Greater Norwich Level 2 Strategic Flood Risk Assessment Detailed Site Summary Tables	
Site details	
Site Code	**CC16**
Address/Grid Ref.	Land adjoining Norwich City Football Club, Kerrison Road./ 624252,307694
Area	2.23ha
Current land use	Brownfield
Proposed land use	Carried forward mixed use allocation
Sources of flood risk	
Location of site within catchment	The site is in the River Wensum catchment, just upstream of the confluence with the River Yare. The River Wensum is an Environment Agency designated main river and rises in northeast Norfolk, flows through the centre of Norwich and flows in an easterly direction under Carrow Road Bridge, out of Norwich, towards the confluence.
Existing drainage features	The site is located on the edge of the River Wensum. The river has been artificially modified through Norwich and the banks of the river have been enforced with steel and concrete. There are no additional watercourses within the site boundary or in close proximity to the site.
Fluvial	**Proportion of site at risk:** **FZ3b –** 0% **FZ3a –** 0% **FZ2 –** 47% **FZ1 –** 53% **Available data:** Modelling has been completed for the River Wensum using TUFLOW. Both defended and undefended scenarios have been modelled and the defended scenarios have been used to assess the risk of flooding to the site. Limitations of the modelling are summarised in the Mapping Information section at the end of this table. Further modelling was undertaken to apply recent climate change uplifts to the fluvial model of the Wensum. **Flood characteristics:** The fluvial flood extent of the River Wensum at 0.1% AEP event affects almost half of the site. The low-lying topography of the north western part of the site means that flood water flows onto the site. The southern part of the site is significantly higher than the surrounding area and is therefore protected from flooding. Flooding during this extreme event is mainly limited to the north western portion, reaching a maximum of 0.9m depth with shallower levels up to 0.4m int the south east corner of the site. The modelled flood hazard shows that the north west of the site is classified as 'Significant- Dangerous for most people' flood hazard risk.
Coastal and Tidal	The site is not at risk from coastal or tidal flooding.
Surface Water	**Proportion of site at risk (RoFfSW):** **3.3% AEP** – 2% Max depth 0.15-0.3m, Max velocity <0.25m/s **1% AEP** – 4%

	Max depth 0.3-0.6m Max velocity >0.25m/s **0.1% AEP** – 15% Max depth 0.6-0.9m Max velocity >0.25m *The % SW extents quoted show the % of the site at surface water risk from that particular event, including the percentage of the site at flood risk at a higher risk zone (e.g. 1% AEP includes the 3.3% AEP %)* **Description of surface water flow paths:** Surface water flood risk on the site is limited to the northwest edge, along the alley between Canary Fields and Geoffrey Watling Way. During the 3.3% AEP event, surface water flooding is minimal, with maximum depths of 0.3m and flow rates below 0.25m/s. During the 1% AEP event, the extent is similar with slightly greater depths, whilst flows remain low. During the 0.1% AEP event, the extent increases significantly, extending across the entire northwest edge of the site at depths of 0.3-0.9m. Flow rates during the 0.1% AEP event are largely below 0.25m/s, however this may be exceeded in small patches along the alley. During such an event, floodwater across the north-western edge is categorized as 'Dangerous for most' due to significant depths and flows. The rest of the site is not at direct risk of surface water flooding during the 0.1% AEP event, however access and egress to the site are likely to be significantly impacted due to the flooding of Kerrison Road, Carrow Road and Geoffrey Watling Way.
Reservoir	The southern edge of the site is shown to be at risk of reservoir flooding from the available online maps. This is the edge of the site bordering the Wensum, encroaching around 5m into the site.
Groundwater	The Environment Agency Areas Susceptible to Groundwater Flooding dataset, provided as 1km grid squares, shows the susceptibility of an area to groundwater flood emergence. The following comments can be made about groundwater flood risk: • The entire site is shown to have a <75% susceptibility to groundwater flood emergence. This assessment does not negate the requirement that an appropriate assessment of the groundwater regime should be carried out at the site-specific FRA stage.
Flood history	The Environment Agency's historic flooding and recorded flood outlines dataset has a record of flooding on the site. The source of flooding was attributed to the River Wensum and flooding occurred in 1912. The site is not located in a postcode area which has previously experienced historic sewer flooding (as identified in the Level 1 SFRA).
Flood risk management infrastructure	
Defences	This site is not protected by any formal flood defences.
Residual risk	There is no residual risk to the site from flood risk management structures.
Emergency planning	
Flood warning	The site is located within the Environment Agency's 'Riverside properties on the River Wensum, through Norwich, including Bishopgate and Norwich City Football Ground' Flood Warning area. The site is also located within the Environment Agency's 'The River Wensum from New Costessey to Thorpe Bridge at Norwich' Flood Alert area.
Access and egress	There are currently 3 roads providing access to the site: Geoffrey Watling Road travelling west along the river, Kerrison Road running along the north edge of the site, and Carrow road running North from the site. All these access roads are from the western portion of the site and there are no access routes currently in place to the eastern side of the site. A further access to Hardy Road, which borders the east edge of the site, could be considered as part of any future development. Access and egress via these roads is not affected by either the 5% AEP or 1% AEP event. In the 0.1% AEP event, both fluvial and surface water flooding may impact access and egress to the site via Carrow Road, Geoffrey Watling Way, and Kerrison Road, with water depths reaching from 0.3-0.6m. Any future access and egress via Hardy Road would be similarly impacted by flood depths 0.3-0.6m. The maximum hazard present on all four roads is classified as dangerous for most.

