Government and the Environment Agency maintain responsibility for the issue overall, Lead Local Flood Authorities (LLFA) have been created through the Floods and Water Management Act (2010). They are required to prepare and maintain a strategy for local flood risk management in their area. In Norfolk this is Norfolk County Council.

2.4.3 Since the previous SFRA was produced the Environment Agency has updated modelling information relating to a number of the watercourses within the study area, which has meant that the outlines of the flood zones are no longer relevant and up to-date.

2.4.4 More detailed information is also now available with regard to surface water and other sources of flooding. This is less of an issue in West Norfolk, fluvial and tidal flooding make up the majority of recorded flood events in the area.

2.4.5 This update provides up-to-date maps of flood risk areas and also provide information to accompany the emerging Local Plan by way of a sequential test to be taken forward by developers as potential development sites come forward.

2.5 Norfolk Local Flood Risk Management strategy (2015) – Policy Review 2021

2.5.1 Following flooding in 2007, the government commissioned a review (The Pitt Review, 2008), which recommended urgent changes in the way the country is adapting to the increased risk of flooding. A principal change was to establish greater clarity in the roles and responsibilities and an increased focus on addressing surface water flood risk through the enactment of the Flood and Water Management Act (2010).

2.5.2 As Lead Local Authority (LLFA), Norfolk County Council has to "develop, maintain, apply and monitor" a Local Flood Risk Management Strategy for Norfolk. The Strategy will be produced in consultation with local partners and will focus on local sources of flooding from surface runoff, groundwater and ordinary watercourses. Interactions between different forms of flooding will be done in conjunction with the Environment Agency which has responsibility for managing flood risk from main rivers, reservoirs and the sea.

2.5.3 The Strategy will be the means by which the LLFA will discharge its general duty to provide leadership and to co-ordinate Flood Risk Management (FRM) on a day to day basis. The Strategy will be the focal point for integrating a range of flood risk related actions across Norfolk.

2.5.4 The strategy must:

- Set out the roles and responsibilities of the various Risk Management Authorities (RMAs) in the area;
- Define what is considered to be 'locally significant' flood risk;
- Specify the objectives for managing local flood risk;
- Identify and describe the measures (actions) proposed to deliver the objectives;

- Where relevant, provide details of the costs and benefits related to any actions, and identify a means or process as to how these may be paid for;
- Identify how the Strategy will contribute to wider environmental objectives;
- Describe and establish a review process and timetable for the Strategy.

2.5.5 The Strategy must assess and define what locally significant flood risk is. This will require the development of criteria to ensure that significance will need to be assessed on a number of different ways depending on the situation, for example through the setting of thresholds that will trigger investigations, the assessment of the effect that structures and other features have on flood risk and how potential flood risk management schemes will be prioritised for funding.

2.5.6 High level objectives proposed in the Strategy include:

- Explain what flooding is, its dangers, and how flood risk can be managed;
- inform about the extent and characteristics of flood risk in Norfolk and signpost other sources of information about flood risk in the county;
- Clarify which Risk Management Authorities are responsible for which flood risk management activities;
- Indicate the objectives of the strategy and make commitments in respect of the actions that will be taken by the Lead Local Flood Authority and other Risk Management Authorities;
- Establish a framework of policies that will ensure that riparian owners, businesses, developers and authorities apply a consistent and strategic approach to flood management;

- Outline a series of proactive measures which will increase understanding of local flood risk and identify further measures to manage those risk
- Clarify how flood risk management is to be funded in Norfolk
- Indicate how flood risk management activities will be monitored and how the strategy will be reviewed

2.5.7 Policy OW4: Culverting The Lead Local Flood Authority (LLFA) will only approve an application to culvert a watercourse if there is no reasonably practicable alternative, or if the detrimental effects of culverting would be so minor that they would not justify a more costly alternative. In all cases, where it is appropriate to do so, adequate mitigation must be provided for damage caused. Wherever practicable the Lead Local Flood Authority and other Risk Management Authorities will seek to have culverted watercourses restored to open channels. The Lead Local Flood Authority will normally reject applications for culverting (other than vehicle accesses) in areas identified as being;

- in Flood Zones 2 or 3a/3b and/or
- at risk of surface run-off flooding as indicated by the Environment Agency's updated flood map for surface water
- and/or other sources of flood risk modelling.

2.5.8 This is due to the potential of proposed works increasing flood risk. Exceptions to this policy will only be considered if the applicant is able to demonstrate that, on the balance of probabilities, the proposed development would not increase flood risk.

Where opportunities arise and there is benefit in doing so, the Lead Local Flood Authority may encourage landowners to remove existing culverts and restore surface watercourses.

3 Existing Site

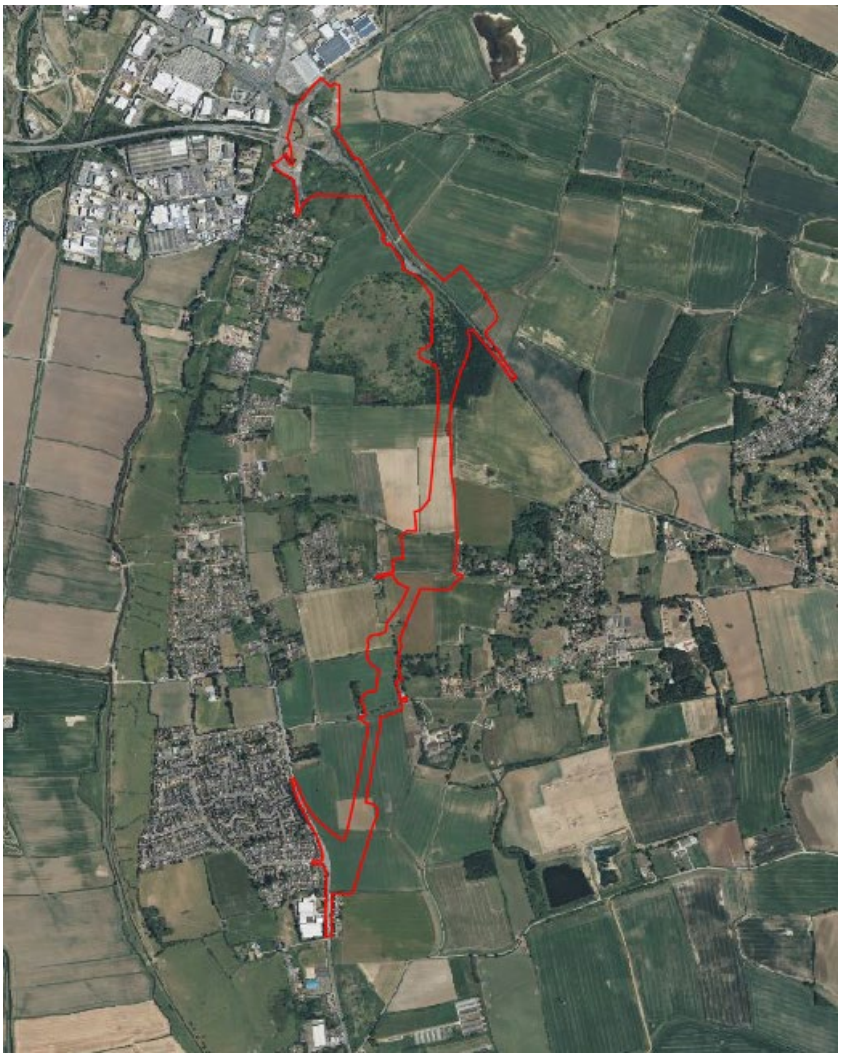
3.1 Site location

3.1.1 The site is located east of the village of West Winch, between the A47, just east of the Hardwick interchange, and the A10 south of West Winch. An approximate postcode is PE33 0NR and approximate OS coordinates are 563779, 316179.

3.1.2 The Site currently consists of existing highways and green open space/agricultural land – refer to figure 3-1. A Site Location Plan can be found in separate document **Appendix A**.

3.1.3 The Proposed Scheme is described in Section 1.1

Figure 3-1 – Site location, current landuse



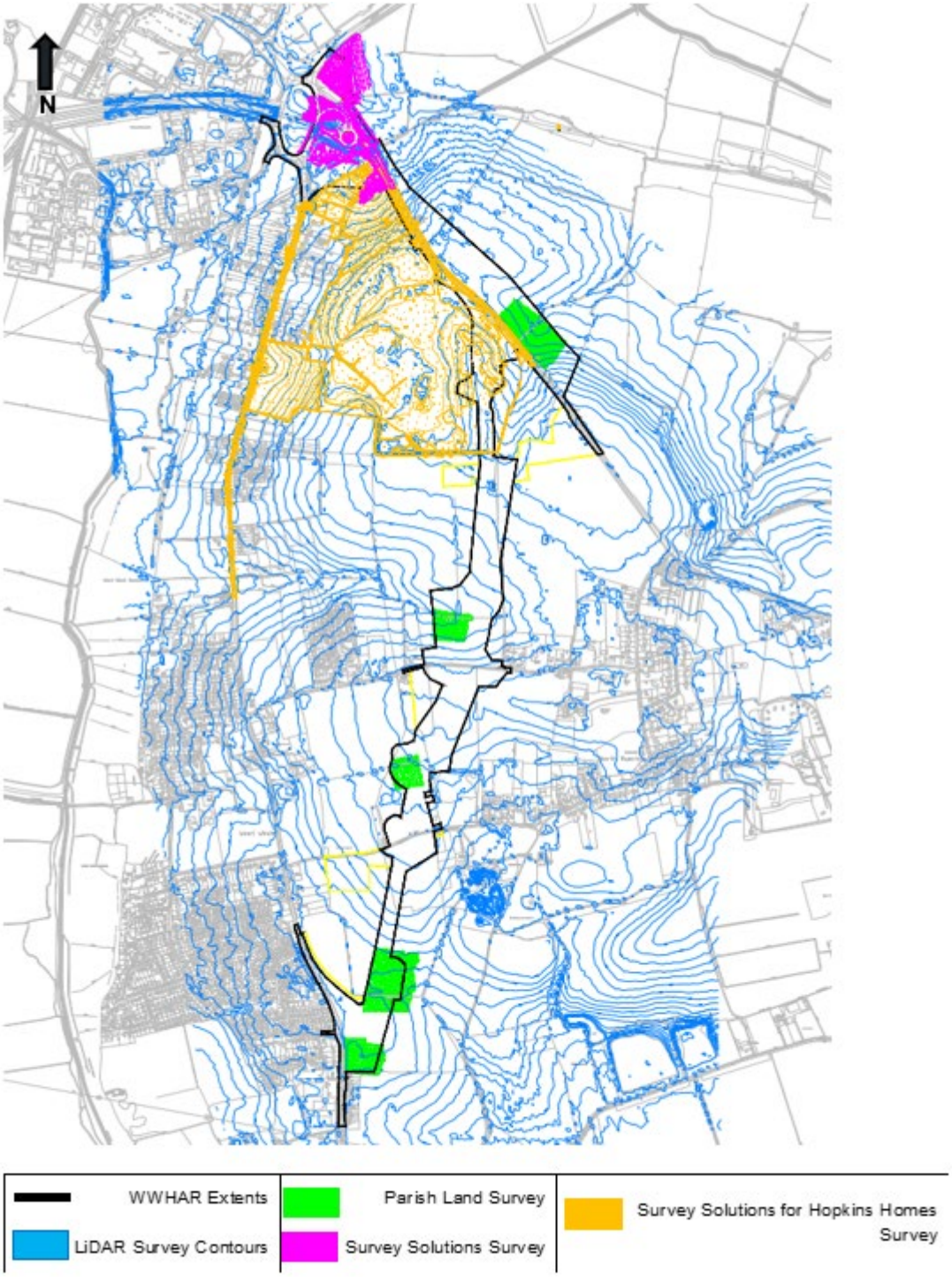
3.2 Site description

3.2.1 Table 3-1 describes the general site characteristics.

Table 3-1 – Characteristics of the site

Characteristics of the Site	Description
Area	The site area is approximately 56 Ha
General Topography	The high point of the site is towards the centre of the proposed road, just south of Rectory Lane with a level of approximately 20.50mAOD. The low point of the site is located near the northwest corner of site, in the Hardwick Junction with a level of approximately 4.50mAOD. The southern section of the site tends to fall east towards an existing watercourse, the central section of the site tends to fall west toward Puny drain and the northern end falls north towards the Pierpoint drain.
Northern Boundary	The northern boundary of the site stretches from the Hardwick junction between the A47 and A10 in the west, along the existing A47 (Constitution Hill) to approximately 1km north of Kings Lynn caravan park in east.
Southern Boundary	The southern boundary of the site runs from a connection into the existing A10, following the alignment of the existing road north and then runs east into adjacent arable land just north of an existing row of housing on the A10.
Eastern Boundary	The eastern boundary of the site runs mainly through arable land from the south, following the alignment of the proposed road, crossing two existing side roads (Chequers Lane and Rectory Lane) and ends just to the north of the existing A47 to allow room for a new roundabout junction.
Western Boundary	The western boundary runs along the A10 south, along the proposed link back into the existing road and out into arable land to the east, following the proposed alignment of the housing access road and then along the existing A47 in the north and terminates at the Hardwick Junction.
Access	Vehicular access to the site is available via the A10, A47 and Rectory Lane.

