Anglia Square, Norwich
Flood Risk Assessment

Dated March 2022

Weston Homes

REPORT

Anglia Square Regeneration, Norwich, Norfolk

Flood Risk Assessment

Client: Weston Homes

Reference: 6645-RHD-ZZ-XX-RP-Z-0001

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1 Introduction

1.1 This Flood Risk Assessment (FRA) has been prepared by Royal HaskoningDHV on behalf of Weston Homes Plc (the Applicant) in support of a hybrid (part full/part outline) planning application, (the Application), submitted to Norwich City Council (NCC) for the comprehensive redevelopment of Anglia Square and various parcels of mostly open surrounding land, (the Site), as shown within a red line on drawing ‘ZZ-00-DR-A-01-0200’.

1.2 The Site is located in a highly accessible position within the northern part of Norwich City Centre and comprises a significant element of the Anglia Square/Magdalen Street/St Augustines Large District Centre, (the LDC). It is thus of strategic importance to the City, and accordingly has been identified for redevelopment for many years within various local planning policy documents, including the Northern City Centre Area Action Plan 2010, (NCCAAP), (now expired), the Joint Core Strategy for Broadland, Norwich and South Norfolk 2014, (JCS), and NCC’s Anglia Square and Surrounding Area Policy Guidance Note 2017, (PGN). The Site forms the principal part of an allocation (GNLP 0506) in the emerging Greater Norwich Local Plan (GNLP).

1.3 This application follows a previous application on a somewhat smaller development parcel, (NCC Ref. 18/00330/F) made jointly by Weston Homes Plc as development partner and Columbia Threadneedle Investments, (CTI), the Site’s owner, for a residential-led mixed use scheme consisting of up to 1,250 dwellings with decked parking, and 11,000 sqm GEA flexible ground floor retail/commercial/non-residential institution floorspace, hotel, cinema, multi-storey public car park, place of worship, and associated public realm and highway works. This was subject to a Call-in by the Secretary of State (PINS Ref. APP/G2625/V/19/3225505) who refused planning permission on 12th November 2020, (the ‘Call in Scheme’).

1.4 In April 2021, following new negotiations with Site owner CTI, Weston Homes decided to explore the potential for securing planning permission for an alternative scheme via an extensive programme of public and stakeholder engagement, from the earliest concepts to a fully worked up application. The negotiations with CTI have secured a “Subject to Planning” contract to purchase the Site, (enlarged to include the southeastern part of Anglia Square fronting Magdalen Street and St Crispins Road), which has enabled a completely fresh approach to establishing a redevelopment scheme for Anglia Square. This has resulted in a different development brief for the scheme, being to create a replacement part of the larger LDC suited to the flexible needs of a wide range of retail, service, business and community uses, reflective of trends in town centre character, integrated with the introduction of homes across the Site, within a highly permeable layout, well connected to its surroundings.

1.5 The new development proposal seeks to comprehensively redevelop the Site to provide up to 1,100 dwellings and up to 8,000sqm (NIA) flexible retail, commercial and other non-residential floorspace including Community Hub, up to 450 car parking spaces (at least 95% spaces for class C3 use, and up to 5% for class E/F1/F2/Sui Generis uses), car club spaces and associated works to the highway and public realm areas (the Proposed Development). These figures are maxima in view of the hybrid nature of the application. This proposes part of the scheme designed in full, to accommodate 367 dwellings, 5,808 sqm non-residential floorspace, and 146 car parking spaces (at least 95% spaces for residential use, and up to 5% for non-residential use), with the remaining large part of the Site for later detailed design as a “Reserved Matters” application, up to those maxima figures.

1.6 This FRA documents the flood risks, hydraulic modelling study and impact assessment relating to the proposals. Mitigation measures have also been addressed in this section. The accompanying hydraulic modelling report (6645_RHDHV_Anglia_Square_Model_Report_v1) details the technical aspects of the modelling study. The proposed drainage strategy and SuDS methods which could be implemented at the site are included in the drainage report, prepared by EAS.

1.7 The site is located entirely within Flood Zone 1 on the Environment Agency (EA) Flood Zone maps, so is at a low risk of fluvial flooding (less than 1 in 1000 probability of flooding each year). As the development site is greater than 1 hectare in size, the National Planning Policy Framework (NPPF) requires a site-specific flood risk assessment to consider the other sources of flooding and drainage options for the site, to demonstrate that any additional surface water runoff from the proposed development can be managed sustainably without increasing flood risk to others.

1.8 The Norwich Surface Water Management Plan (SWMP) (Nov 2011) shows the site is located in a Critical Drainage Area (CDA), identified as CDC2: Catton Grove and Sewell. This CDA primarily occupies the historic valley of one of the lost streams of Norwich known as the Dalymond Ditch. This has resulted in surface water from the upper catchments channelling water through the local area towards the River Wensum. In addition, there is a history of sewer flooding within the CDC2 catchment. The site is located at the southern end of the CDA and mapping from the SWMP shows there to be existing surface water flow paths through the site. Given the sensitive location of the site, it was necessary to obtain, update and re-run the existing CDC2 hydraulic model to identify the vulnerable areas and recommend suitable mitigation measures.

1.9 This report is based on EA Flood Maps, the results of the amended surface water flood model covering the site, the Joint Core Strategy for Broadland, Norwich and South Norfolk, Strategic Flood Risk Assessment (SFRA), the Norwich Urban Area Flood Investigations report, BGS geological information, OS mapping, and topographic survey data.

1.10 The contents of each section of this document are as follows:

Section 2 sets out the national, regional and local flood risk policies.
Section 3 describes the site conditions.
Section 4 analyses the surface water flood risk.
Section 5 discusses the offsite impacts.
Section 6 considers other potential flood sources.
Section 7 details suitable mitigation measures.
Section 8 contains the conclusions of the study.

2 Policy Framework

National Policy

2.1 The contents of this FRA are based on the advice set out in the National Planning Policy Framework (NPPF) and the Planning Practice Guidance (PPG), published in July 2021.

2.2 Paragraph 167 footnote 55 of the NPPF states:

"A site-specific flood risk assessment should be provided for all developments in Flood Zones 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving: sites of 1 hectare or more; land which has been identified by the Environment Agency as having critical drainage problems; land identified in a strategic flood risk assessment as being at increased flood risk in future; or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use".

2.3 The flood risk zones are defined as follows:

- Flood Zone 1 – This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river flooding (<0.1%).
- Flood Zone 2 – This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding.
- Flood Zone 3a – This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), and for tidal flooding at least a 0.5% annual probability of flooding from tidal sources.
- Flood Zone 3b – This zone comprises land where water has to flow or be stored in times of flood.

2.4 A copy of the Environment Agency's Flood Map is included in **Appendix B**. The mapping shows that the site is located entirely within Flood Zone 1 and therefore deemed to be at low risk of fluvial or tidal flooding.

2.5 The above national policy guidance has been taken into account within this site-specific FRA, which should be read alongside the proposed SuDS drainage strategy which offers a reduction in the level of flood risk within the local area.

Local Policy

Greater Norwich Local Plan (GNLP)

2.6 There is an emerging development plan, the Greater Norwich Local Plan (GNLP) which is being prepared by Broadland DC, South Norfolk Council, NCC and Norfolk County Council, (the Partnership), that will supersede the Joint Core Strategy for Broadland, Norwich and South Norfolk (2014) (JCS) and Norwich Site Allocations and Site Specific Policies Local Plan (2014) (NSASSP) once adopted. The GNLP Reg 19 version was submitted to the Secretary of State for examination on 30th July 2021.

