Document 6.2

The West Midlands Rail Freight Interchange Order 201X
Technical Appendix 16.1 - Flood Risk Assessment (FRA)
Regulation 5(2)(e)
Ramboll - April 2018

West Midlands Interchange

Four Ashes Ltd

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Four Ashes Ltd

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WEST MIDLANDS INTERCHANGE

FLOOD RISK ASSESSMENT

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1. INTRODUCTION

1.1. Background

1.1.1. Ramboll Environment & Health UK Ltd ('Ramboll') was appointed by Four Ashes Ltd ('the Applicant') to undertake a Flood Risk Assessment (FRA) to accompany a development consent order (DCO) application for the development of a new Strategic Rail Freight Interchange and associated warehousing at land located at Four Ashes, Staffordshire (the "Site" and the "Proposed Development"). The Proposed Development is also referred to as the West Midlands Interchange (WMI). Figure 1, included in Appendix 1, shows the Site location. The Proposed Development is illustrated in the parameter plans which support the DCO application (Documents 2.5, 2.6 and 2.7).

1.1.2. A copy of this FRA will be submitted with the application for the DCO in order to satisfy the requirement in Regulation 5 (2) (e) of The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009.

1.1.3. The information used to prepare this report comprises:

- A topographical survey of the site by Greenhatch Group (Drawing Reference: 23228_T_F1, March 2016);
- Parameter Plans for the Proposed Development (Documents 2.5, 2.6 and 2.7);
- A Surface Water Drainage Strategy Plan by Waldeck Consulting (Environmental Statement (ES) Technical Appendix 16.3);
- Technical Note: Summary of Ground Conditions by Waldeck Consulting (4th April 2018 – ES Technical Appendix 11.6);
- The South Staffordshire, Cannock Chase, Lichfield and Stafford Strategic Flood Risk Assessment (SFRA) (June 2014)[1];
- British Geological Survey (BGS) maps[2];
- National Planning Policy Framework (NPPF): Flood Risk[3];
- CIRIA 753: The SuDS Manual;
- The National Policy Statement (NPS) for National Networks[4]; and
- The Environment Agency's[5] (EA) online database of indicative floodplain and hydrogeological maps.

1.1.4. Ramboll cannot accept liability for the accuracy or otherwise of any information derived from third party sources.

[1] The South Staffordshire, Cannock Chase, Lichfield and Stafford SFRA (June 2014) [Online]. Available: https://www.cannockchasedc.gov.uk/sites/default/files/volume_1_report_v2.pdf. [Accessed January 2017].
[2] British Geological Society, "Geology of Britain Viewer," 2016. [Online]. Available: http://mapapps.bgs.ac.uk/geologyofbritain/home.html. [Accessed January 2017].
[3] Department for Communities and Local Government, "Technical Guidance to the National Planning Policy Framework," March 2012. [Online]. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6000/2115548.pdf. [Accessed January 2017].
[4] Department for Transport, "National Policy Statement for National Networks", November 2014 [Online]. [Accessed February 2017].
[5] Environment Agency, "Flood Map for Planning," 2016. [Online].

1.2. Scope and Objectives

1.2.1. This document considers the risks of various sources of flooding to the Proposed Development and the consequent risk of flooding to downstream receptors (such as people, property, habitats, infrastructure and statutory sites) from the Proposed Development, as a result of surface water runoff. A comparison is made between the existing baseline situation and the Proposed Development.

1.2.2. This FRA has been carried out in accordance with paragraphs 5.90 to 5.97 of the NPS for National Networks (the 'NPS') to inform the Environmental Impact Assessment (EIA), in particular Chapter 16 (Water Environment and Flood Risk) of the ES. It is to be used to assist statutory consultees, when considering the flooding issues of the Proposed Development, as part of a DCO application. An FRA is required for the Site as it has an area greater than 1ha.

1.2.3. This report provides the following information:

i. An assessment of the flood risk to the Proposed Development based upon flood data and the flood maps provided by the EA and SFRA;
ii. An assessment of the impact of the Proposed Development in terms of surface runoff;
iii. Proposals for measures to mitigate the generation of surface water runoff from the Proposed Development;
iv. Proposals to mitigate any residual flood risks to the Proposed Development (if any); and
v. An assessment of various options for surface water drainage for the Proposed Development.

1.2.4. This report takes account of paragraph 5.94 of the NPS, including taking account of climate change and identifying 'residual' risk.

2. SITE DESCRIPTION AND BASELINE

2.1. Site Description, Location and Setting

2.1.1. The Site comprises a parcel of land of approximately 297ha, at Four Ashes, Staffordshire and is broadly centred at approximate National Grid Reference (NGR) 392288, 309675.

2.1.2. Although the Site is irregular in shape, it is broadly bound to the north by the A5, the east by the M6 and to the west by the A449 (Stafford Road). The southern Site boundary broadly follows the Staffordshire and Worcestershire Canal. This passes along the southern Site boundary before turning broadly north to pass through the Site. The Site is situated within a predominantly agricultural area, with some industry close by, including the industrial development at Four Ashes adjacent to the Site.