Figure 3-2 – LiDAR topography/topographical survey extents existing waterbodies



3.2.2 Several ordinary watercourses have been identified within the site, from south to north;

- Just north of Rectory Lane, a land drain/ditch has been identified that falls to the west and outfalls to Puny Drain 1.35km west of the site.
- Another land drain/ditch between Rectory Lane and Chequers Lane appears to fall west, likely to also outfall into Puny Drain west of the site.
- To the south of the site a further drainage ditch/land drain falls southeast and outfalls into Puny Drain 1.15km south of the site.
- North of the proposed junction with the A47 there is a land drain falling into the Pierpont Drain 0.8km north, which then itself outfalls into the River Nar 2.5km west of the site.
- Just south of the existing Hardwick junction the road crosses a drain which also appears to fall north and then west into Pierpont Drain

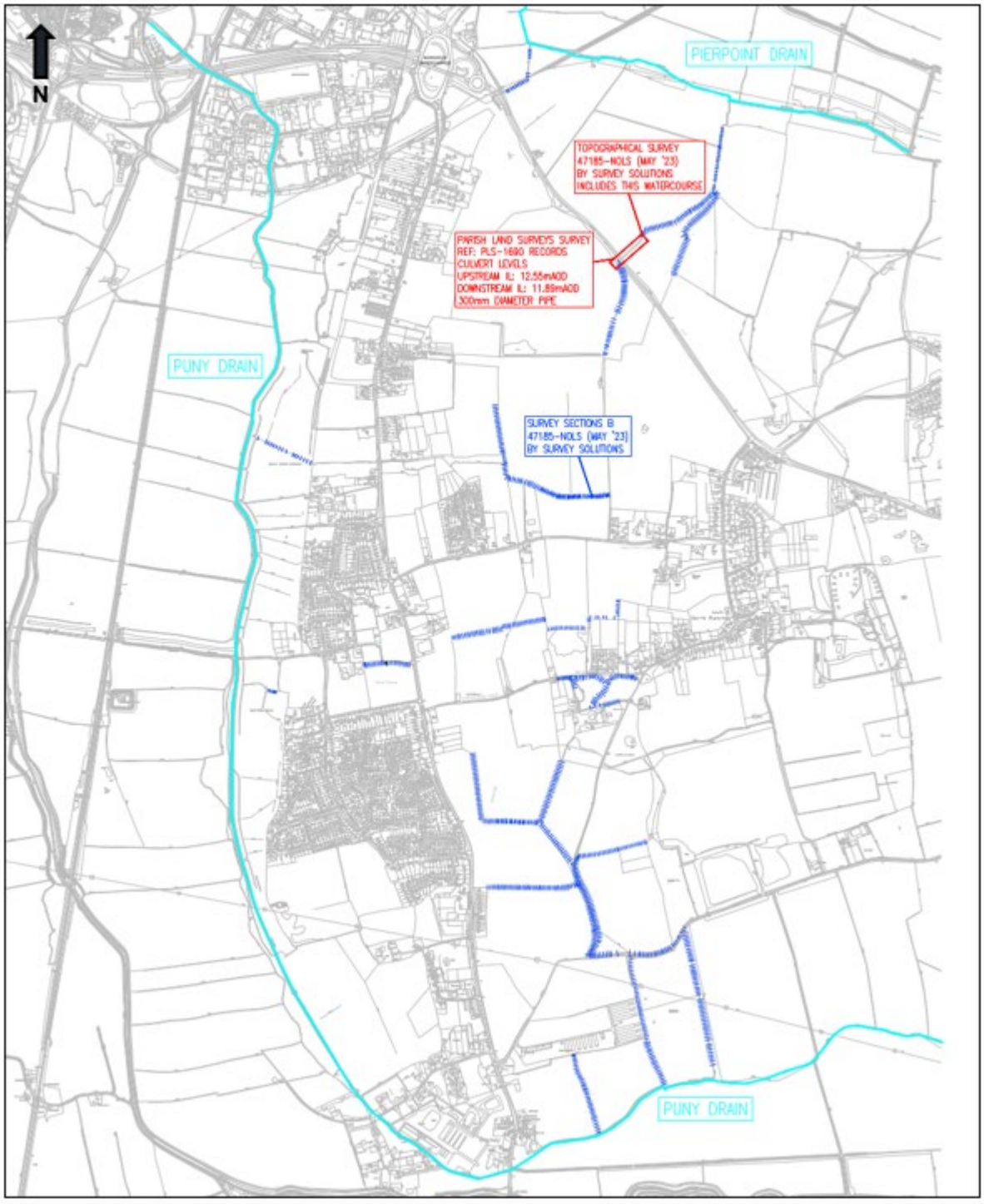
3.2.3 Neither Puny Drain or Pierpont is classified as a main river by the EA with both out falling into the River Nar.

3.2.4 The nearest watercourse to the site classified as a Main River by the EA is the River Nar which is located 0.95km southwest. It is a tributary that feeds into the River Great Ouse at King's Lynn approximately 2.5km northwest of the site – see **Figure 3-3**.

Figure 3-3 – Environment agency main river map

3.2.5 Topographical surveying has been undertaken for the watercourses within the site boundary that form points of discharge for the drainage strategy. The LLFA requested that connectivity through to the Puny Drain to the south and west and the Pierpoint drain to the north is established, ensuring outflows from the scheme drainage will be effectively conveyed away. **Figure 3-4** below shows the extents of watercourses surveyed – additional survey was scoped but was not possible due to the vegetated nature of the watercourses and ecological risks associated with clearing them. Additional surveying should take place at a later stage to confirm remaining connections, this approach was agreed with the LLFA. Survey information can be found in separate document **Appendix O**. In all cases the watercourses were found to be flowing towards the Pierpoint and Puny Drains, with connectivity established where full extents were surveyed. Details for the culvert beneath the existing A47 as indicated are also given.

Figure 3-4 – Watercourse surveys



3.3 Existing Sewers

3.3.1 Anglian Water sewer records can be found in separate document **Appendix B**.

Foul Water Sewers

3.3.2 There is a 150mm foul sewer running east-west adjacent to Rectory Lane, which the proposed road will cross, details of invert and cover levels for this sewer are not given in asset records. Anglian Water have confirmed there will be no requirement to divert this sewer subject to detailed design.

3.3.3 Additionally, there is a 4 inch cast iron pumped sewer running in the A10/Main Road at the approximate location of the southern arm of the junction and a sewer of unknown size running in the back gardens of houses adjacent to the A10 that may be impacted, details of invert and cover levels for these sewers are not given in asset records. Anglian Water have confirmed there will be no requirement to divert this sewer subject to detailed design, refer to separate document **Appendix L** for correspondence.

Surface Water Sewers

3.3.4 There are no public surface water sewers within the site boundary.

3.3.5 The nearest surface water sewer to the site is located 200m north of Rectory Lane where it discharges into a land drain approximately 100m east of the site. The size of this sewer is currently unknown. No other surface water sewers are known to be located near the site.

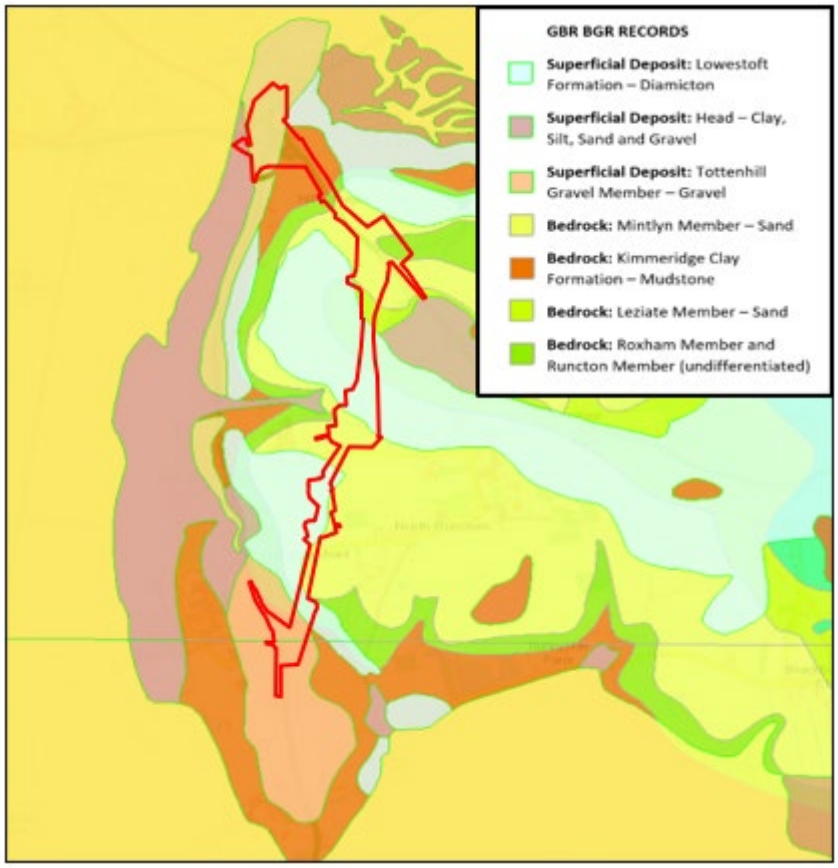
3.4 Geology and hydrogeology

The British Geological Survey

3.4.1 The British Geological Survey (BGS) online Geology of Britain Viewer indicates the site has a variable underlying bedrock geology, with sands through the north and centre of the proposed road, Leziate Member – Sand (shown as light green in **figure 3-5**), Mintlyn Member – Sand (yellow) and Roxham and Runcton Members – Sand (dark green). Whilst the south of the alignment is underlain by Kimmeridge Clay (dark orange). The superficial deposits are an area of Head – Clay, Silt, Sand and Gravel (purple) in the northern extent, bands of Lowestoft Formation – Diamicton (light blue)

towards the centre of the site and an area of Totenhill Gravel Member – Gravel (light orange) around the southern junction.

Figure 3-5 – GBR BGS bedrock



3.4.2 The above mapping is supported by the findings of the GI appraisal undertaken by WSP in January 2021, which shows typical strata as follows – summarised in **tables 3-2 to 3-4**:

Topsoil

3.4.3 Encountered within all exploratory hole locations, ranging in thickness from 0.30 to 0.65m. Topsoil was recorded as dark brown to brownish grey, slightly gravelly, sandy silty slightly clayey topsoil, with some rootlets and straw and an organic odour.

Alluvium

3.4.4 Encountered underlying the topsoil at one location in the north of the scheme, in TP217. Alluvium was recorded as dark grey, very sandy silty clay with

occasional roots and a slight organic odour. The Alluvium measured 1m in thickness and reached up to 1.60m bgl.

Head deposits

3.4.5 Encountered underlying the topsoil at one location in the south of the scheme, in WS106. The Head deposits were granular in nature, recorded as mottled orange brown and grey, slightly silty to very silty, slightly gravelly clayey fine to medium sand. The gravel was medium sub-angular to sub-rounded of flint. The Head deposits measured 1.50m thick.

