Greater Norwich Level 2 Strategic Flood Risk Assessment Detailed Site Summary Tables	
Site details	
Site Code	**CC30**
Address/Grid Ref.	Westwick Street Car Park/622613,309086
Area	0.3ha
Current land use	Car Park
Proposed land use	Residential
Sources of flood risk	
Location of site within catchment	The site is in the catchment of the River Wensum. The River Wensum rises between the villages of Colkirk and Whissonsett and flows through Fakenham and the Pensthorpe nature reserve, and on through Swanton Morley, Taverham and Norwich to its confluence with the River Yare.
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 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 –** 100% **FZ1 –** 0% *The % Flood Zones quoted show the % of the site at flood risk from that particular Flood Zone/event, including the percentage of the site at flood risk at a higher risk zone, e.g. FZ2 includes the FZ3 %. FZ1 is the remaining area outside FZ2 (FZ2 + FZ1 = 100%).* **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. Further modelling was undertaken to apply recent climate change uplifts to the fluvial model of the Wensum. **Flood characteristics:** Fluvial flooding associated with the River Wensum is wide in extent and is modelled to flood most of the site in an extreme event. The low-lying topography of the site means that flood water flows onto the site. The site is not at risk of flooding during the 5% and 1% AEP flood events. In the 0.1% AEP flood event, the entire site is at risk of flooding. Flood depths on the site are significant and are up to 1.2m in depth in the centre of the site, with shallower levels of between 0.6m-0.8m around the rest of the site. Flood velocities on the site have been modelled as less than 0.6m/s. The modelled flood hazard rating shows that most of the site has a 'dangerous for most people' flood hazard risk. A small area to the south of the site is has a lower flood hazard risk and is categorised as 'dangerous for some' and 'Caution'.

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** – 0% Max depth 0m, Max velocity 0m/s **1% AEP** – 0% Max depth 0m Max velocity 0m/s **0.1% AEP** – 71% 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:** The site is not at risk of surface water flooding during the 3.3% AEP or 1% AEP flood event. There is significant surface water ponding on the site during the 0.1% AEP flood event. Surface water flows onto the site from a flow path from Barn Road to Westwick Street (to the west of the site). Due to the flat and lower lying topography of the site (in comparison to the surrounding land) surface water from the flow path ponds on the site. Flood depths are greatest (0.6m-0.9m) in a small part of the centre of the site with lower depths (0.15m-0.6m) seen in the across the rest of the site.
Reservoir	The eastern part of the site is shown to be at risk of reservoir flooding from the available online maps. Flood depths in this area reach up to 0.3m with flow speeds of up to 0.5m/s.
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 entirety of the site has a >50%- <75% susceptibility to groundwater flood emergence from superficial deposits. 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 in a postcode area which has previously experienced two incidences of 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 in the Environment Agency's 'River Wensum, through Norwich' flood warning area. The site is in the 'The River Wensum from New Costessey to Thorpe Bridge at Norwich' flood alert area.
Access and egress	The site is only accessible from the southern boundary of the site, from Westwick Street. In terms of fluvial flood risk, the entire site is in the modelled 0.1% AEP flood extent and is modelled to experience flood depths of up to 1.2m during a flood event. Due the significant flood extent and depths on the site, access and egress from the site may not be possible during a flood event. The site entrance point on Westwick Street is also at risk of flooding during a flood event. 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 2.1mm above ground level in a 0.1% AEP event considering the highest risk climate change scenario (+65%). The Risk of Flooding from Surface Water dataset shows that most of the site and Westwick Street is affected by flooding during the 0.1% AEP flood event. Surface water flooding could therefore affect access and egress to the site. The depths, velocities, hazards, durations and speeds of onset of surface water and fluvial flooding along access/ egress routes should be investigated further in a site-specific assessment, to confirm whether access for emergency vehicles could still be obtained.
Dry islands	The site is not located on a dry island.
Climate change	
Implications for the site	• The site is sensitive to climate change causing increased in fluvial flows in the River Wensum. The site is not at risk during the 5-year event in the Upper end (+65%) scenario. The site is not currently at risk during the 1% AEP event, but is flooded up to depths of 1m during the 1% AEP Central (+35%) scenario and up to 1.3m in the 1% AEP Upper End (65%) scenarios. • The entire site is in future Flood Zone 3a. Flood depths during the 1% AEP plus the Upper End (65%) scenario range between 0.4m and 1.3m across the site with higher depths present in the centre of the site. Flood hazard ratings on the site are 'Dangerous for most' for nearly all the site and a small area around the northern boundary rated as 'Danger to some'. Even for the less severe scenarios, the 1% AEP plus the Central (35%) climate change scenario results in flooding across the site with depths of between 0.1m and 1m present on the site. During this scenario, the flood hazard rating of 'dangerous for most' for most of the site with areas of lower hazard ratings located to the south east and north of the site. This scenario 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 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 0.9m and 1.8m present on the site. The highest depth areas are in the centre of the site. During this scenario, the flood hazard rating of 'dangerous for all'. • The modelled 1% AEP with 40% Climate Change Surface water flooding shows a small area of ponding in the west of the site.
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).
	• Soils at the site consist of:
	  ○ Fen peat soils - peaty, naturally wet, mixed fertility very low to lime-rich.
	