2.7 The examination process is underway, for which hearing sessions took place during February and March 2022. As a result of the hearings, many policies, including the emerging allocation for the Site were subject to debate, addressing their soundness and the consequential need for amendment, alongside requests for additional information by the Inspectors. It is therefore considered likely the Council will prepare and consult upon Modifications or at least minor changes to both policy text and supporting text, relevant to this application. This process, and the publication of the Inspectors' report may extend beyond the determination of this application, and so final GNLP policy wording may not be available at that stage.

2.8 Paragraph 48 of the National Planning Policy Framework 2021 (NPPF) requires decision makers to give weight to relevant policies of emerging Local Plans according to the stage of preparation, the extent of unresolved objections, and the degree of consistency between emerging policies and the NPPF. In this instance, there are currently unresolved objections, in respect of some of which the Inspectors have requested additional information, and accordingly there are likely to be Modifications to some policies relevant to this application before they can be considered sound. On this basis, it is considered that in respect of those policies, the emerging development plan currently holds limited weight in decision making. In this context, those policies are not considered in detail.

2.9 It is noted that Anglia Square has been identified as a new allocation under Policy GNLP0506 of the GNLP. This states:

"The capacity of Anglia Square to deliver a significant element of the plan's housing need on a highly accessible brownfield site means that is has strategic significance for Greater Norwich. The Employment, Town Centre and Retail Study (GVA, 2017) acknowledges the considerable potential of Anglia Square to accommodate a much-enhanced retail and leisure offer including extensive public realm improvements.

Development of the site must address a number of constraints including…critical drainage catchment area."

2.10 The Sequential Test should be applied to new development sites at high risk of flooding, to direct development to areas with the lowest flood risk. However, given that the site has been allocated for a mixed-use development in the GNLP, it is considered to have already passed the Sequential Test.

Local Plan for Norwich

2.11 The Adopted Local Plan for Norwich (2014) is made up of the Joint Core Strategy (JCS) for Norwich City Council, Broadland District Council and South Norfolk District Council; the Site Allocations and Site-Specific Policies Local Plan (2014) and Development Management Policies Local Plan (2014).

2.12 Norwich City Council are working with Broadland District Council, South Norfolk District Council and Norfolk County Council to prepare the Greater Norwich Local Plan (GNLP) which will plan for development until 2036. However, this has not yet been adopted so the 2014 Local Plan is still current.

Joint Core Strategy for Broadland, Norwich and South Norfolk

2.13 The Joint Core Strategy (JCS) was adopted by Norwich City Council in March 2011, along with Broadland District Council and South Norfolk District Council. The JCS amendments were adopted in 2014. The JCS is the strategic development plan document in the Local Development Framework (LDF) and sets out principles for future development within the boroughs until 2026.

2.14 Objective 1 of the JCS is to minimise contributors to climate change and address its impacts throughout the area. With regards to flooding, this means that new developments will be generally guided away from areas with a high probability of flooding. In areas where new development is required for reasons of sustainability, flood mitigation and flood protection will be maintained and enhanced.

2.15 Policy 1: *Addressing climate change and protecting environmental assets* sets out how this objective will be achieved, highlighting that development should be located to minimise flood risk, mitigating any such risk through design and implementing sustainable drainage.

2.16 Policy 11: Norwich City Centre states:

"*Areas of the city centre will be comprehensively regenerated:….the Northern City Centre will be developed in accordance with its Area Action Plan to achieve physical and social regeneration, facilitate public transport corridor enhancements, and utilise significant redevelopment opportunities."*

2.17 This policy identifies the requirement for regeneration in the Northern City Centre, where the site is located.

2.18 The JCS discusses key areas for new development in Policy 14, and notes at paragraph 6.57 that "*New development will have to take particular account of surface water flooding issues*".

Development Management Policies Local Plan

2.19 The Development Management Policies Plan (DM policies) sets out policies which will apply across the whole city, as well as policies which apply in designated areas. The purpose of this document is to help guide and manage change and development in Norwich until 2026.

2.20 Policy DM5: Planning effectively for flood resilience details the policy for flooding, sustainable drainage and surface water flooding and surface treatment. The policy states:

"Developers will be required to show that the proposed development:

- *would not increase the vulnerability of the site, or the wider catchment, to flooding from surface water run-off from existing or predicted water flows; and*
- *would, wherever practicable, have a positive impact on the risk of surface water flooding in the wider area.*

Development must, as appropriate, incorporate mitigation measures to reduce surface water runoff, manage surface water flood risk to the development itself and to others, maximise the use *of permeable materials to increase infiltration capacity, incorporate on-site water storage and make use of green roofs and walls wherever reasonably practicable.*

The use of permeable materials, on-site rainwater storage, green roofs and walls will be required unless the developer can provide justification to demonstrate that this would not be practicable or feasible within the constraints or configuration of the site, or would compromise wider regeneration objectives."

2.21 The landscaping of the development in terms of surface water management is also considered in Policy DM5. This states:

"*Development proposals will be required to maximise the use of soft landscaping and permeable surfacing materials unless the developer can provide justification to demonstrate that this is not feasible.*

Where permission is required, proposals involving the provision of new or replacement paved and other impermeable surfaced areas will only be permitted:

- *in areas of impermeable soils as identified in Appendix 1;*
- *in other areas where it can be demonstrated that permeable surfaces are not practicable due to poor soil infiltration capacity, high groundwater levels or risk of subsidence; and*
- *in areas with soils with average or good infiltration capacity, where it can be demonstrated that there is an exceptional and overriding justification for such surfaces.*

In cases where poor soil infiltration capacity or other factors preclude the use of permeable surfacing materials, development proposals should seek to manage and minimise the impact of surface water run-off by suitable measures for water storage on-site."

2.22 The proposed drainage strategy will incorporate sustainable drainage (SuDS) and is detailed in the drainage report prepared by EAS. Surface water runoff from the site will be restricted as far as possible to ensure that the risk of flooding both to the site and elsewhere is minimised, taking into account the effects of climate change.

Investigation Report into the flooding within the Norwich Urban Area during the summer of 2014 (Report Ref. 622) (January 2015)

2.23 Norfolk County Council prepared the investigation report into flooding within the Norwich Urban Area in 2015, following significant flooding within Norwich as a result of rainfall on the 27th May and 20th July 2014 where 80 properties flooded internally. The report was prepared in consultation with Norwich City Council, Broadland District Council, Anglian Water and the Fire and Rescue Service.

2.24 The key findings of the flood investigation report are as follows:

a) Maintenance is not co-ordinated between Anglian Water and the relevant Highways Authority where connected drainage systems are in multiple ownership. This contributes to flooding.
b) Access constraints within the Norwich City area limit the maintenance on drainage systems and it is difficult to determine where drainage cannot be maintained by contractors.

c) There is a lack of regular maintenance in the Norwich Urban Area, partly due to insufficient resources being allocated to regularly maintain drainage systems.
d) Highway drainage systems are not fully mapped or digitised, so it is difficult to schedule maintenance.
e) Impacts of increased impermeable surfaces at private properties (e.g. driveways) and unmaintained or insufficient property level drainage.
f) Significant flooding experienced where properties are located along natural flowpaths or low points, e.g. close to historic watercourses and historic drainage features such as ponds.
g) Localised areas experience extreme rainfall which cannot be reasonably accommodated by the design standard of the drainage system.
h) Planning decisions on some new developments (post 2012) did not fully consider the flood risk to the development or the constraints in the local drainage systems.