Tottenhill Sands and Gravels

3.4.6 Encountered within the central and southern portion of the scheme and were absent in the north of the site. Deposits ranged in thickness between 0.40 and 1.85m. The Tottenhill Sands and Gravels were recorded as dark brown to brownish grey, slightly clayey, silty very gravelly fine to medium sand. Gravel was fine to coarse, angular to sub-rounded of flint, quartz, ironstone and carstone. WS103 recorded a number of lenses of grey clay at 0.60m bgl.

The Lowestoft Formation

Encountered within the central and southern portion of the scheme and was absent in the north of the site. Ranging in thickness between 0.40 to 4.80m the full thickness of the Lowestoft Formation was not proven in this investigation. The Lowestoft Formation was recorded as firm to very stiff, orange brown to dark grey, sandy slightly silty gravelly clay. Gravel was fine to coarse, angular to sub-rounded of flint, chalk and mudstone. Occasional flint cobbles were encountered with depth. In TP205, numerous lenses of orange brown very sandy silty clay was reported at 0.80m bgl.

The Mintlyn Beds Formation

3.4.7 Encountered throughout the scheme, ranging from 0.50 to 4.60m in thickness. The base of the unit was not proven in parts of the central portion of the scheme in this investigation. The Mintlyn Beds were predominantly encountered as granular deposits, recorded as light brown to dark grey, slightly clayey silty slightly gravelly fine to medium sand, within laminations

and thin beds of weak to moderately weak sandstone, weak reddish-brown ironstone and siltstone. Cohesive deposits were recorded as stiff, mottled reddish brown and orange, brown very sandy gravelly clay. Gravel was fine to coarse, angular to sub-rounded of flint, ironstone, chert and phosphatic nodules.

Note 1 – the base depth of some units was not confirmed at the investigation locations.

Note 2 – Kimmeridge Clay was not encountered during this investigation within the central section, anticipated to be present underlying site.

Table 3-2 – Northern section typical findings summary

Strata	**Top Depth (m bgl)** **Elevation [m AOD]**	**Depth to Base (m bgl)** **Elevation [m AOD]**	**Thickness (Average)**
Topsoil	0.00 [15.29 - 20.36]	0.30 - 0.65 [14.94 - 20.06]	0.30 - 0.65 (0.39)
Tottenhill Sands and Gravels	0.30 - 0.35 [17.32 - 20.06]	1.50 - 2.00 [16.17 - 18.76]	1.15 - 1.70 (1.38)
Lowestoft Till Formation	0.35 - 1.50 [14.94 - 18.04]	1.90 - 5.45 (NP) [12.19 - 15.77]	0.40 - 4.80 (NP) (2.65)
Mintlyn Beds Formation	0.40 - 2.00 [15.77 19.52]	3.00 - 5.00 (NP) [14.67 - 16.46]	1.10 - 4.60 (NP) (2.46)
Roxham and Runcton Beds	3.85 - 3.90 [15.33 - 16.46]	5.00 - 5.45 (NP) [13.73 - 14.18]	1.10 - 1.60 (NP) (1.35)
Kimmeridge Clay	See note 2 below	No data	No data

Table 3-3 – Central section typical findings summary

Strata	Top Depth (m bgl) Elevation [m AOD]	Depth to Base (m bgl) Elevation [m AOD]	Thickness (Average)
Topsoil	0.00 [7.29 - 13.45]	0.30 - 0.65 [6.69 - 13.10]	0.30 - 0.65 (0.48)
Alluvium1	0.60 [6.69]	1.60 [5.69]	1.00 (1.00)
Mintlyn Beds Formation	0.35 - 1.60 [5.69 - 13.10]	1.65 - 2.30 [4.99 - 11.80]	0.70 - 1.30 (1.00)
Roxham and Runcton Beds	1.65 - 2.30 [4.99 to 11.80]	2.60 - 3.00 (NP) [4.69 to 10.45]	0.30 - 1.35 (NP) (0.83)
Kimmeridge Clay2	2.60 [4.69]	3.00 (NP) [4.29]	0.40 (NP) (0.40)

1/2 Encountered in one location within TP217 in the very north of the Site. Note, the base depth of some units was not confirmed at the investigation locations.

Table 3-4 – Southern section typical findings summary

Strata	Top Depth (m bgl) Elevation [m AOD]	Depth to Base (m bgl) Elevation [m AOD]	Thickness (Average)
Topsoil	0.00 [10.71 - 17.74]	0.30 - 0.60 [10.31 - 17.14]	0.30 - 0.60 (0.43)
Head Deposits1	0.50 [11.20]	2.00 [9.70]	1.50 (1.50)
Tottenhill Sands and Gravels	0.30 - 2.00 [9.70 - 16.24]	0.85 - 3.85 [7.85 - 15.34]	0.40 - 1.85 (0.95)
Lowestoft Till Formation	0.60 - 3.85 [7.85 - 17.14)	1.40 - 5.00 (NP) [6.70 - 15.74]	0.55 - 1.40 (NP) (0.91)
Mintlyn Beds Formation	0.80 2.00 [10.01 - 15.74]	1.90 - 3.30 [9.51 - 15.04]	0.50 - 2.10 (1.15)
Roxham and Runcton Beds	1.35 - 3.30 [9.36 to 15.04]	1.90 - 5.45 (NP) [8.81 to 15.36]	0.20 - 2.60 (NP) (1.16)

Strata	Top Depth (m bgl) Elevation [m AOD]	Depth to Base (m bgl) Elevation [m AOD]	Thickness (Average)
Kimmeridge Clay	1.50 - 2.10 [8.81 - 9.73]	2.60 - 5.45 (NP) [5.26 - 8.81]	0.50 - 3.55 (NP) (1.73)

1 Encountered in one location within WS106 in the south of the Site. Note, the base depth of some units was not confirmed at the investigation locations.

3.4.8 As part of the GCA, during monitoring visits on 18 August 2020 and 9 November 2020, groundwater samples were collected from the installed window sample locations. **Table 3-5** below provides a summary of the encountered groundwater during the monitoring visits on 18 August 2020 and 9 November 2020. As can be seen groundwater levels were variable between 3.41m to 0.1m BGL, the levels do not seem to be consistent across the site, with only one monitoring location for each of the strata, so a cohesive model of groundwater depths cannot be formed based on the information given. Further and more extensive monitoring should be undertaken at a later date to inform detailed design.

Table 3-5 – Groundwater monitoring findings

Exploratory Hole	Elevation of screen top (m AOD)	Elevation of screen base (m AOD)	Geology of Response Zone	Groundwater Level mbgl (m AOD) Min	Groundwater Level mbgl (mAOD) Mean	Groundwater Level mbgl (mAOD) Max
WS101	18.92	14.92	Mintlyn Beds	1.20 (18.72)	2.30 (17.62)	2.79 (17.13)
WS102	17.18	13.18	Lowestoft Till Formation	0.10 (18.08)	0.69 (17.49)	0.90 (17.28)
WS103	18.18	14.18	Tottenhill Sand and Gravels	0.65 (18.58)	1.33 (17.85)	1.82 (17.36)
WS105	15.54	11.54	Roxham and Runcton Beds	1.10 (15.44)	2.82 (13.72)	3.41 (13.13)
WS106	10.70	6.70	Head Deposits, Tottenhill Sand and Gravels and Lowestoft Till Formation	0.70 (11.00)	1.17 (10.53)	1.55 (10.15)
WS107	9.71	5.71	Roxham and Runcton Beds and Kimmeridge Clay	0.76 (9.95)	1.34 (9.37)	1.80 (8.91)

**metres below ground level*

*** metres above ordnance datum*

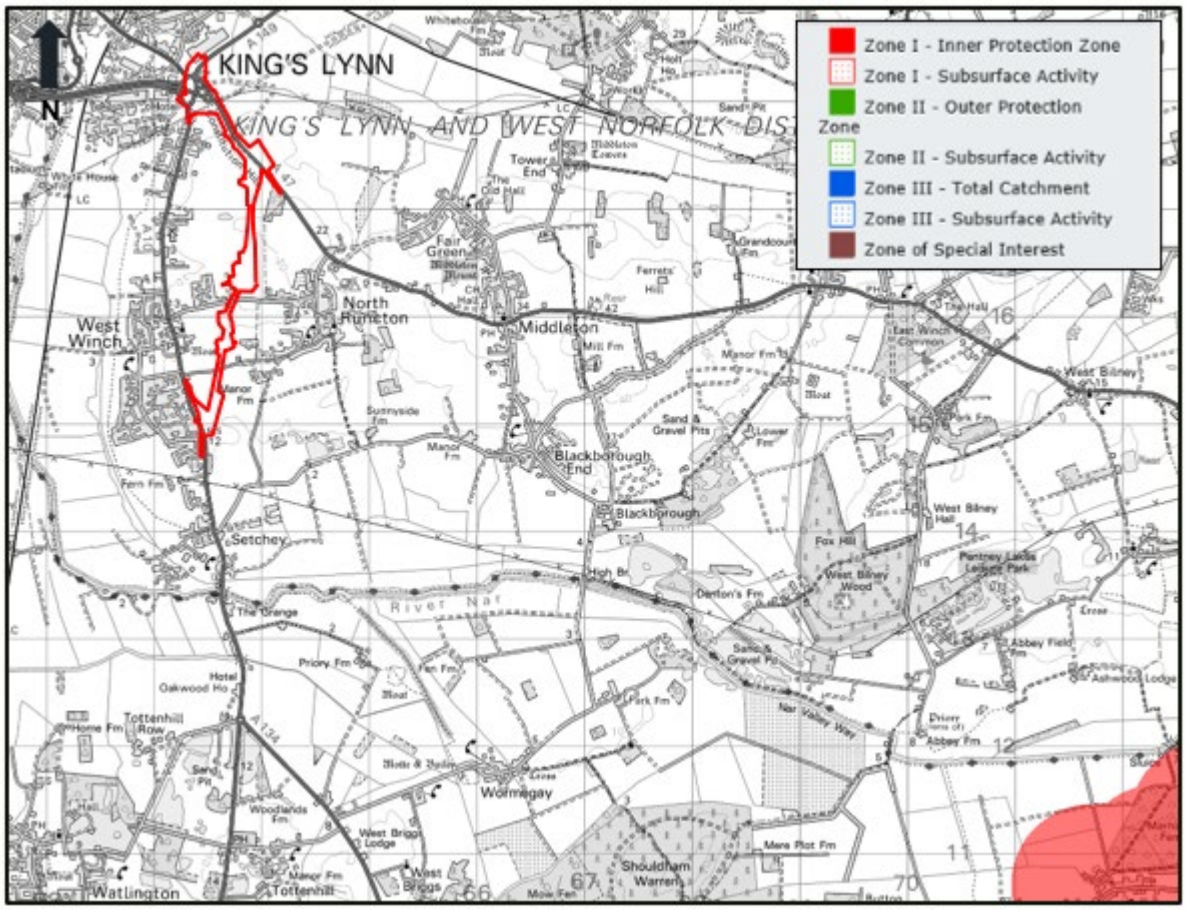
3.4.9 A summary of soakage testing undertaken as part of the GCA can be found in **Table 3-6**. As can be seen, favourable infiltration rates were found in the Tottenhill Sands and Gravels, Mintlyn Beds and Roxham and Runcton Beds in the range of 7.7x10-5 m/s to 3.5 x10-6 m/s. The Lowestoft Formation did not give a viable rate due to it's cohesive nature. Whilst the geology at depths for shallow infiltration (approx. 1-2m) does vary across the site, groundwater findings as explained in section 3.6.8 above would not give a sufficient clearance (1.2m as per LLFA guidance) between seasonally high groundwater and the base of any such infiltration feature, therefore infiltration is not considered to be a viable form of discharge, subject to further works.

