Greater Norwich Level 2 Strategic Flood Risk Assessment Detailed Site Summary Tables	
Site details	
Site Code	**GNLP3053 (East Norwich Regeneration Area)**
Address/Grid Ref.	Bracondale/King Street, Carrow Works and Carrow House/ 624255,307419
Area	19.90ha
Current land use	Open land, commercial
Proposed land use	Residential led mixed use
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 River Wensum flows from west to east along the northern boundary of the site before its confluence with the River Yare. The river has been artificially modified through Norwich and the banks of the river have been enforced with steel and concrete, including the north edge of the site. The River Yare is located 320m east of the site. The river flows along the southern boundary of the city of Norwich, before flowing north-east to its confluence with the River Wensum.
Fluvial	**Proportion of site at risk:** **FZ3b –** 0% **FZ3a –** 1% **FZ2 –** 2% **FZ1 –** 97% *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 and the downstream extent of the River Yare (from Trowse Newton Weir to Kirby Marsh) 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. **Flood characteristics:** The site is not at risk of flooding from the River Wensum during the 5% AEP flood event. In the 1% AEP event, a very small area of flood water is present in the north east of the site. Flood depths are very shallow with a maximum depth of flooding of 0.4m and have a flood hazard rating of 'dangerous for some'. During the 0.1% AEP event, a small area in the north eastern part of the site is at risk of flooding. Depths are a maximum of 1m but remain mostly below 0.8m. The flood hazard risk ranges between 'caution' and 'dangerous for most'.
Coastal and Tidal	The site is not at risk from coastal or tidal flooding. Coastal breach modelling indicates that the site remains unaffected even in the most extreme climate change (present day +80%) scenario.

Surface Water	**Proportion of site at risk (RoFfSW):** **3.3% AEP** – 1% Max depth 0.6-0.9m, Max velocity <0.25m/s **1% AEP** – 5% Max depth 0.6-0.9m Max velocity <0.25m/s **0.1% AEP** – 12% 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:** Minor areas of surface water ponding are scattered around the site during all the surface water flooding modelled events, the most significant of which are in the north of the site. The surface water map shows water ponding around existing buildings that are likely to be blocking natural flow paths for surface water. In the 3.3% AEP event, small areas of surface water pooling are modelled along the edge of some of the existing buildings on the site. These areas are small in extent and flood depths are largely between 0.15 and 0.3m, with a very small areas reaching up to 0.9m in depth. The maximum flood hazard rating on the site is 'dangerous for some'. In the 1% AEP event, surface water flooding is marginally increased across the site, however flooding is still confined to the edge of the existing buildings on the site. During this event, flood depths are again largely below 0.3m, with isolated areas in the centre, west and on the site boundary reaching 0.3 to 0.9m in depth. The maximum flood hazard rating on the site is still 'dangerous for some'. In the 0.1% AEP event, all the areas of surface water ponding significantly increase. Additional areas of surface water ponding are also scattered around the site however these are small in extent. Flood depths in the larger areas of ponding range between 0.15m and 0.9m and have a maximum flood hazard rating of 'dangerous for most'. In the smaller areas of surface water flooding scattered around the site, flood depths are a maximum of 0.3m with a flood hazard rating of 'caution'.
Reservoir	The site is not shown to be at risk of reservoir flooding from the available online maps.
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 majority of the site has a >75% susceptibility to groundwater flood emergence from superficial deposits. • The western part of the site has a <25% 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 1 incidence 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	A small part of the north-eastern corner of the site is located within the Environment Agency's 'The River Wensum, through Norwich' flood warning area. The same area is also in the Environment Agency's 'The River Wensum from New Costessey to Thorpe Bridge at Norwich' flood alert area.