2.25 Of the above key findings, point (f) is particularly relevant to the site as it is located in the valley of the historic Dalymond Dyke. Points (b) and (c) will be considered in the drainage report, to ensure that the proposed drainage system serving the development will be located in areas which are easily accessible for maintenance and a regular maintenance schedule is in place. Point (g) has also been considered with respect to the development, to ensure both the flood risk and drainage aspects have been assessed against the extreme 1 in 100 year (+40%CC) rainfall event.

2.26 The key recommendations following the Flood Investigations study fell into four categories: Maintenance of drainage systems, funding, improved understanding of drainage capacity and surface water flows, and planning. Specific recommendations were as follows:

Maintenance

a) There is a requirement for better co-ordination between the City Council, County Council and Anglian Water in relation to routine maintenance/works on the drainage systems.
b) Norwich City Council Highways, Anglian Water and Norfolk County Council should prioritise the maintenance of drainage systems where there are known flooding issues.
c) More detailed record keeping of maintenance activities by Norwich City Council on drainage systems is required.

Funding

a) Risk management authorities could work together to apply for funding to mitigate flood risk associated with their areas of responsibility, including large or small scale SuDS, provision of alternative points of discharge and property level protection.
b) Additional funding may be required to provide an increase in the level of maintenance of the drainage systems in priority areas.

Improved understanding of drainage capacity and surface water flows

a) Increase the number of rainfall gauges across Norwich to ensure all areas of high risk have access to rainfall event data.
b) Share information between risk management authorities to ensure the responsibilities and capacity of surface water, foul and combined systems are identified.
c) Utilise evidence from Anglian Water Sustainable Drainage System pilot project to identify the preferred locations for the infiltration of excess surface water.
d) Utilise updated surface water and catchment mapping across organisations to inform plans and projects.

Planning

a) Local Planning Authorities should work closely with the Lead Local Flood Authority and the Environment Agency to fully consider and incorporate lessons learnt from flood investigations in relation to the proposed development.
b) Local Planning Authorities should note that there is an automatic right to connect to the public sewer. As such, Anglian Water's ability to reduce flood risk within current systems is limited if new development is approved in a manner which does not provide appropriate mitigation. Local Planning Authorities should include Anglian Water as a consultee for significant developments.

2.27 Of the above key recommendations, the maintenance aspects of the proposed development have been discussed in the drainage report prepared by EAS. All parts of the development drainage systems will remain private and it will be the responsibility of the site manager or owner to ensure these are regularly inspected and remain effective.

2.28 The discussions in this FRA have attempted to quantify the surface water risk at the site and the surrounding area, to enable appropriate mitigation measures to be implemented as part of the development. It is noted that the modelling carried out in the preparation of this report has assumed there is minimal drainage, therefore the development has been assessed against a 'worst case' scenario. Surface water flood risk information and modelling was shared by Norfolk County Council for the preparation of this FRA.

2.29 An Addendum to the Investigation Report into the flooding within the Norwich Urban Area during the summer of 2014 (Ref. FIR008/A) was prepared in 2019. This addendum included additional properties that flooded in summer 2014 but were only subsequently identified as being flooded internally. Properties included in the 2014 report which then experienced repeat flooding in 2015 and 2016 were also included in the addendum. The site and surrounding area were not highlighted as experiencing flooding in the addendum report. A number of specific mitigation measures were recommended in the original 2014 report; an update to the work carried out in response to the recommendations has been included in the addendum. Notably, none of the work carried out in the Dalimond Catchment is in close proximity to the site.

2.30 The key findings and recommendations of the Flood Investigation report were considered and addressed where possible during the preparation of this FRA.

Norwich Urban Area Surface Water Management Plan (2011)

2.31 A Surface Water Management Plan (SWMP) for the Norwich Urban Area was completed in 2011 to help understand the causes of surface water flooding and agree a preferred strategy for the management of surface water flood risk (flooding from land; roads; buildings; small watercourses and ditches as a result of heavy rainfall).

2.32 An outcome of the plan was detailed modelling of extreme rainfall events and surveying to identify areas that are more susceptible to surface water flooding.

2.33 North of the boundary of the site (north of Edward Street) has been identified as part of the Catton Grove and Sewell Critical Drainage Area (CDA) which follows the natural channel of the Dalymond Dyke, one of the "lost rivers" of Norwich.

Local Flood Mitigation Options Assessment (2014)

2.34 This document was produced for Norfolk County Council by Capita URS in 2014 and includes depth and hazard mapping for the Critical Drainage Catchments. This extends the modelling scope to the wider catchment for the Critical Drainage Areas identified in the SWMP.

2.35 As a result of this, surface water modelling was included for the Anglia Square site. This is discussed further in Section 4.

Greater Norwich Area Level 1 Strategic Flood Risk Assessment (2017)

2.36 Norwich City Council, Broadland District Council, South Norfolk District Council and parts of the Broads Authority administrative areas commissioned a joint Strategic Flood Risk Assessment (SFRA) in 2008 to help inform preparation of the Local Development Framework and assess the flood risk in the area. This report has been updated to inform the selection of options for the Local Plan site allocations and support determination of planning applications.

2.37 Surface water and fluvial flooding are highlighted as being the predominant flood risk sources to the study area.

2.38 Critical drainage issues are identified at Catton Grove and Sewell, with 240 properties at risk within the catchment.

2.39 The report highlights the importance of using Sustainable Urban Drainage Systems to minimise the effect that new development will have upon the existing sewer network. However, it is noted that use of infiltration in the past has resulted in collapse of cavities in the underlying chalk strata within Norwich City, which could preclude the use of infiltration SuDS in some areas.

2.40 A total of 264 sewer flooding incidents have been identified in the Greater Norwich area, taken from Anglian Water's DG5 register. There are no records of flooding from reservoirs impacting properties within the study area.

2.41 The flood risk mapping in Appendix A (Index Grid: GN_34) covers the site. The surface water map shows the overland flow path from the north of the catchment flowing towards and through the site. Parts of the Anglia Square site are shown to be within all return periods with respect to surface water flooding. One of the main areas on the site to experience surface water flooding appears to be along the southern boundary, where the overland flow is blocked by the flyover.

2.42 The western half of the site is identified as having between 50% and 75% of the area being susceptible to groundwater flooding. The eastern side of the site is shown to have between a 25% and 50% risk of being susceptible to groundwater flooding.

Greater Norwich Level 2 Strategic Flood Risk Assessment (2021)

2.43 This document builds upon the conclusions of the Level 1 SFRAs and assesses 26 of the proposed development sites in the study area. The site is not included in this document, although the Level 2 SFRA notes that much of the catchment is located within designated Critical Drainage Areas. As such, future development proposals should identify opportunities to reduce runoff rates through implementation of SuDS features, noting rainwater harvesting and reuse be included where possible.