2.1.3. The Site predominantly comprises large areas of undeveloped farm land and quarry works and at present is predominantly used for agricultural purposes and quarry activities. The Site also contains part of an area of woodland known as Calf Heath Wood.

2.1.4. The west coast railway line passes through the western part of the Site, in a north-south direction. Vicarage Road and Straight Mile also pass through the southern part of the Site in a broadly north-east and east direction respectively.

2.1.5. There are some isolated buildings and corresponding access roads situated within the Site boundary. These include:

- Woodside Farm and a Children's Home and the corresponding access road for these properties off the Vicarage Road;
- Heath Farm, also situated off Vicarage Road;
- A residential property and stables situated off the A5;
- Gravelly Farm, situated off Gravelly Way;
- A residential property situated off Stafford Road; and
- Various Quarry buildings and infrastructure.

2.2. Geological Setting

2.2.1. The British Geological Survey (BGS) geological map for the area (Sheet 153, Wolverhampton) 1:50,000 series Solid and Drift edition) shows the Site to be underlain by Wildmoor Sandstone Formation bedrock and superficial deposits comprising Devensian sands and gravels.

2.2.2. There are numerous historic BGS borehole records within the Site boundary. These confirm the presence of sand and gravel deposits underlain by sandstone formation, with some shallow alluvium and clay geology, as well as made ground and topsoil, also present beneath the Site.

2.2.3. Several boreholes were installed across the Site as part of site investigation works, of depths up to 10m. The findings of these are detailed in the Geotechnical Considerations Summary report. In summary, these found the presence of topsoil across the majority of the Site of thicknesses in the region of 0.03m to 0.5m and made ground across small parts of the Site at depths of up to 1.8m below ground level (bgl).

2.2.4. The boreholes also confirmed the presence of sand and gravel superficial deposits and well as alluvium, glacial till and glacial fluvial deposits. These varied in depths bgl of 0m to approximately 8m.

2.2.5. Clay mudstone was found across parts of the Site at depths up to 6m bgl. This was confirmed to be part of Bromsgrove Sandstone Formation. Wildmoor Sandstone Formation was also found across the whole Site, below the clay and superficial deposits, in line with the BGS mapping.

2.2.6. The Summary of Ground Conditions (ES Technical Appendix 11.6) details groundwater encountered across the Site at depths broadly in the region of 2.5 to 4m bgl across the Site, however groundwater was also recorded at depths as shallow as 0.4m bgl and up to 6.30m bgl.

2.3. Hydrological Setting

2.3.1. The Staffordshire and Worcestershire Canal passes along the southern and south-eastern boundary of the Site, in a broadly east-west direction, before turning north to pass through the Site in a broadly south-northeast direction. A second canal, Hatherton Canal, joins with the Staffordshire and Worcestershire Canal approximately 350m south-east of the Site boundary.

2.3.2. Two canal feeder reservoirs, Calf Heath Reservoir and Gailey Reservoir, are situated immediately adjacent to and approximately 500m north-east of the north-eastern generally Site boundary. These are both linked to the Staffordshire and Worcestershire Canal via a partially culverted watercourse situated partly within the Site, along the northern Site boundary, as well as to Hatherton Canal via a partially culverted watercourse to the east and south-east of the Site. The River Penk is situated approximately 1km south-west of the Site at its closest point, although it is situated approximately 1.5km to the west of the Site, and flows broadly in south-north direction. An unnamed drainage watercourse passes through the Site, beginning in the north-west part of the Site and flowing broadly in a north-west direction to join with the River Penk approximately 1.5km north-west of the Site.

2.3.3. Saredon Brook is situated approximately 350m to the south of the Site and flows in a broadly east-west direction. It joins with the River Penk approximately 1km south-west of the Site.

2.3.4. In addition to this, several land drains, drainage ditches and ponds are present within and adjacent to the Site. Almost all field boundaries within the Site comprise a hedgerow and associated ditch, some of which hold water seasonally. The Surface Water Drainage Report provided by Waldeck Consulting identifies 8 separate surface water catchments across the Site, with 3 discharging to the River Penk, 3 discharging to the Staffordshire and Worcestershire Canal and 2 understood to collect runoff via a series of ditches prior to a combination of infiltration and evaporation.

2.3.5. The River Penk is the largest tributary of the River Sow, for which the confluence is located at Stafford to the north, approximately 17km downstream of the Site. The Sow is a tributary to the River Trent, and joins the Trent at Great Haywood / Shugborough, approximately 24km downstream of the Site.

2.3.6. Figure 2, included within Appendix 1, illustrates the water environment on-site.

2.4. Hydrogeological Setting

2.4.1. The EA has developed Groundwater Source Protection Zones (GSPZ) to assist in assessing the risk to groundwater supplies taken from an abstraction point.

2.4.2. The majority of the Site is situated within a Total Catchment (Zone 3) GSPZ, aside from the north-western part of the Site, which is situated within an Outer Zone (Zone 2) GSPZ.