Table 3-6 – Soakage testing findings

Borehole ID	Depth of water (m bgl)	No. of Tests	Infiltration Rate (m/sec) Min	Infiltration Rate (m/sec) Mean	Infiltration Rate (m/sec) Max	Strata
WS102	4.90	1	4.40E-09	4.40E-09	4.40E-09	Lowestoft Formation
WS103	1.50	3	1.5E-05	2.0E-05	1.7E-05	Tottenhill Sands and Gravels
WS105	3.25	3	3.5E-06	9.2E-06	5.6E-06	Mintlyn Beds
WS107	1.70	3	7.2E-05	7.7E-05	7.4E-05	Roxham and Runcton Beds Formation

Groundwater Protection Zones

3.4.10 The site does not fall within a Groundwater Source Protection Zone. Refer to **Figure 3-6** for the Source Protection Zone Map of the site.



4 Sources of Flood Risk

4.1.1 This chapter assesses the risk of flooding to the site from all current and future potential sources of flooding.

4.1.2 **Table 4-1** summaries the findings of the assessment. A more detailed explanation of the flood risk issues on the site and determination of flood risk ratings are presented in the sections below.

Table 4-1 – Degree of risk from each source of flooding source risk

Source	Risk
Fluvial	Low (aside from the small area of Flood Zone 2 east of the Hardwick Junction on the A47)
Ground Water	Low
Surface Water	Low
Sewer	Low
Other – Reservoir	Negligible
Other – Canals	Negligible
Other – Culverts	Negligible

4.2 Fluvial Flood Risk

4.2.1 The Environment Agency's (EA) Flood Map for Planning indicates that the vast majority of the site is located within Flood Zone 1 (land having a less than 1 in 1,000 annual probability of river or sea flooding); see the area identified at risk can be mitigated through appropriate raising of levels. Any loss of flood plain capacity can be compensated for onsite so as not to increase flood risk elsewhere.

4.2.2 Correspondence from the EA indicates that the site is outside the area of any fluvial hydraulic modelling and will not be affected by breaching of any flood defences. The Internal Drainage Board (IDB) have also confirmed that the site is outside the influence of any of their pumping stations. A copy of their correspondence can also be found in separate document Appendix E.

4.2.3 Figure 4-1 and separate document **Appendix E** for EA correspondence. A small area of Flood Zone 2 (land having between a 1 in 100 and a 1 in 1,000 annual probability of river flooding) is shown just east of the Hardwick Junction on the A47. Figure 4-2 provides a more detailed view of the flood zone extents in relation to the proposed road. The existing road is currently

within Flood Zone 2, with the proposed improvements to the A47 increasing the total extent within Flood Zone 2 from approximately 0.0027ha to 0.004ha, representing an increase of 48%. It should be noted that this area also benefits from flood defences providing protection against up to a 1 in 200 year flood event.

4.2.4 It is proposed that levels in the area within Flood Zone are to either:

- remain at existing or be increased;

4.2.5 If the levels are to be raised any loss in flood plain volume could be compensated for on a level for level basis on site to the north of the A47 alignment. Based on the available information, the risk of fluvial flooding is considered to be predominantly low for the proposed site aside from the area identified as at risk from the 1:1000 year event. The area identified at risk can be mitigated through appropriate raising of levels. Any loss of flood plain capacity can be compensated for onsite so as not to increase flood risk elsewhere.

4.2.6 Correspondence from the EA indicates that the site is outside the area of any fluvial hydraulic modelling and will not be affected by breaching of any flood defences. The Internal Drainage Board (IDB) have also confirmed that the site is outside the influence of any of their pumping stations. A copy of their correspondence can also be found in separate document **Appendix E.**

Figure 4-1 – EA flood map for planning

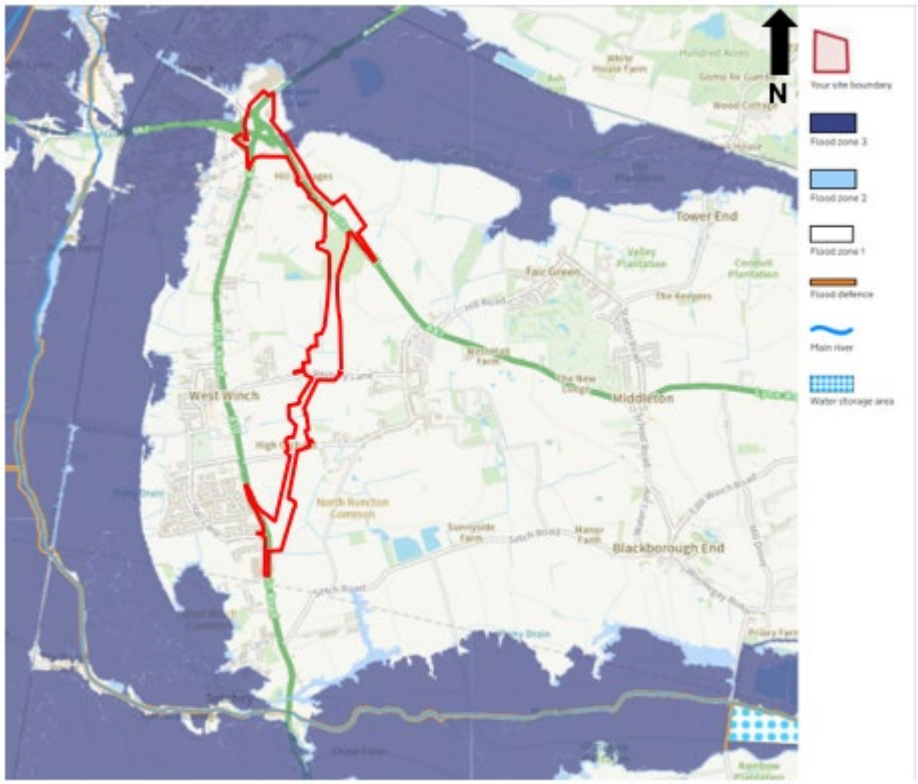
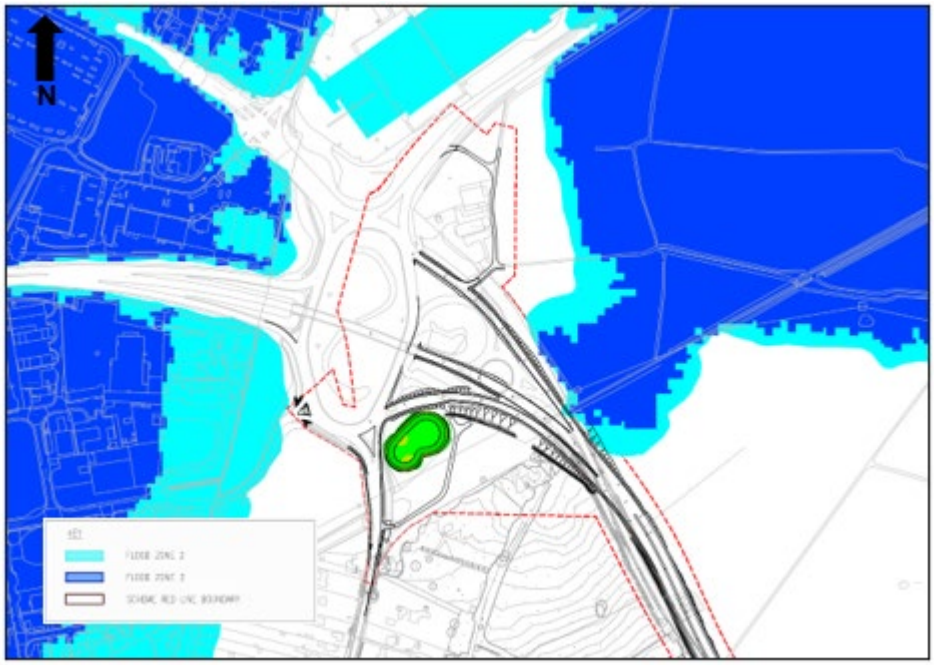


Figure 4-2 – Detailed view of development area within flood zone



4.3 Ground Water Flooding

4.3.1 The water level recorded in the BGS Borehole data (see Section 3.6 for further details) is variable across the site with ground water levels recorded between 1.52-8.23m BGL.

4.3.2 Groundwater monitoring from the WSP Ground Conditions Appraisal from 2021 (separate document **Appendix D** & Section 3.6) found that groundwater was present in all monitoring station with minimum recorded depths ranging from 0.1m to 1.2m BGL. However no consistent level for groundwater was found.

4.3.3 The Borough Council of King's Lynn and West Norfolk Strategic Flood Risk Assessment (SFRA) 2018 gives an indication of the risk of groundwater flooding in its flood risk maps (see SFRA Ground Water Flood Risk mapping in separate document **Appendix F**), this shows the lowest level of risk in the north and east of the site (<25%) and a higher level of risk in the south (25%<50%).

4.3.4 Based on the available information, as there are no reported incidences of groundwater flooding, the risk is considered to be low for the proposed site, with no significant re-profiling of the site below existing ground levels proposed. However, further groundwater monitoring should be undertaken to form a more cohesive model of the existing groundwater and inform the detailed design to ensure any risk is mitigated.

4.4 Surface Water Flooding

4.4.1 The surface water flooding was modelled by the EA, identifying areas that may experience ponding during each of a 1 in 30 year, 1 in 100 year and 1 in 1,000-year return period storm. The Environment Agency's Risk of Flooding from Surface Water map (refer to **Figure 4-2**) indicates that some isolated small areas of land adjacent to existing land drains near the centre of the site are at risk of surface water flooding. The proposed attenuation basins are to be located outside of areas at risk of flooding form surface water.

Figure 4-3 – EA risk of flooding from surface water

4.4.2 The production of the EA mapping for surface water flood risk was undertaken at a national scale to provide the first publicly available generation of surface water flood risk mapping. The two previous generations were primarily developed for regulator use as the approach and risk was refined. For example, the first did not include any allowance for sewers, whilst the second incorporated a national loss coefficient. Although this generation incorporates local estimates of the sewer infiltration loss, along with various other refinements in runoff estimation. However, it does not allow for local improvements to the underlying DTM (Digital Terrain Model). This means that local features such as onsite ordinary watercourses will be represented as obtained from the LiDAR without any consideration to drainage features such as culverts which link the onsite ordinary watercourses to the north, west and south of the site. The omission of these drainage features is likely the cause of the ponding shown around watercourses throughout the site.

4.4.3 Furthermore, aside from the missing sewer connections, the EA modelling is based on LiDAR results for the area, this can result in inaccuracies due to several factors, including:

- The model is not able to accurately identify surface water drainage features such as ditches under tree canopies.
- Environment agency LiDAR data has a vertical accuracy of 50mm-150mm +/- RMSE (Root mean square error) and a horizontal accuracy of 40mm +/- RMSE.
- The Updated Flood Maps for Surface Water uses a grid size appropriate for strategic modelling at a national scale however analysis using a finer grid can affect the flood risk extents.

4.4.4 Based upon a review of the LiDAR information it can be seen that the areas at low and medium risk of surface water flooding relate to the low points of the site. This identified flow paths running through the site following the existing ditches, the risk post-development should be mitigated following the implementation of a suitably designed surface water drainage strategy, including appropriately sized culverts at the points where the road crosses any of the identified ordinary watercourses.

4.4.5 The vast majority of the site is shown to be at very low risk of surface water flooding.

4.4.6 Based on the available information, the flood risk from surface water is considered to be low for the proposed site.

4.5 Surcharged Sewer Flooding

4.5.1 Review of the Anglian Water Sewer Records (refer to separate document **Appendix B**) indicates there are two existing foul water sewers crossing the site with no surface water sewers identified, full details can be found in section 3.5.

4.5.2 The Borough Council of King's Lynn & West Norfolk SFRA 2018 records 4 historic sewer flooding events in the PE33 0 postcode, which covers the area of development. These records are taken from Anglian Waters' historic sewer flooding register. Detail of the flooding incidents are not provided.

4.5.3 Based on the available information the flood risk from surcharged sewers is considered to be low.

4.6 Flooding from Other Sources

4.6.1 Non-natural or artificial sources of flooding can include reservoirs, lakes, canals, culverts etc. The potential effects of flood risk management infrastructure and other structures also needs to be considered.

4.6.2 Environment Agency Reservoir Flood Mapping and information from the King's Lynn and West Norfolk SFRA shows no risk of flooding from reservoir failure to the site area.

4.6.3 No canals have been identified within the vicinity of the site and so the flood risk from these sources will be negligible.