	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.
	
	• Infiltration may be suitable. Mapping suggests a medium risk of groundwater flooding and underlying soils may be permeable. Further site investigation should be carried out to assess potential for drainage by infiltration. If infiltration is suitable it should be avoided in areas where the depth to the water table is <1m. As the site is located within a Source Protection Zone, infiltration techniques should only be used where there are suitable levels of treatment although it is possible that infiltration may not be permitted. 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 techniques are 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. • Given the highly constrained nature of the site, a carefully considered and integrated flood resilience and sustainable drainage design suitable for the urban setting should be considered. For example, the use of rainwater harvesting and floodable areas at the ground flood level (for example outdoor open storage areas/ rain gardens that are usually dry) should be integrated into the overall design of the development.
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 the climate change upper end scenario, with an allowance for freeboard- approximately 1.6m 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 considering climate change (upper end scenario)- approximately 1.8m 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' development. As the site is mostly covered by Flood Zone 2 and is not in Flood Zone 3, the Exception Test is not required for the site. The site is 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 the development is located within 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 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 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 considering climate change (upper end scenario) with an allowance for freeboard- approximately 1.6mAO 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 0.1% AEP plus 65% 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 the policy of shelter in situ. • Compensatory flood storage is required for any land raising and all proposed buildings (unless left open and able to accept flows) wherever there is built development on land within the 1% +35% climate change flood extent. This will be challenging given the entire site is within Future Flood Zone 3 • Due to the highly constrained nature of the site, resilience measures will be required. 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). • 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. Some rationalisation of the site is advised to concentrate the area at risk of surface water flooding into one part of the site that is not then built on e.g. by creating a dry basin that would only occasionally flood. 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 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 (approximately 4.6m AOD including freeboard) and a facility for all occupants to shelter above the extreme fluvial flood event (0.1% AEP) taking into account climate change (approximately 0.8m above ground level).
- 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.
- The site discharges 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 point would be from Westwick Street to the west. 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 was modelled as part of the Level 2 SFRA modelling for the 2080s. This

	included Central (+25%), Higher central (+35%) and Upper end (+65%). Level 1 SFRA surface water climate change scenario model results were used to assess the risk of surface water flooding in the future.
Fluvial depth, velocity and hazard mapping	Fluvial depth and hazard mapping has been taken from existing models for the River Wensum. Future depth and hazard are modelled outputs from the Level 2 SFRA.
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 from the Environment Agency's Risk of Flooding from Surface Water mapping.