Norfolk County Council Pre-Application Comments

2.44 The initial flood model was submitted to the Lead Local Flood Authority (LLFA) Norfolk County Council for a pre-application review. The pre-application comments are included at **Appendix C** and summarised below:

- External inflows from adjacent catchments to be scaled up to 1 in 100 year plus 40% climate change rather than 20% climate change;
- 1 hour storm duration to be considered;
- Both summer and winter storm profiles to be considered to determine critical storm;
- Concerns over infiltration parameter using 7mm/hour to represent discharge to sewers and infiltration to ground. Requested including of Anglian Water sewer network within model;
- Ground truthing checks to be carried out;
- Flyover on the southern site boundary to be better represented in 2D domain, using variable levels;
- Culvert representing subway in original model to be removed since it was infilled in 2018;
- Threshold survey carried out along Magdalen Street to better understand risk to the properties;
- Model calibration based on the 2014 storm events;
- Further sensitivity testing to be carried out;
- Model stability checks to be carried out;
- Below ground car park in Block A to be set at or above ground level. Threshold level at car park entrance to be at least 300mm higher than 1 in 100 year plus climate change flood level;

2.45 Most of the points above have been addressed within the modelling report (6645_RHDHV_Anglia_Square_Model_Report_v1). However, some of the points were not considered to be feasible within the scope of this study. These are:

1) Including the Anglian Water sewer network within the model. This request is not reasonable given the scope of the study, which is to support the redevelopment of a site within the catchment, and not to undertake a strategic surface water catchment study, which would be the responsibility of the LLFA. The original SWMP CDC2 model used a constant rate of 7mm/hour to represent drainage to the public sewer and this was accepted by NCC. Details of Anglian Water sewers covering the whole catchment were not available at the time of producing the model and in any case, would have little impact on the study area as is assumed that most public sewers would be close to capacity in an extreme storm event. The infiltration/drainage rate of 7mm/hour is very low, so presents a worst-case scenario. Following a further pre-application meeting with the LLFA, it was considered more representative of the catchment to use the 'Net Rainfall' hyetographs, which accounted for losses, for example due to seasonal variation and area reduction. Notably, there were no losses to sewers within the hyetographs, thereby providing a worst-case scenario in terms of rainfall.

2) Locating the below ground car park at or above ground level. The LLFA requested justification of the basement car park location, given its vulnerable location in the surface water flood risk area. The Applicant has provided the information below:

2.46 It is acknowledged that the inclusion of a basement within Block A raises concern for the LLFA in respect of flood risk due to existing off-site surface water flows. However, the inclusion of a basement within Block A is essential for the design and layout to achieve a balance amongst the numerous other site constraints such as maintaining the functioning of a successful shopping centre during construction and operational phases, viability, impact on heritage and townscape, and quality of accommodation.

2.47 NCC have highlighted that one of the fundamental considerations for the Proposed Development is to ensure the function of Anglia Square with the Large District Centre is maintained and enhanced, requiring the public square and existing businesses fronting onto it to remain accessible and operational during the construction phase so viability and vitality of the LDC as a whole is not compromised. This has had a strong influence on the layout and phasing; four blocks have been positioned around the existing public square taking account of existing buildings and routes to the square, and have a mixture of small and large format sized commercial units at ground floor. The public square and streets to access it are pedestrianised. The demolition and construction has been phased to ensure as many as businesses as possible can remain operational with access to the square.

2.48 The phasing has also taken account of works HIFF funding covers (which underpins the viability of the Proposed Development) and deadline to complete those works to receive the HIFF funding. Phase 1 includes Block A, C, D and M on the north site of the square. Phase 2 includes Block K/L and J3 on the east side of the square. Phase 3 and 4 involve the remainder of the Blocks on the south and west side of the square. Phase 1 includes the area to the north side of the square because it includes the redundant multi-storey car park which includes a substantial amount of demolition which the HIFF funding covers and results in the least disruption to the square and businesses as main routes into the square and service yard can remain open.

2.49 Phase 1 includes delivery of 253 dwellings, 1,830 sqm commercial floorspace for existing businesses in the next phase to relocate to, a 653sqm service yard, and a 725.5 sqm community facility. Therefore delivery of 135 car parking spaces to support those uses within the first phase is essential.

2.50 Providing undercroft car parking at ground level is not an option because it would not be possible to deliver sufficient number of car parking spaces whilst also delivering the ground floor commercial floorspace and service yard required, alongside the plant rooms, refuse and cycle stores associated with residential and commercial units.

2.51 Providing car parking at first floor and above is also unfeasible, as the scale and mass of the scheme is underpinned by the careful balance of achieving approximately 1,100 dwellings within the site to ensure the development is viable whilst not adversely impacting the setting of heritage assets and wider townscape, and ensuring the number of dual aspect dwellings is maximised and amenity space and dwellings receive adequate daylight and sunlight. At the early design stages car parking was included at first floor and above within Block A, however feedback from NCC, Historic England and the Design Review Panel required reduction in height and massing of the blocks to address harm against heritage and townscape, reduce overshadowing of amenity spaces and dwellings, and improve proportion of dual aspect dwellings. The only way to achieve the balance, was to reduce the amount of car parking within the scheme to the lowest amount possible (whilst ensuring dwellings remain saleable for scheme viability) and to place majority of the spaces at basement level.

2.52 The only block within Phase 1 large enough to support a basement car park is Block A. That block also sits within the footprint of the multistorey car park and its ramp which have a substantial foundation slab, the demolition of which will already result in the formation of a hole approximately 1m deep meaning substantially less excavation and removal of waste needed to construct a basement. The demolition of the other buildings and structures do not result in the formation of a hole reducing excavation to that scale. Therefore, there is substantially less construction cost for a basement within Block A and less excavation on other parts of the site at risk of disturbing potential below ground archaeology. The placement of the basement within Block A is essential to ensure the Proposed Development remains viable to deliver with an element of affordable housing provision and minimise potential disturbance to archaeological remains.

2.53 Given that, as set out above, the inclusion of a basement car park within Block A is essential to enable the design and layout to achieve the balance of maintaining the functioning of a successful shopping centre during construction and operational phases, viability, impact on heritage and townscape, and adequate quality of accommodation, and the flood risk assessment / drainage strategy demonstrates the flood risk posed to the basement from surface water can be adequately mitigated and ensure development is safe. It is contended that the inclusion of the basement parking within Block A is acceptable and retained within the scheme.

2.54 As the basement car park cannot be relocated, a flood warning system and inclusion of a self-raising flood barrier at the car park entrance have been discussed within the Flood Risk Assessment. Further discussion on the location of the basement car park is included in Section 7.

3 Site Description

3.1 The site is located at Anglia Square, Norwich and consists of a shopping precinct including stores such as Iceland and Boots and former cinema that is now vacant and unused. Disused large office blocks are also present at the site. These include the seven-storey Sovereign House which runs north-south along Boltoph Street and previously housed Her Majesty's Stationary Office (HMSO) and the six-storey Gildengate House, built over shops underneath, which is partially occupied by artists on a temporary basis.

3.2 The northern part of the site comprises a redundant multi-storey car park, which was closed in 2012, with two further surface level car parks occupying the vacant western part of the site.

3.3 The main site is bounded to the south by the A147 Ring Road, known as St Crispins Road; Pitt Street and New Boltoph Street to the west and Edward Street to the north. Magdalen Street forms the eastern boundary. The site also consists of two parcels of land north of Edward Street which are currently used as car parks.