2.4.3. Definitions for the GSPZs based on those provided by the EA website, can be summarised as follows:

- Inner zone (Zone 1): "*The 50 day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres.*"

- Outer zone (Zone 2): "*A 400 day travel time from a point below the water table. The previous methodology gave an option to define SPZ2 as the minimum recharge area required to support 25 per cent of the protected yield. This option is no longer available in defining new SPZs and instead this zone has a minimum radius of 250 or 500 metres around the source, depending on the size of the abstraction.*"

- Total catchment (Zone 3): "*The area around a source within which all groundwater recharge is presumed to be discharged at the source. In confined aquifers, the source catchment may be displaced some distance from the source. For heavily exploited aquifers, the final Source Catchment Protection Zone can be defined as the whole aquifer recharge area where the ratio of groundwater abstraction to aquifer recharge (average recharge multiplied by outcrop area) is >0.75. There is still the need to define individual source protection areas to assist operators in catchment management.*"

- Special interest (Zone 4): "*A fourth zone SPZ4 or 'Zone of Special Interest' was previously defined for some sources. SPZ4 usually represented a surface water catchment which drains into the aquifer feeding the groundwater supply (i.e. catchment draining to a disappearing stream). In the future this zone will be incorporated into one of the other zones, SPZ 1, 2 or 3, whichever is appropriate in the particular case, or become a safeguard zone.*"

2.4.4. The EA website also shows aquifers and provides designations in line with the Water Framework Directive, based on maps produced by the BGS. The EA maps show the Site to be underlain by a Principal Aquifer associated with the bedrock formation; and a Secondary A aquifer associated with the superficial deposits.

2.4.5. Definitions for the aquifer types based on those provided by the EA website, can be summarised as follows:

- Principal aquifer: "*Layers of rock or drift deposits that have high intergranular and/ or fracture permeability – meaning they usually provide a high level of water storage. They may support water and/ or river base flow on a strategic scale.*"

- Secondary A aquifer: "*Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.*"

- Secondary B aquifer: "*Predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.*"

- Secondary 'undifferentiated' aquifer: "*It has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.*"

2.5. Existing Surface Water Runoff and Drainage Regime

2.5.1. As described in section 2.1, the Site comprises largely undeveloped land, aside from a few isolated buildings, the west coast mainline and sections of road and highway. Aside from this infrastructure, the Site is currently almost entirely permeable.

2.5.2. As described in section 2.3, the agricultural fields within the Site are served by a network of drainage ditches situated along the field borders and surface water runoff within the Site discharges via a combination of ditch outfalls to both the River Penk to the west and the Staffordshire and Worcestershire Canal to the south, with some runoff dispersing via evaporation and infiltration to ground.

2.5.3. The topographical and utilities survey data does not identify any public sewerage infrastructure within the Site. It is considered most likely that surface water flows from existing properties within the Site discharge via private drainage infrastructure either to the surface water drainage ditch network serving the Site or to ground. It is understood that roads both within and adjacent to the Site boundary, including the A5, M6 and A449, are served by highway drainage infrastructure.

2.5.4. In summary, surface water runoff is understood to discharge via gravity unrestricted to the drainage ditch network present on Site. Although, given the geology present on Site, it is likely that there is a degree of infiltration to ground, the majority of surface water is considered to discharge to either the River Penk or to the Staffordshire and Worcestershire Canal.

2.6. Existing Flood Risk

Tidal/Fluvial

2.6.1. The EA's indicative planning floodplain maps identify areas in England at risk of flooding by allocating them into flood risk zones. However, the flood risk zones specifically do not take into account flood defences (i.e. they present the undefended scenario).

2.6.2. The flood risk zones shown on the Flood Map for Planning are defined in Table 2 of the Technical Guidance to the NPPF and these are as follows:

- Zone 1: Low Probability
  According to the NPPF, land in this zone is considered to have less than 1 in 1000 annual probability of river or sea flooding in any year. This is < 0.1%.
- Zone 2: Medium Probability
  According to the NPPF, land in this zone is considered to have between a 1 in 100 and 1 in 1000 annual probability of river flooding in any year (between 1% and 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding in any year (0.5%-0.1%).
- Zone 3a: High Probability
  According to the NPPF, land in this zone is considered to have a 1 in 100 or greater annual probability of river flooding in any year (>1%) or a 1 in 200 or greater annual probability of flooding from the sea in any year (>0.5%).
- Zone 3b: The Functional Floodplain
  According to the NPPF, land in this zone is used for water flow or storage in times of flood. This flood zone should be identified by a SFRA. It is considered to have a 1 in 20 or greater chance of river flooding in any year which is > 5%. Another probability however can also be agreed between the LPA and the E.A.

2.6.3. The EA's flood map shows the Site to be entirely situated within Flood Zone 1, at less than a 1-in-1000 year probability of tidal and fluvial flooding. This is confirmed by Figure FZ-SS

included in Volume 2 of the SFRA. Therefore, overall tidal and fluvial flood risk to the Site is considered to be low.