Access and egress	The site is only accessible from an access road connected to the A147. In terms of fluvial risk, the extent of flood water on the site is minimal and does not prevent access to the site. Access and egress should not be affected. In terms of surface water flood risk, surface water flooding impacts the site and some of the surrounding road network in the 30, 100 and 0.1% AEP modelled events. Acess and egress from the site is unlikely to be affected during the 0.1% AEP event. There is very minor surface water pooling modelled in isolated areas around the site and this will not restrict access. Access and egress remains unaffected even in the most extreme H++ (+80%) climate change scenario.
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. • A small area of the site is in future Functional Flood Zone 3b. The 5% AEP plus the Upper End (65%) climate change scenario results in flooding of a small area in the north-eastern part of the site. Flood depths in this area reach up to 1m. This area has a flood hazard rating of 'caution' and 'dangerous for most'. • A small part of the site is in future Flood Zone 3a, which is the 1% AEP plus the Upper End (65%) climate change scenario. This scenario results in a small area of flooding in the north-eastern corner of the site. Flood depths in this area range from 0.1m-1.3m. This area has a flood hazard rating of 'caution' and 'dangerous for most'. • A small part of the site is in future Flood Zone 2 which is the 0.1% AEP plus the Upper End (65%) climate change scenario. This scenario results in a small area of flooding along the northern boundary of the site. Flood depths in this area range from 0.1m-1.8m. This area has a maximum flood hazard rating of 'dangerous for most'. • The 0.1% AEP plus 80% climate change scenario (H++) poses the most significant risk to the site, however the extent of flooding is only marginally bigger than the other climate change scenarios. Flood depths from this scenario range between 0.1m-1.8m for the at risk area. During this scenario, the flood hazard rating for the site is 'Dangerous for most'. • The modelled 1% AEP with 40% Climate Change Surface water flooding shows a minor increase in surface water flooding on the site. **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 – River Terrace Deposits (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 from groundwater. Mapping also suggests that slopes may be unsuitable for selective source control techniques.
	
	• 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 is unlikely to be feasible as mapping suggests mean site slopes are >5%. Feasibility of such options should be assessed as part of a site-specific assessment. If this feature is feasible a liner may be required to prevent the egress of groundwater.

	• Filtration techniques are unlikely to be feasible as mapping suggests mean site slopes are >5%. Feasibility of such options should be assessed as part of a site-specific assessment. If this feature is feasible it should be located where the depth to the water table is >1m, additionally a liner may be required to prevent the egress of groundwater. • 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. A liner may be required to prevent the egress of groundwater. • 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	• Space on the site should be made for green infrastructure, which presents wider opportunities to improve biodiversity and amenity as well as climate change adaptation. 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. Natural surface water flow paths should be restored if existing buildings are demolished. • **To enable development in the East Norwich Regeneration Area, a carefully considered flood risk and sustainable drainage strategy covering sites GNLP0360, GNLP3053 and R10 must support early master planning and feasibility work. This will involve sacrificing some areas as functional floodplain and increasing flood storage to allow other areas of sites to be defended against fluvial flooding. There should be no overall loss of floodplain storage and the risk of flooding should not be increased up or downstream of the sites. The most suitable site in flood risk terms is GNLP3053 (this site).**
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. Residential development is classified as 'More Vulnerable' and commercial is classed as 'Less Vulnerable'. A small part of the site is in Flood Zone 3, and the Exception test will be required should development be proposed in this area. Owing to the close proximity to existing Flood Zones it is recommended that a precautionary approach is taken and any developer should undertake a site-specific flood risk assessment for the entire site.
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 for any development proposed within Flood Zone 3. It is recommended that site-specific Flood Risk Assessment is undertaken for the entire site, owing to the close proximity to existing Flood Zones. This should be informed by an overall strategy for flood risk and sustainable drainage for the East Norwich Regeneration Area. • 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:** • 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. Alternatively, risk could be managed by inclusion of a higher refuge and a flood response plan that meets the requirements of the Local Council and their Emergency Planner.

	• Where possible, development should be located outside of a flood risk area. Across the East Norwich Regeneration Area, the most vulnerable development should be located on site GNLP3053 (this site). • Compensatory flood storage is required for any land raising and all proposed buildings whenever there is built development on land within the 1% +35% climate change flood extent. • Natural surface water flow paths should be restored if existing buildings are demolished. 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). Development on greenfield land should discharge at rates no greater than the existing greenfield rates for the 100% and the 1% rainfall events. • 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

To enable development in the East Norwich Regeneration Area, a carefully considered flood risk and sustainable drainage strategy covering sites GNLP0360, GNLP3053 and R10 must support early master planning and feasibility work. This will involve sacrificing some areas as functional floodplain and increasing flood storage to allow other areas of sites to be defended against fluvial flooding. There should be no overall loss of floodplain storage and the risk of flooding should not be increased up or downstream of the sites. The most suitable site in flood risk terms is GNLP3053.

The development is likely to be able to proceed if:

- Development is located outside of the area of fluvial risk.
- An integrated flood risk management and sustainable drainage solution is implemented.
- A site-specific flood risk assessment should be produced for the site.
- New developments should adopt exemplar source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff. Assessment for runoff should include allowance for climate change effects.
- 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).

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 Level 2 SFRA modelling of the Rivers Wensum and Yare 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 the existing model for the River Wensum and, and from the 2D outputs of the River Yare model produced for 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.