3.4 A location plan is contained in **Appendix A**.

3.5 The proposals are for a mixed-use development of residential and commercial uses as follows:

3.6 Hybrid (part full/part outline) application on site of 4.65ha for demolition and clearance of all buildings and structures and the phased, comprehensive redevelopment of the site with 14 buildings ranging in height from 1 to 8 storeys, for a maximum of 1,100 residential dwellings, (houses, duplexes and flats) (Use Class C3); a maximum of 8,000 sqm flexible retail, commercial and other non-residential floorspace (retail, business, services, food and drink premises, offices, workshops, non-residential institutions, community hub, local community uses, and other floorspace (Use Classes E/F1/F2/Sui Generis (public conveniences, drinking establishments with expanded food provision, bookmakers and/or nail bars (up to 550sqm), and dry cleaner (up to 150sqm))); service yard, cycle and refuse stores, plant rooms, car parking and other ancillary space; with associated new and amended means of access on Edward Street and Pitt Street, closure of existing means of access on Edward Street, New Botolph Street, Pitt Street and St Crispins Road flyover, formation of cycle path between Edward Street and St Crispins Road, formation of wider footways, laybys and other associated highway works on all boundaries, formation of car club parking area off New Botolph Street, up to 450 car parking spaces (at least 95% spaces for class C3 use, and up to 5% for class E/F1/F2/Sui Generis uses), hard and soft landscaping of public open spaces comprising streets and squares/courtyards for pedestrians and cyclists, other landscape works within existing streets surrounding the site, service infrastructure and other associated work; (All floor areas given as maximum Net Internal Area); Comprising;

- <u>Full planning permission</u> on 2.25ha of the site for demolition and clearance of all buildings and structures, erection of 8 buildings ranging in height from 1 to 8 storeys for 367 residential dwellings (Use Class C3) (149 dwellings in Block A, 25 dwellings in Block B, 21 dwellings in Block C, 34 dwellings in Block D, 8 dwellings in Block J3, 81 dwellings in Block K/L, and 49 dwellings in Block M) with associated cycle and refuse stores), and, for 5,808 sqm flexible retail, commercial and other non-residential floorspace (retail, business, services, food and drink premises, offices, workshops, non-residential institutions, community hub, local community uses, and other floorspace (Use Classes E/F1/F2/Sui Generis (public conveniences, drinking establishments with expanded food provision, bookmakers and/or nail bars (up to 550sqm), and dry cleaner (up to 150sqm))), service yard, cycle and refuse stores, plant rooms, car parking and other ancillary space, with associated new and amended means of access on Edward Street, closure of existing means of access on Edward Street and New Botolph Street, formation of cycle path from Edward Street to St Crispins Road, formation of wider footways, laybys and other associated highway works on Edward Street, New Botolph Street, and Magdalen Street, formation of car club parking area off New Botolph Street, 146 car parking spaces (at least 95% spaces for class C3 use, and up to 5% for class E/F1/F2/Sui Generis uses) within Blocks A and B, hard and soft landscape works to public open spaces comprising streets and squares for pedestrians and cyclists, other landscape works, service infrastructure and other associated works; (All floor areas given as maximum Net Internal Areas); and

- Outline planning permission on 2.4ha of the site, with landscaping and appearance as reserved matters, for demolition and clearance of all buildings and structures, erection of 6 buildings (Blocks E – H and J) ranging in height from 3 to 8 stories for up to 733 residential dwellings, (houses, duplexes, and flats) (Use Class C3), a maximum of 2,192 sqm flexible retail, commercial and other non-residential floorspace (retail, business, services, food and drink premises, offices, non-residential institutions, local community uses and other floorspace (Use Classes E/F1/F2/Sui Generis (drinking establishments with expanded food provision, bookmakers and/or nail bars (up to 550sqm), and dry cleaner (up to 150sqm))); cycle and refuse stores, plant rooms, car parking and other ancillary space; with associated new and altered means of access on Pitt Street and St Crispins Road, closure of means of access on Pitt Street and St Crispins Road flyover, formation of wider footways, laybys and other associated highway works on Pitt Street and St Crispins Road, a maximum of 304 car parking spaces (at least 95% spaces for class C3 use, and up to 5% for class E/F1/F2/Sui Generis uses), service infrastructure and other associated works (landscaping and appearance are reserved matters); (All floor areas given as maximum Net Internal Areas).

3.7 Proposed development plans are enclosed in **Appendix D**. This FRA relates to the whole application site, i.e. both the full and outline application boundaries shown on the masterplan in **Figure 1.** However, more detailed flood warning and mitigation measures in Section 7 have been discussed for the development within red line boundary, covered by the full planning application.

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Figure 1: Site Boundary

3.8 The total site areas for development based on the above plans are set out in **Table 1**:

Table 1: Proposed site areas for development

Area	Size (ha)
Main development area (Anglia Square) – Full Application	2.25
Main development area (Anglia Square) – Outline Application	2.40
Site B (included in Full Application)	0.27
Site C (included in Full Application)	0.13
Total	4.65

3.9 The application boundaries and corresponding areas are shown in **Appendix D**.

Proximity to Watercourses

3.10 Meanders of the River Wensum are approximately 200m to the south and west of the site at their closest points. The confluence of the River Wensum and River Yare are downstream of Norwich City Centre.

3.11 A lost watercourse, known as the Dalymond Dyke, passes close to the site. Although subject to historical interpretation, it is believed that Cockeys (as they are locally known) such as the Dalymond Dyke originally followed the course of natural streams but came to form an integral part of the sewerage system of medieval Norwich.

3.12 In Rawcliffe and Wilson's book titled 'Norwich Since 1550', the following information is given about the Dalymond Dyke:

"The longest (cockey) called Dalymond Dyke, has been traced from outside the city walls near the parish boundary of St Augustine's and St Paul's thence through St Saviour's and St Edmund's to enter the river west of Whitefriars bridge. As it flowed through St Edmund's this stream connected with another, called Spitaldyke, which arose near St Paul's church, crossed Norman's Lane, then bent to cross Rotton Row before joining the Dalymond." (Rawcliffe and Wilson, 2004).

3.13 They also note that: "*river and stream accounts…indicate a system of Cockeys was more elaborate, and more artificial, than is suggested simply by tracing their courses as streams."*

Site Levels

3.14 A site-specific topographic survey is included in **Appendix E**. For the main Anglia Square site, levels vary between 5.09m AOD in the northwest corner to 2.40m AOD at the existing access road from St Crispin's Road to the south of the site. Away from this low spot, levels in the southeast corner of the site are in the region of 3.08m AOD. For the existing Anglia Square shopping centre, levels are around 3.51m AOD. The site slopes in a generally south easterly direction at a gradient of approximately 1:125.

3.15 The parcel north west of New Boltoph Street (Site B) slopes in a southerly direction, at a gradient of approximately 1:185 with the highest level to the north west of the site at 5.40m AOD and the lowest level at 5.11m AOD at the southern extent of the parcel. The site is approximately 0.35-0.4m higher than the carriageway of New Boltoph Street/ Edward Street.

3.16 The parcel directly north of Edward Street (Site C) slopes at a gradient of approximately 1:100, with the highest point in the south west corner at a level of 4.27m AOD and the lowest point in the north at 3.87m AOD.

Underlying Geology

3.17 With reference to the online British Geological Survey (BGS) mapping, the bedrock consists of Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation with superficial deposits of Alluvium - Clay, Silt, Sand And Gravel.

3.18 River Terrace Gravels have also been found to underlay the site (WYG Geo-Environmental Report 2010). This is supported by BGS borehole records surrounding the site:

- BGS borehole record 'TG20NW951' at the Norwich Crown Court building indicated sand and gravel at 2.8m deep overlain by silty and clayey alluvium. Groundwater ingress occurred at 4.2m BGL.

- BGS borehole record 'TG20NW636' at 77-87 Magdalen Street indicated clay to 2.0m BGL with course flint gravel to 8.0m. Groundwater was struck at 6.0m BGL. The clay was noted as 'stiff- very stiff' remoulded chalk, indicating a putty chalk with low permeability at the upper boundary. It is therefore likely that groundwater is stored within the superficial deposits before infiltrating slowly into the chalk aquifer beneath, giving rise to locally high groundwater.