Surface Water and Sewer Drainage Risk

2.6.4. The EA's indicative surface water flood maps identify areas in England and Wales at potential risk of surface water flooding. As for the tidal and fluvial flood risk maps, the surface water flood maps define flood risk as follows:

- High Risk
  Considered to have a greater than 1 in 30 annual probability of surface water flooding in any year (>3.3%).
- Medium Risk
  Considered to have between a 1 in 30 and 1 in 100 annual probability of surface water flooding in any year (between 3.3% and 1%).
- Low Risk
  Considered to have between a 1 in 100 and 1 in 1000 annual probability of surface water flooding in any year (between 1% and 0.1%).
- Very Low Risk
  Considered to have a less than 1 in 1000 annual probability surface water flooding in any year (>0.1%).

2.6.5. The EA's flood mapping shows the vast majority of the Site to be at very low risk of surface water flooding. There are some small localised areas shown to be at low, medium and high susceptibility of surface water flooding, predominantly along the route of the Staffordshire and Worcestershire Canal, and along some field boundaries. The EA maps show the expected depth of flooding at all these locations to be less than 900mm, with the majority of depths expected to be less than 300mm.

2.6.6. The EA mapping is broadly in agreement with the data shown on Figure SW-SS of Volume 2 of the SFRA. This shows very small parts of the Site to be a risk of surface water flooding during a 1-in-20 storm, 1-in-100 storm and 1-in-1000 storm.

2.6.7. Figure HF-SS of volume 2 of the SFRA shows the locations of historic flooding records. This shows no records of previous surface water flooding within the Site. On this basis, surface water flood risk to the Site as a whole is considered to be low, although it is noted that some very small parts of the Site remain at medium-high risk of flooding.

2.6.8. Although Figure HF-SS lists a record of highway flooding and a record of flooding from artificial drainage along Station Road/ Vicarage road to the north-east of Four Ashes industrial estate, Figure SF-CC of Volume 2 of the SFRA lists sewer flooding incidents specifically. This shows that there are no records of sewer flooding within or adjacent to the Site.

2.6.9. On the basis of the above, overall sewer and surface water flood risk to the Sit is considered to be low.

Groundwater Flood Risk

2.6.10. Figure GW-SS included in Volume 2 of the SFRA defines groundwater flooding potential across the study area based on geology and groundwater levels during periods of extended intense rainfall. The mapping categorises the Site as *Category A: Limited potential for groundwater flooding to occur*. In addition to this, as discussed in section 2.2, groundwater was encountered cross the Site at depths broadly in the region of 2.5 to 4m bgl. On this basis, groundwater flood risk to the Site is considered to be low.

Artificial Water Bodies

2.6.11. As discussed in section 2.3, the Staffordshire and Worcestershire Canal passes through the Site. In addition to this, the Gailey and Calf Heath canal feeder reservoirs are situated immediately north-east of the Site boundary.

2.6.12. The EA reservoir flood mapping shows a small section of the north-eastern part of the Site, adjacent to the A5, to be at risk of reservoir flooding. Similarly, Figure RIM-SS of Volume 2 of the SFRA shows the northern part of site to be at risk of reservoir inundation, adjacent to the Calf Heath and Gailey reservoirs.

2.6.13. Due to the Statutory requirement for management and monitoring of reservoirs and canals, flood risk from these sources is considered to be a very low risk only. Therefore overall flood risk to the Site from artificial sources is considered to be low.

Flood Risk Summary

2.6.14. Based on the assessment of flooding sources above, the flood risk summary for the Site is presented in Table 2.1.

Table 2.1 – Flooding Sources at Site

Flood Risk	High	Medium	Low	Comments
Tidal/ Fluvial			**X**	Site located within Flood Zone 1, at low risk of tidal and fluvial flooding.
Surface Water and Drainage Flood Risk			**X**	Vast majority of the Site at low risk of surface water flooding, with very small, isolated parts at medium-high risk. No records of previous sewer or surface water flooding. SFRA shows flood risk to be low.
Groundwater			**X**	SFRA shows Site to be at low susceptibility, low groundwater levels.
Reservoirs, canals and other artificial sources			**X**	Reservoir and canal flood risk monitored and regulated, therefore, very low risk of flooding only.

3. PROPOSED DEVELOPMENT

3.1. Proposed Development

3.1.1. It is proposed to construct the WMI Strategic Rail Freight Interchange at the Site. The quarry within the Site will no longer be in operation following development. At the time of writing the demolition of existing buildings within the Site has not occurred.

3.1.2. As discussed in section 2.5, aside from highway infrastructure, the Site is currently almost entirely permeable. Following development, impermeable area within the Site is expected to increase significantly.

3.2. Proposed Surface Water Drainage Strategy

3.2.1. As discussed within section 2.5, the vast majority of the Site is currently undeveloped and land drains to a drainage ditch network along field boundaries. This section summarises the proposed surface water drainage strategy for the Site in line with the surface water drainage strategy information provided by Waldeck Consulting.