	A Flood Warning and Evacuation Plan should be prepared for the site, with a policy of shelter in situ on a level above the maximum water level of 1.7m in a 1 in 0.1% AEP event considering the highest risk climate change scenario. In the future, the majority of the site will be in Flood Zone 2 under the Upper End (+65%) climate change scenario, underscoring the need for a shelter in situ policy.
Dry islands	The site is not located on a dry island.
Climate change	
Implications for the site	• An increase in fluvial flows in the River Wensum to determine the impact of climate change shows that the site is highly sensitive to climate change. • The western section of the site is in future Functional Flood Zone 3b which is the the 5% AEP event plus the Upper End (65%) climate change scenario. This results in flooding on the western and additionally the eastern section. Flood depths on the site during this scenario range from 0.3-0.8m and have a flood hazard rating of 'Dangerous for most'. This scenario presents a significant increase in risk to the site as during the present day 5% AEP flood event, the site is not at risk of flooding. • The majority of the site is in future Flood Zone 3a, which is the 1% AEP plus the Upper End (65%) scenario. The only areas outside limited to the centre of the site. Flood depths during the 1% AEP plus the Upper End (65%) scenario reach up to 1.2m and have a flood hazard rating of 'Dangerous for most' for part of the site. Even for the less severe scenarios, the 1% AEP plus the Central (25%) climate change scenario results in flooding across the site with depths up to 0.8m on the site. This scenario again presents a significant increase in risk to the site as during the present day 1% AEP flood event, the site is not at risk of flooding. • The entire site is in future Flood Zone 2. The 0.1% AEP plus the Upper End (65%) climate change scenario results in flooding across the site with depths of between 1.4m and 1.7m present on the most significant parts of the site. The highest depth areas are in the west of the site, whilst flood depths to the east are shallower, 0.5-1.0m. During this scenario, the flood hazard rating for most of the site is 'Dangerous for all'. **Proportions of the site in Future Flood Zones can be found in Table 6-2 of the Greater Norwich Level 2 SFRA Report**
Requirements for drainage control and impact mitigation	

Broad scale assessment of possible SuDS	**Geology & Soils**
	
	• Geology at the site consists of:
	  ○ Bedrock – Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation, Portsdown Chalk Formation (undifferentiated) – Chalk.
	  ○ Superficial – Alluvium (Clay, Silt, Sand and Gravel).
	
	SuDS
	
	• Most source control techniques are likely to be suitable. Mapping suggests that permeable paving may have to use non-infiltrating systems given the possible risk both to and from groundwater.
	