3.19 The chalk bedrock is considered to be a Principal Aquifer and the superficial deposits are classed as a Secondary A Aquifer. Due to the presence of the chalk aquifer the site lies within a Source Protection Zone (SPZ) and is within Zone 2 (outer zone). This is defined on the gov.uk website as: "*This zone is defined by the 400-day travel time from a point below the water table. Additionally this zone has a minimum radius of 250 or 500 metres, depending on the size of the abstraction. The travel time is derived from consideration of the minimum time required to provide delay, dilution and attenuation of slowly degrading pollutants."*

3.20 The site is also shown to be within a medium to high groundwater vulnerability zone (https://magic.defra.gov.uk/magicmap.aspx). This indicates that pollutants could reach the underlying aquifer and groundwater resources relatively quickly in this area as a result of the permeable geology. The site is also highlighted as being in an area with soluble rock risk, due to the presence of the chalk aquifer.

3.21 A Tier 1 contaminated land report by SES (2016) notes that: *"Potential sources of contamination at the site may include heavy metals, inorganic compounds, chlorinated solvents, trichloroethene, formaldehydes, PVC, BTEX compounds from the fabric manufacturing processes. Potential VOC/ SVOCs and ground gases within made ground. Potential heavy metals, hydrocarbons and PAHs from car parking and leakage of fuels/ lubricants associated with the former engineering works. Asbestos may also be present within soils as the Anglia Square Shopping Centre was constructed in the mid-1960s, and pre-dated segregation of asbestos from other construction demolition rubble".*

3.22 The CIRIA SuDS Manual (C753) states that: "*A depth of at least 1m of unsaturated soils that are not clean gravels or similar with high permeabilities, and/or are not fractured deposits with rapid flow routes…are known to provide good protection to underlying groundwater."*

3.23 Due to the potential for contamination from the site and the potential for high groundwater levels within the chalk aquifer, infiltration is not recommended at this site as it is highly unlikely that the recommendations outlined above can be achieved, therefore posing a risk to groundwater quality. Alternative means of drainage and water treatment have been discussed in the drainage report, which comprises the use of lined permeable paving and downstream defender interceptors.

Sewer Network

3.24 Sewer records, obtained from Anglian Water and included in **Appendix F**, show there to be a 675mm surface water sewer and 300mm foul sewer flowing in a south westerly direction through the main Anglia Square site.

3.25 A 300mm surface water sewer and 225mm foul sewer also run west to east adjacent to Edward Street, to the north of the main Anglia Square. Both sewers connect to the respective foul and surface water sewers in Magdalen Street before flowing southwards and discharging into the River between Fye Bridge Street and Whitefriars Bridge.

3.26 A further 525mm combined sewer flows southwards along Magdalen Street. Given the location of the sewer and the available information on the Dalymond Dyke, it is highly likely that surface water flows from the Dalymond Dyke flow within this sewer.

3.27 The sewer locations and sizes within the site boundary are shown in more detail on the topographic survey in **Appendix E**.

4 Surface Water Flooding

4.1 Surface water flooding refers to flooding caused when the intensity of rainfall, particularly in urban areas, can create runoff which temporarily overwhelms the capacity of the local drainage systems or does not infiltrate into the ground. The water ponds on the ground and flows towards low-lying land. This source of flood risk is also known as 'pluvial'.

4.2 Three sources of surface water flood mapping were identified: Environment Agency's Flood Map for Surface Water, the Greater Norwich Area Level 1 Strategic Flood Risk Assessment and the Local Flood Mitigations Options Assessment mapping. Further investigation and consultation with Norfolk County Council determined surface water flooding to be the primary risk to the local area. A hydraulic modelling study was carried out to quantify this risk, the details of which are in the accompanying Hydraulic Modelling Report (6645_RHDHV_Anglia_Square_Model_Report_v1). The surface water risk to the development and the modelling results have been discussed in this section.

Flood Map for Surface Water

4.3 The Flood Risk from Surface Water mapping (**Appendix G**) is on the GOV.UK website and can be accessed here: https://check-long-term-flood-risk.service.gov.uk/map?easting=623059&northing=309421&map=SurfaceWater

4.4 This shows parts of the site to be at high risk of surface water flooding. The flood extent map suggests that there is an existing flow path thorough the site which passes down Botolph Street, Upper Green Lane and Magdalen Street to the south. The 'low risk' depth mapping is the worst case scenario on the EA surface water maps. This is an event that doesn't occur regularly but can result in the highest volumes of water passing through the site.

4.5 At the south of the site on Cherry Lane, adjacent to St Crispin's Road, an area of ponding 300-900mm is shown in the high-risk scenario, which corresponds with the low spot identified in the topographical survey. As can be seen in the photo in **Figure 1**, this is currently used as an underpass.

Figure 2: Underpass on Cherry Lane (Source: Google Maps)

4.6 Areas of flooding less than 300mm are also shown on Boltoph Street. To the north, there is a continuous flow route along Heath Road as far south as Magpie Road, where the path is shown as isolated areas of surface water flooding between buildings to the north of Edward Street

4.7 In the medium risk event, this flow path continues in a south-easterly direction along Beckham Place to Edward Street, Cowgate, Magdalen Street and southwards through Anglia Square. The mapping shows this to follow Upper Green Lane, however this is an elevated road through Anglia Square as shown in **Figure 2.** The entrance to Upper Green Lane can be seen to the right of the picture above the blue service door. Whilst it is possible that flooding of the basement car park area could occur, no records of flooding have been identified to date.

Figure 3: entrance to car park and Upper Green Lane (Source: Google Maps)

4.8 Flooding also occurs to the parcel north of Edward Street, with depths of between 300mm and 900mm being shown. No surface water flooding is shown on the parcel of land northwest of New Botolph Street.

4.9 A secondary flow route on the A1067 towards Boltoph Street can also be seen. The main area of flooding within the site boundary, to the north of St Crispin Road, is still within 300-900mm in the medium risk scenario.

4.10 In the low-risk scenario, the flow route from Waterloo Road and described above becomes continuous in a southerly direction through Anglia Square, Magdalen Street and in an easterly direction along Cowgate. The flow route from the A1067 also becomes continuous along Boltoph Street and joins the ponded area to the north of St Crispin Road.

4.11 The majority of flooding is less than 900mm, with very small areas to the south of Edward Street deeper than 900mm. To the north of Edward Street, a greater extent of flooding within the land parcel north of Anglia Square, with the majority of this in the 300mm to 900mm range.

4.12 In the low-risk scenario, flow routes within the site boundaries have velocities of greater than 0.25m/s.

4.13 As the surface water mapping uses a generalised methodology to account for sewer networks, it is likely that the size of the surface water sewer network both within the site and the immediate vicinity have been underestimated in the modelling. In particular, the document "What is the Risk of Flooding from Surface Water map?" (EA, 2019) notes:

"We assumed a single drainage rate for all urban areas within the nationally produced modelling unless LLFAs were able to give us better local data. Modelled flood extents are particularly sensitive to the way drainage is taken into account. Omitting large subsurface drainage elements such as flood relief culverts and flood storage can also significantly affect the modelled pattern of flooding."

Local Flood Mitigations Options Assessment Mapping

4.14 The site is included within the mapped extents for CDC2 which are available online at https://www.norfolk.gov.uk/what-we-do-and-how-we-work/policy-performance-and-partnerships/policies-and-strategies/flood-and-water-management-policies/surface-water-management-plans/norwich-urban-area-swmp

4.15 The mapping included hazard and depth mapping for the 1 in 30, 1 in 75, 1 in 100, 1 in 100 plus climate change, and 1 in 200 year events.

4.16 For all events, the low spot to the north of St Crispin's Road was identified as a moderate-significant hazard (danger for most).