3.2.2. Infiltration testing, in line with the requirements of BRE Digest 365, was undertaken at the Site as part of the Ground Investigation works detailed in the Ground Investigation Considerations Summary Report. The soil infiltration rates showed that the use of infiltration as part of the drainage regime at the Site may be feasible, however due to the requirements for soakaways to be situated minimum distances away from buildings, it was noted as part of the Ground Investigation that this may not be a feasible option for the Site due to the nature of the Proposed Development. Furthermore, the Surface Water Drainage Report identifies that due to the presence of made ground, combined with shallow groundwater and the underlying Groundwater Source Protection Zone designations across the Site, infiltration of surface water runoff to ground is not considered to be appropriate as part of the Proposed Development. Therefore, in line with the existing drainage regime at the Site, it is proposed to discharge surface water off-site via to both the River Penk and the Staffordshire and Worcestershire Canal.

3.2.3. Surface water drainage across the Site is to be divided into four catchment areas, summarised as follows:

- Catchment A: Drains the majority of the Site area including development zones A2, A3, A4a, A4b, A5a and A5b. Discharges to an existing ditch to the west of the A449, which then discharges to the River Penk. This catchment includes an inverted syphon to facilitate crossing of the west coast mainline (WCML);
- Catchment B: Drains the rail terminal area to the south of Gravelly Way (Development Zone A1). Discharges to an existing ditch to the west of the A449, which then discharges to the River Penk;
- Catchment C: Drains part of development zones A7(a-c) to the south of Vicarage Road. Discharges to an existing ditch via a pumped outlet which then discharges to the Staffordshire and Worcestershire Canal; and
- Catchment D: Drains development zone A6 and part of development zones A7(a-c). Discharges directly to the Staffordshire and Worcestershire Canal via a pumped outlet. The volume and rate of discharge proposed, and the detailed outfall arrangement, are to be agreed by the Canal & River Trust through their Code of Practice application process,

but it has been agreed to date that a peak discharge rate of 60 litres/second will not be exceeded.

3.2.4. The drainage catchments across the Site are designed such that the proportion of the Site discharging to each watercourse is in line with the existing catchments present across the Site.

3.2.5. Surface water flows are to be conveyed to outfalls via a combination of pipe networks, swales, detention ponds and drainage ditches.

3.2.6. It is proposed to restrict runoff rates within the Site to greenfield rates, in line with the existing drainage regime at the Site, although it is noted that the rate of discharge for outfall D, discharging to the Staffordshire and Worcestershire Canal has been restricted further in order to meet a maximum discharge rate of 60 litres/second agreed with the Canal & River Trust.

3.2.7. Attenuation storage is to be provided for up to the 1-in-100 year storm, including allowances for the predicted effects of climate change (40%). Attenuation storage is proposed in the form of detention ponds as well as conveyance swales. The use of these Sustainable Drainage Systems (SuDS) as part of the proposed drainage strategy for the Site will also provide water quality treatment in line with CIRIA 753 requirements.

3.2.8. The development lifetime for warehouse buildings is understood to be 25 years. In accordance with the EA Climate Change guidance issued in February 2016, for developments with a lifespan up to the years 2070-2115, the ‘upper end’ climate change allowance is 40% and the ‘central’ climate change allowance is 20%. The Climate Change Guidance states that for "less vulnerable" development situated within Flood Zone 1, the impact of both the "upper end" and "central" climate change allowances should be assessed over the lifetime of the Proposed Development. The drainage strategy calculations provided by Waldeck Consulting include a climate change allowance of 40% has been applied to rainfall intensities over the lifetime of the Proposed Development.

3.2.9. In line with the existing situation, the drainage infrastructure serving the sections of highway within the Site boundary will remain separate from the proposed drainage regime serving the Site itself.

4. ASSESSMENT METHODOLOGY

4.1. Policy

4.1.1. This FRA has been completed in accordance with the guidance in the NPS. To avoid duplication, a summary of this guidance and policy is provided in Chapter 16 of the Environment Statement: *Water Environment and Flood Risk.*

4.2. Methodology

4.2.1. Following establishment of the Site baseline in relation to the flood risk and surface water, this baseline has been assessed in line with the *Flood Risk Vulnerability Classification* guidance and *Flood Zone 'Compatibility'* guidance detailed in the Planning Practice Guidance to the NPPF. These classifications have been used to apply the sequential test, as set out within the NPPF, to establish whether the Proposed Development is appropriate with regard to flood risk and whether any flood mitigation measures are required to be included as part of the Proposed Development.

4.2.2. In addition to assessing flood risk to the Proposed Development, an assessment of the proposed drainage strategy as prepared by Waldeck Consulting has also been undertaken to ensure that flood risk to downstream receptors doesn't increase as a result of the Proposed Development with regard to surface water runoff.

5. ASSESSMENT OF PROPOSED DEVELOPMENT

5.1. Sequential Test

5.1.1. The NPS seeks to direct new development to areas at lower risk of flooding through the sequential test.

5.1.2. As presented in section 2.6, the Site is situated within Flood Zone 1. Therefore, in line with the guidance detailed in paragraph 5.105 of the NPS, the sequential test is deemed to be passed and the exception test is not required.