	• Mapping suggests that there is a high risk of groundwater flooding at this location, therefore it is likely infiltration techniques will not be suitable. This should be confirmed via site investigations to assess the potential for infiltration. As the site is located within a Source Protection Zone, if infiltration is possible and permitted, it should only be used where there are suitable levels of treatment. Additionally, proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints.
	
	• Detention may be feasible provided site slopes are <5% at the location of the detention feature. If the site has contamination or groundwater issues, a liner will be required.
	
	• Filtration is probably suitable provided site slopes are <5% and the depth to the water table is >1m. If the site has contamination or groundwater issues, a liner will be required.

	• All forms of conveyance are likely to be suitable. Where the slopes are >5% features should follow contours or utilise check dams to slow flows. If the site has contamination or groundwater issues, a liner will be required. • Developers should investigate and consider in full all Suds options and demonstrate that SuDS are not appropriate where they are not implemented. • The site is not designated by the Environment Agency as previously being a landfill site.
Opportunities for wider sustainability benefits and integrated flood risk management	• Due to the size of the site, there is likely to be limited space for green infrastructure. It is recommended that areas of hard paving are designed to ensure that flood water can be stored during a flood event alongside the use of green features such as rain gardens and tree pits. • A resilient approach to urban design should be taken. Habitable floor levels must be above the 1% AEP flood level taking into account climate change upper end scenario with an allowance for freeboard. For this site, this is approximately 1.5m above ground level. • A shelter in situ for an extreme fluvial event must be designed into the building and supported by a flood warning and evacuation plan. Suitable shelter for all occupants of any buildings must be above the 0.1% AEP flood level taking into account climate change (upper end scenario). For this site, this is approximately 2.0m above ground level.
NPPF and planning implications	
Exception Test requirements	The Local Authority will need to confirm that the sequential test has been carried out. The Sequential Test will need to be passed before the Exception Test is applied. The NPPF classifies residential development as 'More Vulnerable'. As the site is mostly covered by Flood Zones 1 & 2, the Exception Test is not required for the site. Significant portions of the site are however in Future Flood Zone 3 and it is recommended that a precautionary approach is taken, and the Exception Test is applied.
Requirements and guidance for site-specific Flood Risk Assessment	**Flood Risk Assessment:** • At the planning application stage, a site-specific Flood Risk Assessment will be required as part of the development is located in Flood Zone 2. • All sources of flooding, particularly the risk of fluvial and surface water should be considered as part of a site-specific flood risk assessment. • The site-specific FRA should be carried out in line with the National Planning Policy Framework; Flood Risk and Coastal Change Planning Practice Guidance, Norwich City Council's Local Plan policies, and the Norfolk County Council Lead Local Flood Authority's Statutory Consultee for Planning Guidance Document. • Consultation with the Local Authority, Lead Local Flood Authority and the Environment Agency should be undertaken at an early stage. • The development should be designed to ensure that mitigation measures are in place to ensure the development does not flood, or that ground level space is used for less vulnerable parts of the development. **Guidance for site design and making development safe:** • Flood resilient design is essential for this highly constrained urban site: o A resilient approach to urban design should be taken. Habitable floor levels must be above the 1% AEP flood level taking into account climate change (upper end scenario) with an allowance for freeboard- approximately 1.7m above ground level. o A shelter in situ for an extreme fluvial event must be designed into the building and supported by a flood warning and evacuation plan. Suitable shelter for all occupants of any buildings must be above the 0.1% AEP flood level taking into account climate change (upper end scenario)- approximately 2.0m above ground level. • The developer will need to show, through an FRA, that future users of the development will not be placed in danger from flood hazards throughout its lifetime. It is for the applicant to show that the development meets the objectives of the NPPF's policy on flood risk. For example, how the operation of any mitigation measures can be safeguarded and maintained effectively through the lifetime of the development. (Para 048 Flood Risk and Coastal Change PPG). • Safe access and egress will need to be demonstrated in the 1 in 0.1% AEP plus climate change fluvial and rainfall events, using the depth, velocity and hazard outputs. Ideally, the access route should be situated 300mm above the designed flood level and waterproofing techniques should be used where necessary. Raising of access routes must not impact on surface water flow routes or contribute to loss of floodplain storage. Consideration should be given to the siting of access points with respect to areas of surface water flood risk. Due to