4.17 For the 1 in 75 year event, a number of areas were identified as being moderate or significant hazards:

- The flow path along the north and east of the site boundaries to the north of Edward Street was identified as significant. Due to the resolution of the mapping it is not clear whether the flow route enters the site.
- South of Edward Street was identified as being at significant risk and shows a larger flood extent than in the Risk of Surface Water Flooding map. This is most likely due to differences in the modelling technique, and is likely to represent flooding of the basement car park.
- An area to the east of Boltoph Street was identified as being a moderate hazard. In the Surface Water Flood Map this was routed around the building by the model (effectively flooding the existing car park), however in this modelling the buildings were set to a 0.1m height.

4.18 For the 1 in 100 year event plus climate change the following areas were identified as hazards:

- The parcel to the north of Edward Street was shown as a significant flood risk across the site
- Moderate flooding was still modelled to the east of Boltoph Street, although the extent increased.
- The extents of the predicted flooding to the north of the site (south of Edward Street) and the low spot to the south of the site (north of St Crispin Road) also increased.

- The areas to the northwest of New Boltoph Street and the centre of Anglia Square were not shown as being a flood hazard and therefore the two areas of flooding described above are distinct and should not be considered a flow route. Instead, flows from the north are more likely to be routed along Magdalen Street to the east, which does show a continuous flow route.

4.19 It is noted that losses to the sewer network were reduced to 7mm/hr in this modelling exercise and the hydraulic model is not integrated with the Anglian Water sewer network. Furthermore, due to the methodology used, buildings on sloped sites may be effectively modelled as basement units and therefore are more likely to be show as flooded than if the thresholds had been individually defined. Therefore, these have been considered below in more detail before using the modelled

Hydraulic Modelling

4.20 Norfolk County Council were approached for initial comments on the surface water flood risk to the proposed development for an earlier application in 2018. They highlighted the location of the site in the middle of an overland flow path and the requirement for further investigation of the surface water mechanisms in the local area, given that it is within a CDA. Following a meeting (between EAS and the Norfolk County Council Flood Risk Team in 2017) it was confirmed that the Norwich Urban Surface Water Management Plan Model CDC2 could be used as a basis for preparing a hydraulic model to assess the proposed development.

4.21 A similar approach has been taken for this application, with the SWMP CDC2 model being used as a base for the modelling study. However, given the age of the CDC2 model, some parts of it were updated in this modelling study. The hydraulic modelling assessment has been detailed in the modelling report entitled '6645_RHDHV_Anglia_Square_Model_Report_v1' and summarised below.

4.22 The surface water model provided is a 1D ESTRY-2D TUFLOW direct rainfall model representing the Catton Grove and Sewell catchment. The FEH 2013 rainfall model was used to generate hyetographs for a number of return periods. The hydraulic modelling study used a scaled-up hyetograph to simulate the 1 in 100year (+40%CC) rainfall event, as previously agreed with Norfolk CC.

4.23 The latest EA 0.50m LiDAR was used to create the ground surface. As in the original CDC2 surface water model, the whole catchment was included, as the flow path originates north of the site. Initial model runs applied the gross rainfall hyetographs (i.e. with no losses accounted for), and a constant 7mm/hour was then removed from the whole catchment, to simulate runoff entering the sewer system. However, during a pre-application meeting with the LLFA, concerns were raised about the application of the 7mm/hr due to it not being representative of the whole catchment. Subsequently, the 'Net Rainfall' hyetographs were applied, which accounted for a range of losses based on the catchment characteristics. The original materials layers were included in the model, although these were reviewed in details around the site and updated where necessary. The Manning's roughness value for buildings was 0.04 in the original model, which was considered to be too low. This was increased to 0.1 to better simulate flow through buildings. Buildings across the catchment outside of the application site were specified as having thresholds set to 0.10m above the ground level, and roads were set to 0.125m below ground level. An exception was Magdalen Street, which the LLFA commented as having lower thresholds; the buildings along Magdalen Street were instead set at ground level. Finally, analysis of aerial photography identified some new buildings just north of Edward Street which had not been represented in the original model. These were included in the new model as buildings with threshold levels of 0.10m above ground level.

4.24 An existing and proposed scenario were built for comparison of flood extents and changes in flows.

4.25 Limitations in the existing model were that site-specific levels were not used, and the water at the southern site boundary (adjacent to St Crispins Road) flowed 'on to' the flyover whereas in reality, the flyover was significantly higher than the ground level so this would not be possible.

4.26 The model for the existing scenario was adjusted slightly to set more accurate finished floor levels across Anglia Square (informed by the topographic survey) and to include the flyover 'barrier' at the southern boundary, which prevented runoff from the site from flowing onto the flyover. Flows instead were directed to the southeast and exited the site at Magdalen Street, which is the flood mechanism in the local area.

4.27 The model for the proposed scenario removed the existing buildings within the application boundary and replaced them with the proposed blocks, pedestrian walkways and ground/finished floor levels. The finished floor levels were typically set between 4.00m AOD and 5.00m AOD. **Figure 4** shows the finished floor levels used for each block in the hydraulic model. It should be noted that the hydraulic model and the floor levels used are illustrative for comparison purposes, to represent a worst-case scenario.