5.2. Surface Water Runoff

5.2.1. As discussed within section 3.2, it is proposed to drain all areas of hardstanding within the Site to either the River Penk or to the Staffordshire and Worcestershire Canal, via existing drainage watercourses, with the exception of one direct connection to the canal, in line with The Canal and River Trust requirements. Flows are to be restricted to greenfield rate equivalents and attenuation storage provided in the form of detention ponds and swales. Attenuation storage is to be designed to accommodate the 1-in-100 year storm event, including allowances for climate change over the lifetime of the development.

5.2.2. In line with the existing situation, the drainage infrastructure serving the sections of highway within the Site boundary will remain separate from the proposed drainage regime serving the Site itself.

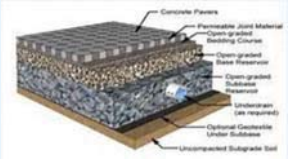
5.2.3. In line with planning policy, an assessment of different sustainable drainage systems (SuDS) options for the Proposed Development is provided in the following section. However, on the basis of the above, flood risk to downstream receptors will not increase following development.

5.2.4. As discussed in section 2.6, the vast majority of the Site is considered to be at low risk of surface water flooding, with very small isolated areas at medium to high susceptibility. Therefore, in addition to ensuring that there is no increase in flood risk to downstream receptors following development, implementation of the proposed drainage regime at the Site will also assist in alleviating surface water flooding susceptibility at the Site.

5.3. Assessment of Attenuation Options

5.3.1. The NPS promotes sustainable management of surface water runoff from a new development and the use of SuDS is recommended (paragraphs 5.110 and 5.111 of the NPS). Table 5.1 below outlines various SuDS options and their suitability for use as part of the Proposed Development.

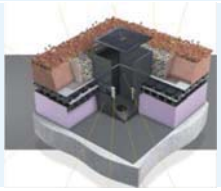
Table 5.1 – SuDS Options for the Proposed Development

SUDS group	Technique	Image	Description	Advantages	Disadvantages	Maintenance Requirement	Suitable for use at site
Retention	Balancing pond		Provides both storm water attenuation and treatment. Runoff from each rain event is detained and treated in the pool. The retention time promotes pollutant removal through sedimentation.	Good removal of pollutants, can be used where groundwater is vulnerable, good community acceptability, high ecological, and amenity benefits.	No reduction in runoff volume, land take may limit use in high density sites.	• Routine inspection • Check inlets, outlets, control structures and overflows • Litter and debris removal • Grass Cut • Weeding • Inspect and clear inlets • Manage vegetation • Sediment removal • Silt removal • Returfing/Re-seeding • Repair or replace inlets	✓ This may be a suitable option for the Proposed Development, although appropriate locations within the Site may be limited space constraints. One possible location is the proposed open storage lagoon area towards the centre of the Site.
	Subsurface storage		Oversized pipes, tank systems and modular geocellular systems that can be used to create a below ground storage structure.	Modular and flexible, dual usage (infiltration/storage), high void ratios, can be installed beneath trafficked and soft landscaped areas.	No water quality treatment.	• Check inlets, outlets, control structures and overflows • Jetting and suctions • Reinstate	✓ This may be a feasible option for the Site, although may not be preferable for achieving gravity discharge to existing watercourses.
	Porous paving		Porous paving with sub-surface storage.	Reduces the rate of runoff, effective at pollutant removal, contributes to groundwater recharge, dual usage (infiltration/storage).	Requires appropriate pre-treatment, basins require a large flat area, offset from foundations.	• Inspect and repair damaged pavement • Replacement of clogged geotextile	✓ This may be a suitable option for the Proposed Development, although may not be appropriate in parts of the Site where heavy vehicle loading. Is anticipated.
Wetland	Shallow wetland Extended detention wetland Pond wetland Pocket wetland Submerged gravel wetland Wetland channel		Wetlands provide stormwater attenuation and treatment. They comprise shallow ponds and marshy areas, covered in aquatic vegetation. Wetlands detain flows for an extended period to allow sediments to settle and to remove contaminants They can provide significant ecological benefits.	Good pollutant removal and if lined can be used where groundwater is vulnerable. Good community acceptability, ecological and amenity benefits.	Land take is high, requires baseflow, little reduction in runoff volume, not suitable for steep sites.	• Routine inspection • Check inlets, outlets, control structures and overflows • Grass cutting • Meadow Grass • Manage wetland planting in micropools • Sediment removal • Level reinstatement • Inspect and repair damaged inlets, outlets, banks and overflows • Replacement of topsoil	✓ This may be a suitable option for the Proposed Development, although appropriate locations within the Site may be limited space constraints. One possible location is the proposed open storage lagoon area towards the centre of the Site.