4.6.4 Existing culverts have also been identified under the A47, these will be retained as part of the proposed works. It is unlikely that most of these culverts are included within the EA Updated Maps for Surface Water and so the mapping can be seen as a conservative estimate of surface water flood risk, assuming the culverts are blocked. Review of the mapping, as per section 4-4, indicates the risk is low.

4.7 Historical Flood Records

4.7.1 The Borough Council of King's Lynn and West Norfolk SFRA 2018 does not detail any flood events within the area of study but does highlight within 2.5 km of the site 1 known incident of internal flooding since April 2012.Following flood events in King's Lynn and West Norfolk in the summer of 2014 an investigation was carried out to understand the causes of the flooding and inform Local Flood Risk Management Strategy. A report was compiled by

Norfolk County Council based on the investigation, Investigation Report into the flooding within the Borough of King's Lynn and West Norfolk during the summer of 2014. The report details a flood event on 27th June 2014, approximately 900m west of the proposed WWHAR on the existing A10, with one property experiencing internal flooding as a result. Causes of the flood event and subsequent recommendations are shown in table 4-2, below.

Table 4-2 – Investigation findings, puny drain catchment (*Investigation Report into the flooding within the Borough of King's Lynn and West Norfolk during the summer of 2014)*

Location	What caused the flooding?	Who has responsibilities to manage the cause(s) of the flood?	What was their response in relation to the cause of the flood?	Recommendations
Puny Drain Catchment Main Road	[C1] Run-off from significant rainfall was concentrated at a low point within the catchment in the vicinity of which the affected property is positioned. [C4] Water was found to flow from the highway by the camber of the road adjacent to the property access which concentrated flood water in the vicinity of the affected properties. The above causes were exacerbated by: [B]: The structure of the affected property was not able to withstand the impacts of flood water. As such flood water entered the property through low thresholds at entrances.	NCC Highways for cause [C4] Property owners for causes [B].	The Fire and Rescue Service responded and pumped out the water from the internally flooded property as well as from the gardens of adjacent properties on the 27th June 2014. NCC Highways carried out maintenance work to the drainage system after the incident. Some property owners on Main Road avoided being internally flooded by undertaking flood protection measures on their property.	(R4) NCC Highways could determine the wider systems integrity and/or capacity to understand the systems role in accommodating normal rainfall events and mitigating flooding as well as identify where the drainage network conveys flows to. (R12) The property owners could protect their buildings through flood protection measures where appropriate.

4.7.2 The report lists several factors as the overall cause of the flooding events, including; properties located at catchment low points, lack of positive drainage features on roads, lack of interaction between drainage systems in adjacent catchments managed by different organisations, surface water discharging to foul sewers, and lack of maintenance of open dykes causing overgrowth and reducing capacity.

4.7.3 The key recommendations of the overall report state that the key risk management authorities (NCC Highways, Internal Drainage Boards and Anglian Water) should have maintenance programmes in place, these should be reviewed where there are known flood issues and better coordination should be sought in relation to routine maintenance. It also states that lessons learnt from flood investigation reports should be considered in relation to proposed development.

5 NPPF Sequential and Exception Text

5.1 The Sequential Test

5.1.1 Highway developments are not classified in Table 2 of the Flood Risk and Coastal Change Chapter of the Planning Practice Guidance (2015).

5.1.2 The Sequential Test, within the National Planning Policy Framework, aims to steer all new development to areas at the lowest risk of flooding and to ensure that the development type proposed is appropriate by reference to the flood risk.

5.1.3 The proposed development site is identified to be partially in Flood Zone 2 through assessment of flood water heights as noted in section 4.2.

5.1.4 The proposed development will trigger a sequential test. Due to the nature of the development, no alternative routes have been identified outside of Flood Zone 2. It should be noted the area within Flood Zone 2 falls to the east of the Hardwick Junction on the existing A47 rather than any part of the proposed new route on the greenfield element of the site. This area has been included

within the red line as the proposed access road ties into the A47 junction and therefore it is not possible to avoid this area. As identified within Section 4.2, the risk of flooding both onsite and offsite should not increase as a result of the proposed road.

5.2 The Exception Test

5.2.1 Table 2 of the Flood Risk and Coastal Change Chapter of the Planning Practice Guidance (2015) classes different types of development depending upon their vulnerability. Highway developments are not classified. As the proposed housing access road will serve a new residential development, it can be considered within the 'More Vulnerable' flood risk classification. Furthermore, as part of the trunk road network, the works on the A47 would be classed as 'Essential Infrastructure' under the same guidelines.

5.2.2 Table 3 of the Flood Risk and Coastal Change Chapter of the Planning Practice Guidance (2015) shows that both More Vulnerable development and essential infrastructure is appropriate within Flood Zone 2 and no exception test is required.

6 Surface Water Management – Policy Context

6.1 National Planning Policy Framework (NPPF) – February 2019

6.1.1 The Extracts from applicable national planning policy documents are set out below.

6.1.2 The National Planning Policy Framework (NPPF) supersedes Planning Policy Statement 23 (Planning and Pollution Control) and Planning Policy Statement 25 (Development and Flood Risk) and associated Practice Guide.

6.1.3 The NPPF ensures that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding and to direct development away from areas of highest flood risk.

6.1.4 Where new development is exceptionally necessary in such areas, policy aims to make it safe without increasing flood risk elsewhere and, where possible, reducing flood risk overall.

6.2 Sustainable Drainage Systems Written Statement HCWS161 (December 2014)

6.2.1 The Secretary of State for Communities and Local Government laid a Written Ministerial Statement in the House of Commons on 18 December 2014 setting out changes to planning that will apply for major development from 6 April 2015. This confirms that in considering planning applications, local planning authorities should consult the relevant Lead Local Flood Authority (LLFA) on the management of surface water; satisfy themselves that the proposed minimum standards of operation are appropriate and ensure, through the use of planning conditions or planning obligations, that there are clear arrangements in place for ongoing maintenance, over the lifetime of the development.

6.2.2 Therefore, from 6 April 2015 local planning policies and decisions on planning applications relating to major development are required to ensure that sustainable drainage systems (SuDS) are used for the management of surface water.

6.2.3 Major development is development involving any one or more of the following:

- The winning and working of minerals or the use of land for mineral-working deposits;
- Waste development;
- The provision of 10 dwellings or more;
- The provision of a building or buildings where the floor space to be created by the development is 1,000 square metres or more; or
- Development carried out on a site having an area of 1 hectare or more.

6.3 Defra Sustainable Drainage Systems Non-Statutory Technical Standards For Sustainable Drainage Systems (March 2015)

6.3.1 This document sets out non-statutory technical standards for sustainable drainage systems. It should be used in conjunction with the National Planning Policy Framework and Planning Practice Guidance.

6.3.2 For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.

6.3.3 Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event should never exceed the greenfield runoff volume for the same event.

6.3.4 Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with the above, the runoff volume must be discharged at a rate that does not adversely affect flood risk.

6.3.5 The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event.

6.3.6 The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.

6.3.7 The design of the site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that minimise the risks to people and property.

6.4 British Standard 8582:2013 Code of Practice for Surface Water Management for Development Sites (November 2013)

6.4.1 In the absence of specific local guidance on the management of surface water run-off, BS 8582 should be considered as best practice guidance for the development of surface water drainage strategies for new development sites.

6.5 Flood and Water Management Act (FWMA) 2010

6.5.1 The FWMA (2010) was first proposed as the legislative vehicle to implement the European Floods Directive, however due to delays in the bill, it was not implemented within the timeframe set out by the Floods Directive, and hence the implementation of the Floods Directive and the FWMA was delayed until 2010.

6.5.2 The FWMA provided the legislative basis for a number of recommendations in the Pitt Review. In October 2010, Section 9 of the FWMA came into force requiring all LLFAs in England to develop, maintain, review, update as well as apply and monitor the application of a strategy for local flood risk in their area. This is known as a Local Flood Risk Management Strategy (LFRMS).6.6 King's Lynn and West Norfolk Settlements Surface Water Management Plan

6.6 King's Lynn and West Norfolk Settlements Surface Water Management Plan - Stage 1 Report (November 2010)

6.6.1 This report details Stage 1 of the King’s Lynn and West Norfolk Settlements Surface Water Management Plan (SWMP). The aim of a SWMP is to understand and resolve complex and high risk surface water flooding problems in urbanised areas.

6.6.2 This document does highlight an area of foul sewer flooding from historical records within the village of West Winch, but the extent of the flood area does not extend to within the site boundary. It also presents areas of surface water flood risk south and west of the site.

6.7 Norfolk LLFA Statutory Consultee Guidance Document (March 2015)

6.7.1 This guidance is for developers involved in the design and development of SuDS in Norfolk. It promotes an integrated approach to SuDS and landscape design, and establishes a set of local design criteria to help shape the development of SuDS in respect of the County's unique environmental context.

6.7.2 Where it is not possible to use or dispose of the additional volume of runoff on the site (i.e. through infiltration or water re-use), it is expected that the final runoff rates from the development be restricted further to ensure compliance with Standard S6 of the SuDS Non-Statutory Technical Standards (2015). Norfolk's' preferred approach is that all runoff from the site should be discharged at a rate of 2l/s/ha or the annual average peak flow rate (QBAR), whichever is the greater.

6.7.3 If complex controls are to be used for control of discharge rates, calculations for the Greenfield runoff rate should be provided for the 100%, 3.33% and 1% AEP events. Calculations showing that the Greenfield volume is also discharged at these rates and additional runoff volumes are discharged at 2l/s/ha.

6.7.4 An assessment of the volume of attenuation storage that would be required on site should be submitted. This should be based on the 1% AEP 6 hour (checked against the critical storm duration) with climate change for the site and the allowable discharge rate. FEH (Flood Estimation Handbook) rainfall data should be used for all storm durations when identifying the critical storm duration. The method of attenuation should be identified and located on a plan of the site.

6.8 Climate Change

6.8.1 The Progress in adapting to climate change Report 2021 by the Climate Change Committee, states that although actions have been taken in tackling flooding, it remains is the greatest threat to the UK from climate change.

Models of the climate system suggest floods of the type experienced in England and Wales in autumn 2000, and between December 2013 and February 2014, have become more likely as a consequence of increased concentrations of greenhouse gases in the atmosphere.

6.8.2 More frequent short-duration, high intensity rainfall and more frequent periods of long-duration rainfall could be expected. Sea levels are also expected to continue to rise.

6.8.3 New EA guidance “Flood risk assessments: climate change allowances” issued on the 19th February 2016 (updated May 2022) and forming part of the NPPF technical guidance provides up to date information on expected changes in rainfall, river flows and sea level rise as a consequence of climate change.

6.8.4 A key change from the previous guidance is that the climate change allowances for peak river flows now are shown as variable on a regional basis; allowances are also now based on percentiles, whereby a percentile is a measure used in statistics to describe the proportion of possible scenarios that fall below an allowance level (e.g. a 50% percentile means that the allowance has 50% chances of not being exceeded).

6.8.5 On this basis key allowances for peak river flows based on percentiles are:

- central allowance, - based on the 50th percentile
- higher central - based on the 70th percentile
- upper end - based on the 90th percentile

6.8.6 These allowances are detailed in Table 1 (Peak river flow allowances by river basin district) of the EA guidance.

6.8.7 As stated in the EA Guidance, the choice of the appropriate allowance for peak river flow (e.g. central or higher central) should reflect the risk for the proposed development and therefore is linked to the expected hazard,

vulnerability and resilience of the scheme; recommendations on the appropriate allowances to be considered are provided in the EA Guidance.

6.8.8 Peak rainfall is based on the lifespan of the development, in this case typically 100 years for residential development. The EA recommends that development with a lifespan beyond 2100 uses the upper end allowance for the 2070s epoch within the catchment, in this case the Cam and Ely Ouse Management Catchment.