	the significant fluvial risk posed to the site, a Flood Warning and Evacuation Plan must be prepared based on a policy of shelter in situ. • Due to the highly constrained nature of the site, resilience measures will be required if buildings are situated in the flood risk area. Due to the significant depths of flooding on the site and its proximity to the River Wensum, it is suggested that a water entry strategy is used for the site (i.e. measures to reduce flood damage once water gets inside rather than trying to keep the water out) • Compensatory flood storage is required for any land raising and all proposed buildings (unless they are left open and allowed to accept flows) whenever there is built development on land within the 1% +35% climate change flood extent. This will more challenging given the majority of the site is in Future Flood Zone 3. • The risk from surface water flow routes should be quantified as part of a site-specific FRA, including a drainage strategy, to ensure that runoff from the development is not increased by development across any ephemeral surface water flow routes. A drainage strategy should help inform site layout and design to ensure there is no increase in runoff beyond current rates. • Areas at risk from surface water flooding should ideally be integrated into green infrastructure, which presents wider opportunities to improve biodiversity and amenity as well as climate change adaptation. An integrated flood risk management and sustainable drainage scheme for the site is advised. It is essential that a detailed model of surface water flooding, using the existing drainage system, topographical and asset survey is constructed at the FRA stage. This will determine the risk from surface water flooding further and to ensure that overland flows do not overwhelm future sustainable drainage features. • Brownfield sites should discharge surface water at the original pre-development (greenfield) runoff rate. If this is not possible, a significant reduction in the current rate of discharge should be achieved and agreed with the relevant drainage body (LLFA). • Developers should refer to Norfolk County Council's 'Norfolk County Council Lead Local Flood Authority Statutory Consultee for Planning Guidance Document' and the Level 1 SFRA for information on SuDS for guidance on the information required by the LLFA from applicants to enable it to provide responses to planning applications.

Key messages

The development is likely to be able to proceed if:

- A carefully considered and integrated flood resilient and sustainable drainage design is put forward, with habitable floor levels above the fluvial design flood event (1% AEP) taking into account climate change and a facility for all occupants to shelter above the extreme fluvial flood event (0.1% AEP) taking into account climate change.
- If flood mitigation measures are implemented then they are tested to ensure that they will not displace water elsewhere (for example, if land is raised to permit development on one area, compensatory flood storage will be required in another).
- Space for surface water to be stored on the site is provided and rainwater harvesting should be considered.
- Brownfield sites should discharge surface water at the original pre-development (greenfield) runoff rate. If this is not possible, a significant reduction in the current rate of discharge should be achieved and agreed with the relevant drainage body (LLFA, IDB or Anglian Water).
- Safe access and egress routes must not be in the areas of high surface water risk or the 1% AEP fluvial design flood event (taking into account climate change).
- The only site access routes would be via Geoffrey Watling Way to the west and Kerrison Road and Carrow Road to the north. A Flood Warning and Evacuation Plan should be prepared for the site.

Mapping Information

The key datasets used to make planning recommendations regarding this site were the broadscale 2D modelling outputs from the Environment Agency's Flood Map for Planning, River Wensum Flood Model and the Risk of Flooding from Surface Water map. More details regarding data used for this assessment can be found below.

Flood Zones	Flood Zones 2 and 3 have been taken from the Environment Agency's Flood Map for Planning mapping.
Climate change	Climate change allowances (for the 2080s) were modelled as part of Level 2 SFRA. This included Central (+25%), Higher central (+35%) and Upper end (+65%).
Fluvial depth, velocity and hazard mapping	Fluvial depth and hazard mapping has been taken from the River Wensum model for present day, and for future flood zones this was modelling produced for the Level 2 SFRA. This should be explored further at site-specific stage.
Surface Water	The Risk of Flooding from Surface Water map has been used to define areas at risk from surface water flooding.

Surface water depth, velocity and hazard mapping	The surface water depth, and hazard mapping for the 1 in 0.1% AEP event is taken Environment Agency's Risk of Flooding from Surface Water mapping.