• SUDS group	• Technique	• Image	• Description	• Advantages	• Disadvantages	• Maintenance Requirement	Suitable for use at site
Infiltration	Infiltration trench Infiltration basin Soakaway		Surface water runoff can be discharged directly to ground for infiltration by soakaways, basins, or trenches. A prerequisite is that both groundwater and ground conditions are appropriate to receive the quality and quantity of water generated.	Reduces the volume of runoff, effective at pollutant removal, contributes to groundwater recharge, simple and cost-effective, easy performance observation.	Requires appropriate pre-treatment, basins require a large flat area, offset from foundations.	• Routine inspection • Check inlets, outlets, control structures and overflows • Litter and debris removal • Trimming roots • Sediment removal • Inspect and repair damaged inlets, outlets, banks and overflows • Reconstruct soakaway and/or replace or clean void fill • Replacement of clogged geotextile	✗ Infiltration rates suggest that infiltration of surface water to ground may be a feasible option for the Site, however this may not be a preferred option for the Site due to the underlying aquifer designations, Groundwater SPZs and potential contamination in certain parts of the Site, as well as the need to install soakaways away from buildings, this option is not considered a practical option in this instance.
Filtration	Surface sand filter Sub-surface sand filter Perimeter sand filter		Structures designed to treat surface water runoff through filtration using a sand bed filter medium. The filters can be designed with or without infiltration. Temporary storage of runoff is achieved through ponding above the filter layer. They are used where particularly high pollutant removal is required.	Flexibility of design, efficient in removing pollutants, suitable for retrofits and in tightly constrained urban locations.	Not for high sediment content, detention times can support algae growth, minimum hydraulic head of 1.2m required, possible odor problems, high capital and maintenance cost.	• Cleaning inlet, outlets, control structures and overflows • Litter and debris removal • Mow • Mange vegetation, Mulching • Check for poor vegetation • Pruning, trimming and Weed control • Surface reinstatement by forking or scarifying, Level reinstatement • Repair or replace inlets, outlets, or overflow structure	✓ This is may be a suitable option for the Proposed Development, although may not be appropriate in parts of the Site due to the industrial nature of the Proposed Development including limited space between building plots combined with HGV movement through the Site

	Bioretention/ filter swale/ raingarden		Vegetated strips of land designed to accept runoff as overland sheet flow between a hard-surfaced area and a receiving system.	Landscaping features, effective in removing pollutants, flexible layout to fit into landscape, suited for highly impervious areas, good retrofit capability, effective pre-treatment option.	Requires landscaping and management, large land requirement, not suitable for steep sites, no significant attenuation or reduction of flows.	• Check inlets, outlets, control structures and overflows • Litter and debris removal • Grass cutting • Weeding and manage vegetation • Silt removal	✓ This is may be a suitable option for the Proposed Development, although may not be appropriate in parts of the Site due to the industrial nature of the Proposed Development including limited space between building plots combined with HGV movement through the Site
	Filter trench/drain		Shallow excavations filled with rubble or stone that create temporary subsurface storage for filtration of storm water runoff. Receive lateral inflow from an adjacent impermeable surface.	Hydraulic benefits achieved with filter trenches, trenches can be incorporated into site landscaping and fit well beside roads and car parks.	High clogging potential without effective pre-treatment, limited to small catchments, high cost of replacing filter material.	• Routine inspection • Cleaning inlet, outlets, control structures and overflows • Litter and debris removal • Grass cutting, cut back overhanging branches • Weed control • Silt removal • Replace clogged geotextile • De-silt stone fill • Remove and replace filter material.	✓ This is may be a suitable option for the Proposed Development, although may not be appropriate in parts of the Site due to the industrial nature of the Proposed development including limited space between building plots and HGV movement through the Site
Detention	Detention basin / retention ponds		Surface storage basins that provide flow control through attenuation. Normally dry and in certain situations the land may also function as a recreational facility.	Cater for a wide range of rainfall events, can be used where groundwater is vulnerable, potential for dual land use, easy to maintain.	Land take, little reduction in runoff volume, detention depths constrained by levels.	• Routine inspection • Cleaning inlets, outlets, control structures and overflows • Litter and debris removal • Grass cutting, Meadow grass, Cut back overhanging branches, Manage wetland planting in micropools • Sediment removal, Re-turfing/re-seeding • Level reinstatement due to erosion • Inspect and repair damage to inlets, outlets, banks and overflows.	✓ This is a suitable option for the Proposed Development and is proposed as part of the drainage strategy for the Site.