6.8.9 For this proposed site, based on the guidance for residential development (considered "'More Vulnerable" in flood risk terms), should be reviewed against the following new climate change allowances:

Table 6-1 – Summary of climate change factors

Flood Criteria	Climate Change Factor
Peak River Flow	45% for the 2080s epoch (upper allowance for the North West Norfolk Management Catchment)
Peak Runoff	3.3% annual exceedance rainfall event 35% for the 2070s epoch (upper end allowance for the North West Norfolk Management Catchment)
Peak Runoff	1% annual exceedance rainfall event 40% for the 2070s epoch (upper end allowance for the North West Norfolk Management Catchment)

How is flood risk likely to be affected by climate change?

6.8.10 The projections for the UK in relation to climate change are that the UK will experience more frequent short-duration, high-intensity rainfall and more frequent periods of long-duration rainfall of the type that has been responsible for the large flood events recently experienced in the UK.

6.8.11 Flood risk is likely to increase with climate change. However, the flood risk management measures described in the following sections will make an allowance for this.

7 Flood Risk Management and Drainage Strategy

7.1 Flood Risk Management Measures

Site Location and Layout

7.1.1 The Environment Agency's Flood Map for Planning indicates that the Site is located partially in Flood Zone 2. Developments classified as More Vulnerable/Essential Infrastructure are both acceptable in Flood Zone 2, as stated in Table 3 of the Flood Risk and Coastal Change Chapter of the Planning Practice Guidance (2015).

Site Levels

7.1.2 Finished site levels should be engineered to provide positive drainage, prevent ponding and channel flows towards attenuation during exceedance events. The accumulation of standing water would therefore not occur and thus not pose a risk to the Proposed Scheme.

Flood Warnings/ Evacuation Plan

7.1.3 The site is not located within a Flood Warning Area or a Flood Alert Area.

Access and Egress

7.1.4 Access and egress will be via the A47, A10 and Rectory Lane. Both the A47 and A10 lie within Flood Zone 2, therefore access and egress may be affected during extreme flooding events.

Compensatory Storage

7.1.5 The site is located partially within Flood Zone 2, this falls to the east of the Hardwick Junction along the existing A47.

7.1.6 As per section 4.2, it is proposed that levels at the area within Flood Zone are to either:

- remain at or below existing or;
- if the levels are to be raised any loss in flood plain volume will be compensated for on a level for level basis on site to the north of the A47 alignment.

7.2 Existing Site

7.2.1 The existing site is predominantly greenfield, other than where the proposed road connects to existing highways. The proposed road being a linear structure will impede the flows along existing drainage ditches and channels and also may impede the natural greenfield runoff (overland flow paths).

7.2.2 For the existing drainage ditches and channels, flows will be maintained by the installation of culverts which will run under the new road. The proposed culverts have been sized by assessing the upstream catchment area of the ditch at the point of the road crossing and from this the greenfield run-rate calculated using the ReFH2 methodology. The calculations for the greenfield run-off rates and culvert sizes can be found in separate document **Appendix G**. Field drainage and natural flow paths of surface water will be mitigated by the installation of open channels or filter drains at the toe of the road embankments and will convey water to receiving watercourses. This methodology has been agreed with the LLFA.

7.3 Proposed Development Drainage

Sustainable Drainage Systems (SuDS)

7.3.1 A Sustainable Drainage Systems (SuDS) hierarchy has been followed in applying the use of sustainable drainage techniques to the proposed development. This has been set out in **Table 7-2** below with justifications provided where particular techniques are deemed feasible.

Table 7-1 – SUDs feasibility

SuDS Technique	Can they be feasibly incorporated into the site?	Reason
Green Roofs	**No**	There are no buildings within the development proposal.
Basins and Ponds	**Yes**	Attenuation basins will be used that will provide attenuation, water quality and biodiversity enhancement. They should be sized to provide adequate attenuation in the 1 in 100 year storm + 40% climate change prior to discharge to the existing watercourses.
Filter strips / Swales / Ditches	**Yes**	Filter strips will be used alongside filter drains to collect and convey surface water runoff from the road into the attenuation basins. Swales could be utilised within the site to provide attenuation, conveyance and water quality enhancements prior to discharge to the attenuation basins as well as between the basins and the final discharge point.
Permeable Surfaces and Filter Drains	**Yes**	Permeable surfacing is not proposed as it is not generally considered suitable for roads in excess of 30mph speed that will be trafficked by HGVs. However, filter drains are considered a viable option to convey over the edge drainage away from the carriageway and Non-Motorised User (NMU) route.

SuDS Technique	Can they be feasibly incorporated into the site?	Reason
Rainwater Harvesting	**No**	We are aware that NCC are a member of Water Resources East, an organisation that is working in partnership with various stakeholders to safeguard a sustainable supply of water for the East of England resilient to future challenges and enabling the area's communities, environment and economy to reach their full potential. With this in mind, discussions have been undertaken with LLFA to consider the potential use of rainwater harvesting as a SuDS technique for the WWHAR scheme and we understand that LLFA has discussed the matter with an Anglian Water representative as well. From these discussions, it has been concluded that at present, rainwater harvesting is not a feasible SuDS technique for the WWHAR scheme due to: • Technology and infrastructure for such a system is not available at this time in the UK; • Uncertainty regarding the potential uses of the harvested water due to the potential for pollutants from vehicles; and • The extended timeframe to investigate and deliver a viable solution is not compatible with the rapid programme constraints of the WWHAR.

SuDS Technique	Can they be feasibly incorporated into the site?	Reason
Tanked Systems	**No**	Tank systems are not proposed in this scheme as they are looked upon unfavourably by the LLFA and/or EA due to long term maintenance concerns and limited wider benefits.
Sediment Forebays	**Yes**	Sediment forebay provision within the basin inlets will provide a level of surface water treatment.

7.3.2 Planning guidance requires drainage to discharge surface water in line with the following hierarchy:

1. Infiltration
2. Existing Watercourse
3. Existing sewer

7.3.3 Based on the BRE 365 infiltration tests described in the Ground Conditions Appraisal in separate document **Appendix D** and the groundwater levels explained in **Section 3.6**, whilst favourable infiltration rates were found in much of the site strata, groundwater levels are such that the LLFA required clearance of 1.2m between base of infiltration features and seasonally high groundwater level would not be achievable. The location of several watercourses in the vicinity of the site and lack of surface water sewers indicates attenuation and discharge to existing watercourses as the most viable discharge option.

7.3.4 Site specific infiltration testing and groundwater monitoring should be undertaken for each of the proposed basin to inform detailed design.

Surface Water Drainage Strategy

7.3.5 As there will be an increase in impermeable area across the site, there will be an increase in the likelihood and magnitude of standing water and surface water runoff occurring. The surface water strategy below has been devised to mitigate this. Refer to separate document **Appendix H** for more details.

7.3.6 SuDS will be implemented within this development scheme. The conceptual SuDS strategy for the proposed development has been derived using the principles outlined within the CIRIA C753 SuDS Design Manual along with BS 8582:2013 – Code of Practise for Surface Water management for Development Sites.

7.3.7 The scheme will utilise the existing topography and natural drainage catchments. No significant profiling of the site is proposed and hence the resultant flood flow paths will replicate the existing and direct flows to the proposed onsite attenuation.

7.3.8 The anticipated impermeable area of the catchment is based upon the entirety of the proposed road and NMU route surface being 100% impermeable.

7.3.9 Where feasible, the drainage strategy will ensure that two separate networks are considered for the areas to form part of the Highways England road network (A47) and the remainder of the housing access road which is proposed to be adopted by NCC as local highway authority. Separate attenuation and conveyance features are proposed.

7.3.10 It is proposed that SuDS features draining the Housing Access Road will be adopted by Norfolk County Council Highways, whilst SuDS features draining the A47 will be adopted by National highways.

7.3.11 For the purposes of detailed design, SuDS features should be designed in line with guidance in the CIRIA SuDS Manual C753.

7.3.12 Where there is no kerbing along the route, it proposed to use a filter drain underlain by a perforated pipe to convey surface water. Where kerbing is

present, typically around proposed junctions, gully or kerb drainage is to be used.

7.3.13 The proposed drainage system should be designed such that there is no surcharging in the 1 in 2 year probability event, and no flooding in the 1 in 30 year probability event as per Sewers for Adoption criteria. The piped system should be designed to adoptable standards.

7.3.14 To ensure the effectiveness of the proposed drainage network a robust maintenance regime in accordance with CIRIA guidance, will be implemented to ensure future performance of all SuDS and drainage components. This will include regular cleaning of SuDS devices located on communal areas. It will also be necessary to implement treatment devices such as trapped gullies and catch pit manholes to prevent any contamination and silt ingress into the drainage system. The SuDS Maintenance and Management Plan along with an initial Construction Surface Water Management Plan can be found in separate documents **Appendix J** and **Appendix K** respectively.

7.3.15 The road has been split into a number of catchments based upon the existing topography. Each catchment will drain to an attenuation basin prior to discharging to the onsite ordinary watercourses.

7.3.16 The discharge for each catchment is based upon the Norfolk LLFA Statutory Consultee for Planning Guidance Document, Version 6.1 from October 22, which stipulates that approach 2 (Simple) for the consideration of run off volume from development sites in the CIRIA SuDS Manual is the preferred approach in Norfolk. This approach is as follows (a summary can be found in **Table 7-3**);

- All runoff from the site should be discharged at a rate of 2l/s/ha or the annual average peak flow rate (QBAR), whichever is the greater.
- The table below shows each catchment, its area, the QBAR discharge rate (from HR Wallingford's Greenfield runoff estimation for sites tool – please find these in separate document **Appendix G**, using the FEH

method and BFIHOST values from the latest set of FEH catchment descriptors) and the 2 l/s/ha discharge rate. From this it can be seen that the 2 l/s/ha discharge rate is the greatest in each instance, therefore this has been taken forward as the proposed discharge in each instance. Vortex flow controls will be used to limit discharges to these rates.

- Although there are more proposed road catchments (7) than natural catchments (5) and there may be some cross-catchment flows, discharges will be limited to the lowest pre-construction greenfield run-off rate (or 2 l/s/ha) to prevent the risk of downstream flooding.

Table 7-2 – Discharge rates

Proposed Catchment	Area (ha)	Greenfield Catchment	BFI Host (FEH Web Service)	QBAR per Ha (l/s)	Catchment QBAR (l/s)	2/l/s/ha Discharge Rate (l/s)
1	1.93	1	0.748	0.84	1.62	3.86
2	2.93	2	0.738	0.89	2.61	5.86
3	0.87	3	0.740	0.88	0.77	1.74
4	3.20	4	0.710	1.03	3.30	6.40
5	1.64	4	0.710	1.03	1.69	3.20
6	2.38	5	0.713	1.03	2.45	4.76
7	3.54	5	0.713	1.03	3.65	7.08

7.3.17 To provide additional levels of surface water pre-treatment prior to discharge to watercourse, it is proposed that each basin is to have a sediment forebay installed at basin inlet. These devices will provide sufficient stages of pre-treatment to satisfy Section 26 of the Ciria C753 SuDS Manual.

7.3.18 For the purposes of pollutant treatment, the same approach has been applied to the entire site, as detailed below, for the traffic flows present on the A10 section of road. The CIRIA SuDS Manual recommends that for trunk roads, such as the A47, that the DMRB guidance for pollutant mitigation should be followed. Section LA113 of the DMRB – Road drainage and the water environment, recommends a HAWRAT assessment is undertaken to assess the risk to receiving water bodies and to inform the appropriate level of treatment in the drainage strategy for such roads. A HAWRAT assessment is to take place for the scheme to ensure the proposed levels of treatment meet the necessary standard. At this stage of design however and as the CIRIA indices approach is often a more rigorous method this has been utilised.

7.3.19 For the Housing Access Road and junction with existing A47 it has been assumed that the road will have more than 300 traffic movements per day and is not classified as a trunk road, table 26.2 of the CIRIA C753 SuDS notes that pollution hazard levels for all roads except low traffic roads and trunk roads/motorways are as follows:

- TSS is 0.7;
- Metals is 0.6;
- Hydrocarbons is 0.7.

7.3.20 Table 26.3 – "*Indicative SuDS mitigation indices for discharges to surface waters"* shows that attenuation basin (detention basin) and sediment forebay (taken as a detention basin from the C753 guidance) are able to provide treatment to the following levels:

- Detention Basin TSS at 0.5 + 0.5(Detention Basin at 0.5) = 0.75
- Detention Basin Metals at 0.5 + 0.5(Detention Basin at 0.5) = 0.75

- Detention Basin Hydrocarbons at 0.6 + 0.5(Detention Basin at 0.6) = 0.90

7.3.21 Each of the above is beyond the level of pollutants expected from the proposed usage therefore the use of a sediment forebay and an attenuation basin is an adequate level of pre-treatment for the site.

7.3.22 It should be noted that a third level of treatment will be provided where viable, this would be in the form of filter drains along the roads collecting surface water runoff and use of filter strips adjacent.

7.3.23 The sediment forebay has been designed assuming that it will be lined to not allow infiltration and that it will be permanently filled with standing water. Sediment forebays will be sized in line with Ciria SuDS Manual C753.

7.3.24 For the A47 dualling around the Hardwick interchange it has been assumed that the road will have more than 300 traffic movements per day and is classified as a trunk road, table 26.2 of the CIRIA C753 SuDS notes that pollution hazard levels for trunk roads/motorways are as follows:

- TSS is 0.8;
- Metals is 0.8;
- Hydrocarbons is 0.9.

7.3.25 Table 26.3 – "*Indicative SuDS mitigation indices for discharges to surface waters"* shows that attenuation basin (detention basin), sediment forebay (taken as a detention basin from the C753 guidance) and a swale between the basin and outfall are able to provide treatment to the following levels:

- Detention Basin TSS at 0.5 + 0.5(Detention Basin at 0.5) + 0.5(Swale 0.5) = 1
- Detention Basin Metals at 0.5 + 0.5(Detention Basin at 0.5) + 0.5(Swale 0.6) = 1 (values >1 not permitted)

- Detention Basin Hydrocarbons at 0.6 + 0.5(Detention Basin at 0.6) + 0.5(Swale 0.6) = 1 (values >1 not permitted)

7.3.26 Each of the above is beyond the pollutant load expected from the proposed usage therefore the use of a sediment forebay and attenuation basin is an adequate level of pre-treatment for the site.

7.3.27 A fourth level of treatment will be provided where viable, this is in the form of filter drains along the road collecting surface water runoff and filter strips adjacent.

7.3.28 Sediment forebays have been designed assuming they will be lined to not allow infiltration and will be permanently filled with standing water. Sediment forebays are to be sized in line with Ciria SuDS Manual C753.

7.3.29 The proposed basins have been sized to attenuate the development surface water run-off for all events up to the critical 1 in 100 year + 40% climate change below the 300mm freeboard. Details of each of the 7 basins (one for each catchment) can be found in **Table 7-3**. Details of the Info drainage modelling for each basin can be found in **Appendix I**. Basins are designed such that if half drain down time exceeds 24 hours, a 1 in 10 year storm event can be accommodated within the freeboard. Until site specific ground investigation results are available, based on existing information, all basins are assumed to be in close proximity to ground water levels and will be lined to prevent infiltration. Basins (and the required tie-in earthworks) and basin outfalls have been designed using topographical survey information (see **Appendix O** for further Information). The wider watercourse network has also been surveyed to ensure connectivity as can also be found in **Appendix O**. Around the north-western extent of the site, in the proximity of the proposed Hardwick Green development, topographical information has been used from a survey undertaken in 2011 by Survey Solutions. Existing ground level information outside of these areas (see fig. 3-2) is based on LiDAR information from the Environment Agency Digital Surface Model at a 1m spatial resolution.

Table 7-3 – Attenuation basin details

Basin Catchment	Contributing Impermeable Area (ha)	Basin Depth (m)	Invert Level (mAOD)	Attenuation Volume (m^3)	Discharge Rate (l/s)
1	1.93	0.75m + 300mm Freeboard	9.65	4315	3.8
2	2.93	1.5m + 300mm Freeboard	9.100	5950	5.8
3	0.87	1.0m + 300mm Freeboard	17.250	878	1.7
4	3.20	1.2m + 300mm Freeboard	13.899	4.35	6.4
5	1.64	1.7m + 300mm Freeboard	9.580	2,135	3.2
6	2.38	1.3m + 300mm Freeboard	10.000	3015	4.7
7	3.54	2.15m + 300mm Freeboard	3.000	5547	7.1

Catchment 1

7.3.31 Catchment 1 comprises the junction with the existing A10, this area will be kerbed and therefore over-the-edge drainage will not be able to be utilised. The catchment will be drained via gulley's into a piped network, this network

will outfall into a sediment forebay followed by an attenuation basin, meeting the SuDS indices requirements. This attenuation basin has an invert level (IL) of 9.650m and in turn discharge south to an existing ditch running west-east along the boundary of the field with an IL of 9.500m. Discharge rates have been limited to the 2/l/s/ha rate of 3.8 l/s using a Hydro-Brake Optimum with an orifice of 93mm.

Catchment 2

7.3.32 Catchment 2 is north of the A10 tie-in junction, crosses Chequers Lane and extends north to the first of the proposed housing access road junctions. Most of this catchment will employ over the edge drainage to a pair of filter drains either side of the road alignment, with the western drain capturing run-off from the NMU route. Where the kerbed section of the alignment around the access road junction and the A10 roundabout and also the NMU route tie-in with the Chequers Lane NMU bridge will utilise gulley and pipe drainage. All discharges from this catchment will drain south into an attenuation basin with an IL of 9.100m and a sediment forebay. This will in turn outfall into an existing ditch with IL of 9.030m, with flows limited to the 2/l/s/ha rate of 2.36 l/s using a Hydro-Brake Optimum with an orifice of 109mm.

Catchment 3

7.3.33 Catchment 3 is the area immediately around the southern housing access road junction, which will be a kerbed section of the alignment, therefore a series of gulley's/ kerb drainage with piped drainage is proposed. This will in turn drain into an attenuation basin of IL 17.250m with a sediment forebay. The outfall of this basin will be to an existing ditch of IL 18.550m south of the proposed junction and will be limited to the 2 l/s/ha rate of 1.7 l/s using a Hydro-Brake Optimum with an orifice of 63mm. This will in turn outfall into the existing ditch with IL of 17.150m. Due to the size of the orifice, a trash screen may be required to prevent blockage.

Catchment 4

7.3.34 Catchment 4 extends north of the southern housing access junction, crossing under a proposed bridge that will carry Rectory Lane and includes the middle access junction. Areas of the alignment which are not kerbed will be drained via filter drains on the east and west of the alignment, where there are kerbs, gulley and pipe drainage will be utilised. All discharges will be directed to an existing ditch in the centre of the catchment where it will enter a sediment forebay and subsequently an attenuation basin of IL 13.899m. Outflow form the basin to the ditch of IL 13.350m will be limited to the 2 l/s/ha rate of 6.4 l/s using a Hydro-Brake Optimum with an orifice of 116mm.

Catchment 5

7.3.35 Catchment 5 extends north from catchment 4 and includes the proposed roundabout junction with the Hardwick Green development and a dualled section north to the junction with the A47. The northern boundary of this catchment is border between the road to be adopted by the local highway authority/Highways England A large proportion of this catchment will be kerbed and be drained via gulleys or kerb drainage into a piped system, the southern area of the catchment, which is not kerbed, will be drained via filter drains. All discharges will be directed to an existing ditch of IL 12.800m in the north-eastern area of the catchment where it will enter a sediment forebay and subsequently an attenuation basin of IL 14.000m. Outflow from the basin to the ditch will be limited to the 2 l/s/ha rate of 2.48 l/s using a Hydro-Brake Optimum with an orifice of 76mm.

Catchment 6

7.3.36 Catchment 6 extends north from catchment 5 and includes the proposed roundabout junction with the A47 and a section of dualling north-west along the A47.The entirety of this catchment will be kerbed and be drained via gulleys or kerb drainage into a piped system. All discharges will be directed to an existing ditch in the north-eastern area of the catchment where it will enter a sediment forebay and subsequently an attenuation basin of IL 10.500m.

Outflow form the basin to the ditch at IL 10.000m will be limited to the 2 l/s/ha rate of 5.32 l/s using a Hydro-Brake Optimum with an orifice of 84mm.

7.3.37 The layby south of the catchment will be drained to the existing A47 drainage system.

Catchment 7

7.3.38 Catchment 7 encompasses the remainder of the A47 improvement works, including dualling of the road north of catchment 6 and works to the Hardwick Junction. The southern end of this catchment will utilise over the edge drainage to filter drains, with the remainder of the kerbed areas draining to gulley's or kerb drainage into a piped system. All discharges will be directed towards the north of the catchment, just south of the Hardwick Junction where it will enter a sediment forebay and subsequently an attenuation basin of IL 2.800m. Outflow from the basin to the existing manhole of IL 1.500m will be limited to the 2 l/s/ha rate of 7.1 l/s using a Hydro-Brake Optimum with an orifice of 118mm. The flows will be conveyed via a swale to provide an additional level of pre-treatment.

7.3.39 National Highways provided a detail for the existing manhole discharge location, which can be found in separate document **Appendix P**. National highways agreed in principal to allow discharge of the network in this location, limited to 2 l/s/ha. Level information should be confirmed by a full drainage survey prior to detailed design. The detail provided by National Highways also shows the ditch running along the southern edge of the A47 (identified in the Hopkins land topographic survey) draining to this Manhole, this arrangement is proposed to continue, with the ditch diverted at its northern end to follow the proposed extents of the A47 earthworks.

Existing Hardwick Roundabout (Catchment 8)

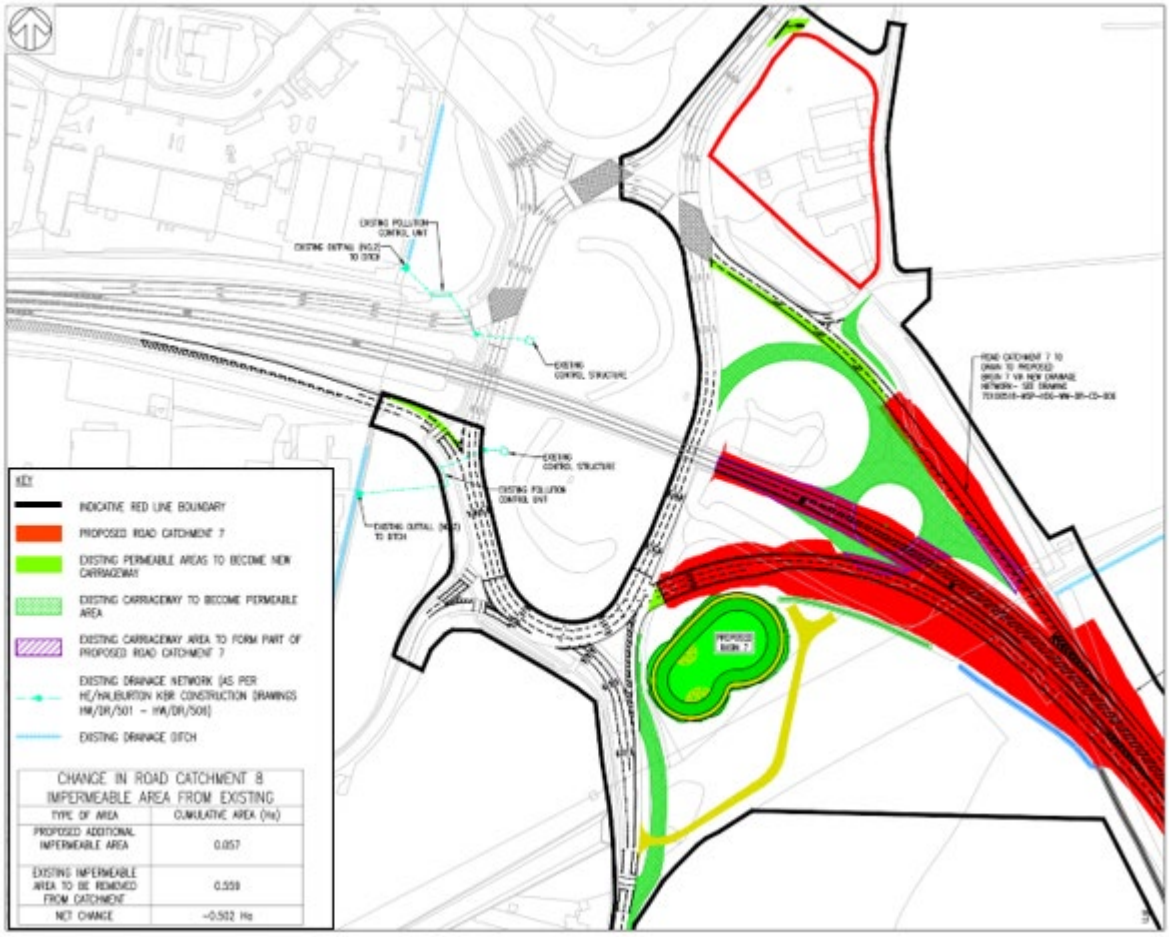
7.3.40 Where works are proposed at the existing Hardwick roundabout, surface water would be directed to the existing drainage system. As per construction drawings received from Highways England, dated September 2003 the existing system drains the entire junction west to two existing drainage ditches

north and south of the western arm of the A47, via storage, flow controls and oil interceptors. It is assumed that the existing system is constructed as shown, is regularly maintained and operates correctly. This should be confirmed by a CCTV and condition survey at a later stage. Refer to separate document **Appendix P** for the A47 construction drawings.