	Enhanced dry swale Enhanced wet swale		Swales are linear vegetated drainage features in which surface water can be stored or conveyed. They can be designed to allow infiltration, where appropriate.	Incorporate into landscaping, good removal of pollutants, reduces runoff rates and volumes, low cost.	Not suitable for steep areas, significant land take, not suitable in areas with roadside parking.	• Check inlets, outlets, control structures and overflows • Litter and debris removal • Grass cutting • Cut back overhanging branches • Weeding and manage vegetation • Silt removal • Repair erosion, Replacement of topsoil, Surface treatment to encourage infiltration	✓ This is a suitable option for the Proposed Development, although may not be appropriate in parts of the Site due to the industrial nature of the proposed development, including limited space between building plots and HGV movement through the Site Where appropriate, swales are proposed as part of the drainage strategy for the Site.
Conveyance	Conveyance swales Rills		Formal linear drainage features in which surface water can be stored or conveyed. They can be incorporated with water features such as ponds or waterfalls where appropriate.	Negate the need for underground pipework. Can provide some attenuation. Possible reduction in runoff volume via plant uptake and infiltration.	Potential trip/wheel hazard, disabled access issues.	• Routine inspection • Cleaning inlet, outlets, control structures and overflows • Litter and debris removal	✓ This is may be a suitable option for the Proposed Development, although may not be appropriate in parts of the Site due to the industrial nature of the proposed development including limited space between building plots and HGV movement through the Site
Source control	Green/brown roof		Multi-layered system that covers the roof of a building with vegetation cover/landscaping over a drainage layer. Designed to intercept and retain precipitation, reducing the volume of runoff and attenuating peak flows.	Mimics greenfield state of building footprint for high density developments, good removal of pollutants, ecological benefits, insulates buildings, sound absorption.	Additional weight, not appropriate for steep roofs, maintenance of roof vegetation.	• Check inlets, outlets, control structures and overflows • Litter and debris removal • Irrigation during establishment, Weeding and plant replacement • Silt removal • Repair erosion, Replacement of topsoil, Surface treatment to encourage infiltration	✓ This is may be a suitable option for the proposed development, although may not be appropriate in parts of the Site due to the Size of the proposed warehouse roof space.
	Rainwater harvesting		Uses rainwater coming from roofs to supply toilets, washing machines and irrigation systems. Harvested rainwater is stored underground and is substituted for potable water mains supply, reducing both site discharge and water	Can provide source control of storm water runoff, reduces demand on mains water.	Use is dependent on demand requirements, contributing surface area, and seasonal rainfall characteristics.	• Check inlets, outlets, control structures, filter, tank, and overflows • Cleaning tank inlet and outlet, gutters, UV lamp • Filter replacement • Sediment removal • Filter replacement • Pump replacement	✓ This is may be a feasible option for the Proposed Development, depending upon demand.

			consumption.			• UV unit replacement • Erosion damage to tank	
	Blue roof		Water is stored within the drainage voids within the thin build-up which is then released slowly through orifice plates into the wider drainage network. This can be incorporated alongside a green roof build-up.	Water can be stored at source, reducing the requirement for below ground drainage attenuation structures.	Additional imposed load added to the roof structure; method can only be used on flat rood systems.	• Check inlets, outlets, control structures and overflows • Litter and debris removal • Silt removal	✓ This is may be a feasible option for the Proposed Development, depending upon the design of the proposed buildings.

5.3.2. In summary, there are many different SuDS options that may be feasible to include within the proposed surface water drainage strategy for the Site. As detailed in section 3.2, the use of swales and detention ponds are proposed as part of the drainage regime at the Site, to provide both storage and water treatment benefits in line with CIRIA 753 guidance.

6. CONCLUSION

6.1.1. Ramboll were commissioned by Four Ashes Ltd to provide a FRA to accompany a DCO application for the development of a new Strategic Rail Freight Interchange and associated warehousing at land located at Four Ashes, Staffordshire.

6.1.2. The EA flood maps show the Site to be situated within the Flood Zone 1, at low risk of tidal/fluvial flooding. All other sources of flooding to the Site are considered to be low, although it is noted that very small parts of the Site are considered to be at medium-high susceptibility of surface water flooding. In line with the NPS (paragraph 5.105), the Proposed Developed is situated in Flood Zone 1 and therefore the sequential test is deemed to be passed and the exception test is not required.

6.1.3. Aside from highways drainage infrastructure serving highways surrounding the Site, it is proposed to discharge all surface water runoff from areas of hardstanding within the Site to either the River Penk or to the Staffordshire and Worcestershire Canal. Flows will be restricted to greenfield rates and attenuation storage, proposed in the form of swales and detention ponds, will be sized to store the 1-in-100 year storm event, including allowances for climate change over the lifetime of the development.

6.1.4. On the basis of the drainage strategy to be employed, flood risk to downstream receptors will not increase following development and surface water flood risk to the Site will be alleviated.

6.1.5. Based on the findings of this report, no further flood risk assessment is required.

Appendix 1 - Figures

Figure 1 – Site Location

Figure 2 – Water Features

Legend

Site Boundary

Client
Four Ashes Limited

Project Title
West Midlands Interchange

Project Number
1620002055

Figure Title
Figure 1
Site Location

RAMBOLL
Tel: 023 8081 7500 southampton@ramboll.co.uk
www.ramboll.co.uk

Date 14/06/2018

Scale 1:12,000 @A3

Legend

- Site Boundary
- EA Main River
- Ordinary Watercourse
- Canal
- Reservoir
- Pond

Abstractions

- Surface Water
- Groundwater

N

Client
Four Ashes Limited

Project Title
West Midlands Interchange

Project Number
UK15-22821

Figure 2
Water Features

RAMBOLL
Tel: 023 8081 7500
www.ramboll.co.uk

Date 14/06/2018

Scale 1:15,000 @A3