7.3.41 An analysis of the area to be drained to the existing network shows an approximate reduction in the impermeable area of 0.57 ha. It has been agreed with the Norfolk LLFA and National Highways as there is no material change to the areas to be drained and an overall reduction in area, that they can continue to discharge at the existing rate. Should this change at a later design stage any areas over and above the existing should be attenuated to greenfield rates prior to discharge. Please Refer to **figure 7-1** for a drawing showing the changes in area discharging to the existing drainage system.

The proposed lengths of access track for Hardwick Farm, outside the existing highway boundary, would consist of a loose bound/permeable construction and would therefore not be included in this catchment or be drained formally. It is anticipated that traffic volumes on this access track will be very low, consisting largely of occasional agricultural vehicle movements.

Figure 7-1 – Hardwick junction drainage/catchment 8



Constraints

7.3.42 The design of the system may be constrained by the levels which have been used from the LiDAR and past topographical surveys, depending on the outcome of a further topographical survey, the design may require refinement. Furthermore, if the highways drainage can be confirmed for the existing roads via a full drainage survey, reuse of this system may be viable.

7.3.43 Any further constraints identified from ecological and environmental survey data yet to be established may result in a change in the locations of the identified attenuation basins and other proposed drainage features.

Culverts

7.3.44 Where the proposed road crosses existing watercourses, a series of culverts are proposed to ensure continuity of flow and prevent any increase in flooding

off-site. As per agreement with the LLFA the Culverts for the WWHAR mainline and A47 have been sized based on the latest Revitalised Flood Hydrograph model (ReFH2) using FEH data and greenfield catchments delineated from LiDAR in conjunction with the LLFA. The culverts have been sized for the 1 in 100 year event plus a 40% allowance for climate change, assuming a half full pipe. Please refer to **table 7-5 and figure 7-** below for details. The proposed culvert 3, a 450mm diameter pipe crossing the A47, provides betterment over the existing surveyed 300mm diameter culvert, which was also shown to be silted and overgrown during survey. Overland catchment 4 drains via an existing ditch to the National Highways drainage network south of the existing underpass at Hardwick Interchange, records (separate document **Appendix P**) indicate the point of discharge to be a 300mm pipe, with a 1:200 fall – which itself discharges to a ditch on the northern side of the underpass. This pipe work is to be retained, based on ReFH2 modelling, this diameter should be sufficient to convey flows, subject to detailed design and additional surveys. It is understood that the consenting of culverts will covered under a separate agreement outside of the planning application and is subject to design development.

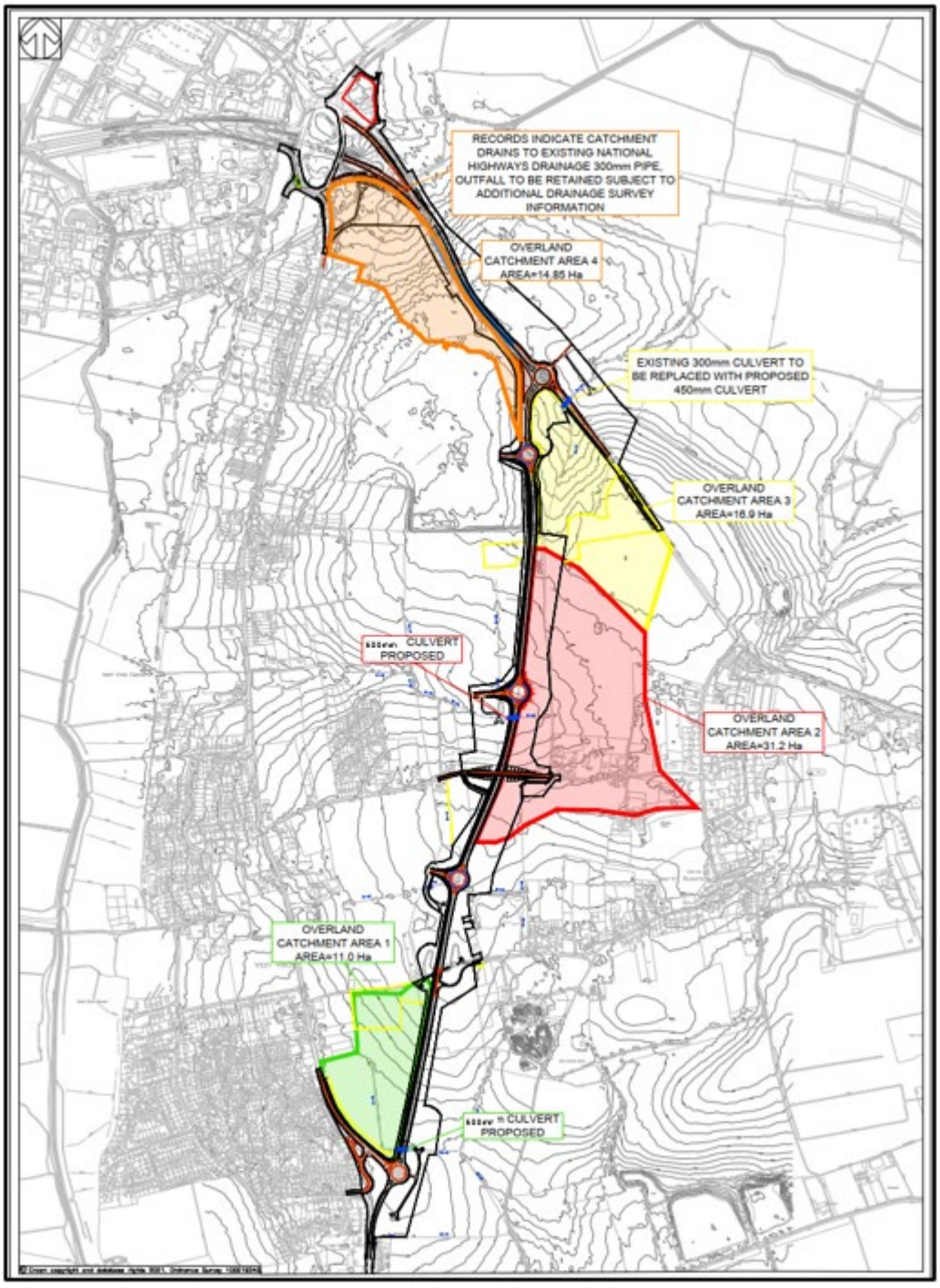
Table 7-4 – Culvert sizing

Culvert Location	Greenfield Catchment Size (ha)	Peak Greenfield Flow (note 1) (l/s)	Proposed Gradient	Proposed Diameter (mm)
1	11.00	47.5	1:400	600
2	31.20	134.6	1:500	600
3 (Replacement of existing A47 Culvert)	16.98	72.9	1:30 (matching existing)	450

Culvert Location	Greenfield Catchment Size (ha)	Peak Greenfield Flow (note 1) (l/s)	Proposed Gradient	Proposed Diameter (mm)
4 (Drains to existing NH network)	14.85	64.0	1:200 (existing)	300 (existing) – in line with required sizing using ReFH2 model

Note 1 - Using ReFH2 Model & FEH data

Figure 7-2 – Existing greenfield catchments and proposed culverts



Biodiversity & amenity considerations

7.3.45 A Biodiversity Net Gain (BNG) feasibility assessment will be undertaken to ensure the principles of BNG are incorporated into the WWHAR proposals as a whole, so that a 10% increase in biodiversity can be achieved. Following

the scheduled completion of the ongoing ecology surveys in October 2021, the WSP landscape lead will liaise with the WSP ecology team to develop a BNG assessment and inform the landscaping proposals that will form part of the WWHAR planning submission, including the choice of species and their location. Where practicable, the BNG assessment will seek to improve biodiversity in the area where the SuDS basins are proposed.

7.3.46 It has been suggested that some of the SuDS basins could be designed as 'wet' ponds and reed beds planted, thus providing a habitat to attract birds and offer biodiversity benefits. However, given the proximity of RAF Marham to the scheme, the provision of wet ponds (including reed beds) is not proposed due to potential risks associated with birds creating a hazard for low-flying military aircraft. Instead, 'dry ponds' are proposed.

7.3.47 Given the nature of the scheme as an access road and junction works, the amenity benefit for the SuDS features proposed will be limited particularly around the A47 where access opportunities will be extremely limited. Caution should be given where basins are relatively deep in terms of access, to ensure safety, and a full assessment of fencing or other safety measures should be made at detailed design.

8 Conclusions

8.1.1 This Flood Risk Assessment (FRA) and Drainage Strategy has been prepared to accompany a Detailed Planning Application for the site submitted on behalf of Norfolk County Council.

8.1.2 The site is currently predominantly greenfield land and is located east of the village of West Winch, Norfolk.

8.1.3 The proposed development comprises the provision of a new housing access road linking the existing A10 and A47, providing access to a proposed new housing development as well as widening of the existing A47 and improvement works to the Hardwick Junction.

8.1.4 Based on the information provided within this report, it is concluded that:

- The development site is located predominantly within Flood Zones 1 with a small area (0.004ha) within Flood Zone 2;
- The site is at low or negligible risk from all sources of flooding.
- The development site is not located within a Groundwater Source Protection Zone;
- The Ground conditions appraisal found favourable infiltration rates in some locations within the Tottenhills Sand & Gravel, Mintlyn and Roxham and Runction beds, with very low values for the Lowestoft formation. However groundwater monitoring undertaken gave minimum levels in the range of 0.1-1.2m BGL, not giving the sufficient clearance from the base of any infiltration structure to groundwater and therefore infiltration was discounted as a method of surface water disposal. As no significant cut is proposed, the risk of groundwater flooding is considered possible but low. Additional groundwater monitoring and site specific infiltration testing should take place at a later stage to inform the detailed design.
- As there will be an increase in impermeable area across the site, there will be an increase in the likelihood and magnitude of standing water and surface water runoff occurring. A surface water strategy has been devised to mitigate this.
- The proposed road drainage arrangement for the site will comprise filter drains, gullies and a piped drainage network that will direct surface water to attenuation basins via a sediment forebay. The basins will discharge to adjacent existing watercourses.
- Surface water runoff will be attenuated on-site for events up to and including the critical 1 in 100 year storm rainfall event with a 40% allowance for climate change, prior to discharge to watercourse. It is

considered that this approach will not increase the risk of flooding elsewhere.

- Where improvement works are proposed at the existing Hardwick Roundabout, surface water will be directed to the existing drainage network, any additional impermeable areas to be drained will be attenuated to 2 l/s/ha rates.
- Flows associated with exceedance events will be directed to the on-site attenuation facilities by suitably designed overland flow routes to surface the proposed attenuation basins.
- To ensure the effectiveness of the proposals a maintenance regime will be in place to ensure the future performance of all the SuDS and drainage devices.

8.1.5 Based upon information provided within this report, it is concluded that the site is presented as sustainable in terms of flood risk and compliant with the criteria set out in the NPPF.