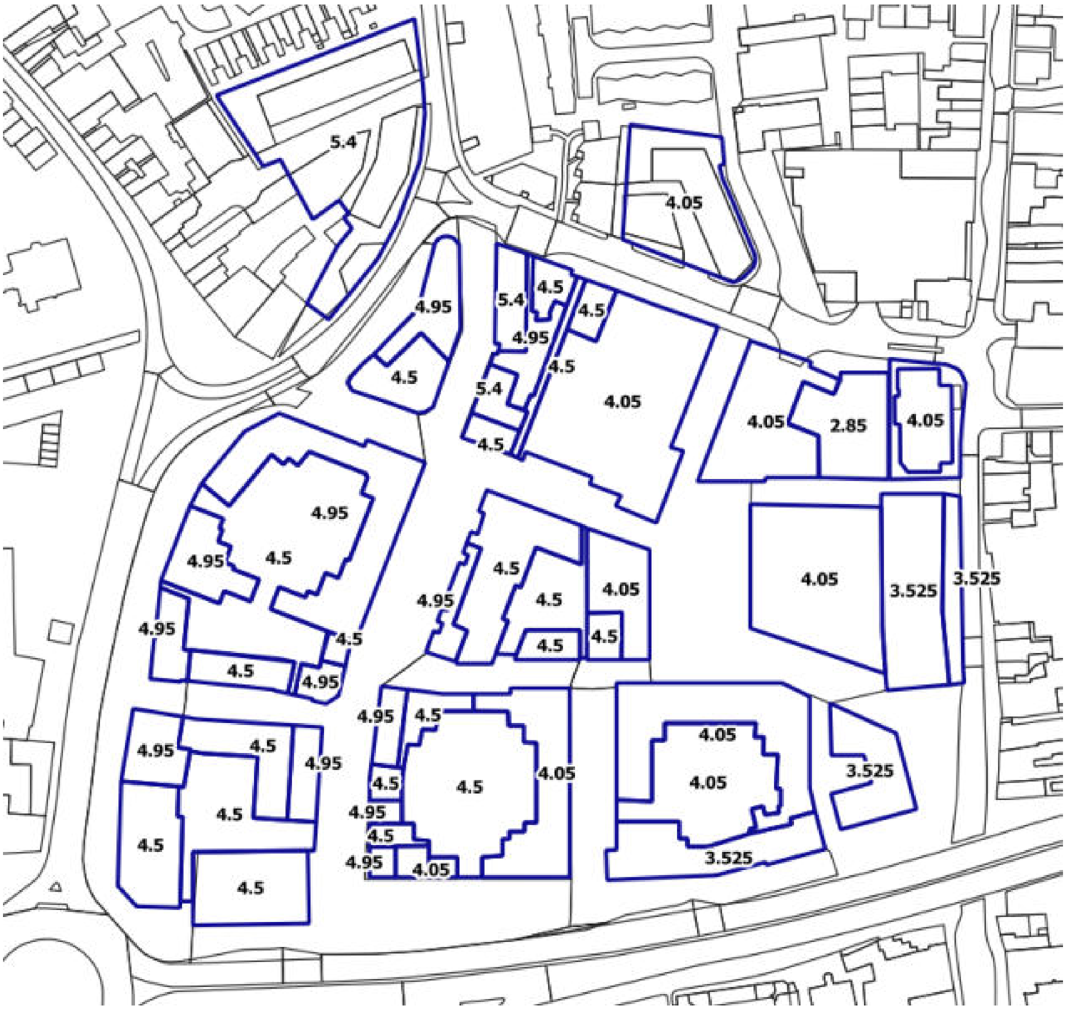

Figure 4: Illustrative finished floor levels for each block represented in Anglia Square model (m AOD)

4.28 The assumptions and limitations of the original model were acknowledged and accepted. In addition, a further limitation was that the interiors of the proposed blocks could not be divided up into individual units as these have not been finalised. As such, the flow of water 'through' a building is not completely accurately represented since there would in fact be walls between the units. However, this was commented on by the LLFA in the 2018 application and considered to be an acceptable representation of the development, as internal walls cannot be shown as preventing floodwater ingress since there would be service conduits etc. that water could pass through. Despite this limitation, the surface water model has provided some useful information on the flooding to the development and allows a comparison to determine any areas where flooding has been increased or decreased as a result of development.

4.29 The landscape consultants have included a number of vegetated features, tree pits and swales throughout the site in the walkways. As such, it was considered acceptable to include the walkways through the site as 'Natural Surfaces' in the materials layers, with a Manning's value of 0.03, rather than 'Roads' which have Manning's values of 0.02. In addition, it is understood there will be steps from many of the buildings to the main walkways, although specific details of the steps were not available during the modelling process. It was therefore considered reasonable to design the pedestrian walkways as sloped on each side to enable surface water flow paths to continue through the site, channelling water from northwest to southeast and away from the proposed buildings. The slopes were based on a cross fall of 1:80 where possible. In some places, this cross fall was not achievable, so the shallowest gradient possible was used in these locations. The sloping walkways were achieved by creating a TIN of these areas.

4.30 The final model was based on the following:

- Ground floor levels are shown in **Figure 4** (typically between 4.00m AOD and 5.00m AOD).
- The Edward Street loading bay set at a lower level of 2.85m AOD.
- A basement car park off Edward Street is set at 0.825m AOD. In reality, this would have a flood barrier at the top of the ramp, therefore the proposed scenario modelled the ramp as a 10m high barrier, to determine the size of the required flood barrier (dependent of the water depth in this location).
- Sloping pedestrian walkways included for most of the external hardstandings, to enable the existing surface water flow route to pass through the proposed development and be directed away from the buildings. A slope of 1:80 was used where possible. However, in some locations is as not possible to achieve this so as shallow a slope as practicable was used.
- Flyover at the southern site boundary is represented as a sloping z-shape rising up from 4.43m AOD to 8.63m AOD, to prevent surface water flowing over it from the site.

Investigating Flooding Mechanisms

4.31 As noted earlier, a limitation of the model is that the internal areas of the buildings cannot be divided up into individual commercial/retail units. The buildings are represented as finished floor levels and water will simply flow 'through' the building to the lowest levels, where it will pool. This means that where an internal floor level suddenly falls from say 4.50m AOD to 4.05m AOD, water will flow straight into the low area. While this may be the case in some areas, it is unlikely to be the case in all instances. Following initial model runs, it was necessary to take a closer look at the flow paths at each of the vulnerable areas to determine whether water can reach them and pool or whether this is a limitation of the model.

4.32 The service yard off Edward Street is directly adjacent to the main flow route within the roads around Anglia Square. The service yard is set at 2.85m AOD which is around 1.20m lower than the adjacent buildings and the road. Given the location of the service yard, it is likely to be in the surface water flow path and therefore vulnerable to flooding. At the entrance to the service yard it is indicated that flood depths up to 0.40m could occur in a 1 in 100 year (+40%CC) event. While a raised threshold could help mitigate this risk, it is acknowledged that it may not be possible to raise the threshold very high, given there will be large vehicles accessing this area. Alternative mitigation measures for the loading bay have been discussed in Section 7.

4.33 Blocks M is shown to flood internally. As previously noted, it is not possible to include building walls within most of the site. Therefore, it is likely that water pooling in the Edward Street service yard is gradually rising and eventually spilling into the adjacent Block M. In reality, it is highly unlikely that water would be able to flow through the buildings in this manner due to the presence of internal walls, flood resilient construction and use of waterproofing techniques around the service yard and walls facing Edward Street.

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Modelling Results

4.34 The amended hydraulic model was run for the critical 1 in 100 year (+40%CC) rainfall event, as well as the 1 in 100 year (+20%CC), 1 in 75 year and 1 in 30 year rainfall events. The modelling results for the 1 in 100 year (+40%CC) event was examined and the vulnerable areas within the proposed development were highlighted. The vulnerable areas and the resulting depths and levels are summarised in **Table 2**.

Table 2: Summary of vulnerable areas and associated depths and levels for 1 in 100 year (+40%CC) surface water event

Location	Water Depth (m)	Water Level (m AOD)
Service yard off Edward Street	1.25	4.10
Entrance to basement car park from Edward Street	0.20	4.37
Block A	0.045	4.08
Block C	0.27	4.32
Block L	0.04 to 0.14	3.57 to 3.66
Block M	0.10	4.14
South of Block J	0.10	3.52
Southeast of Block J/Mobility Hub	0.13	3.50
East of Block H	0.10	3.90

4.35 The resulting depth and level maps are included at **Appendix H**. It should be noted that as this is a rainfall model, it has been assumed that up to 0.05m of water could remain on the roofs and not contribute to surface water flows within buildings. Therefore, the band of 0m to 0.05m has been set to transparent, and it is assumed that any water depth greater than 0.05m can be attributed to overland flow. The main concern of this modelling study was to understand the flow paths and any areas where there were significant depths of overland flow.

4.36 A visual comparison of the existing and proposed flood depth maps suggests that the existing site has deeper water depths over a smaller area. The proposed development has shallower depths across a larger area.

4.37 The existing loading bay and car park to the north of the site off Edward Street is located in the same place as the proposed service yard. The modelling results showed this to be adjacent to the main surface water flow route along Edward Street. The topographic survey identifies ground level of the existing loading bay/car park at this location to be around 3.21m AOD, which is lower level than Edward Street. This is shown in **Figure 3**. As noted previously, there has been no historical evidence of flooding to this area.

4.38 The ground level of the proposed service yard will be set at 2.85m AOD, which is approximately 1.20m below Edward Street. The model showed surface water flows from Edward Street to fill up the loading bay, to a depth of 1.25m. In reality, the loading bay may fill up to the same level at Edward Street before flows would no longer be able to enter the loading bay.

4.39 Flows through the northern boundary of Block M adjacent to Edward Street result in up to 0.10m water passing through the building towards the southeast. As noted in the flood mechanism section, this is unlikely to occur in reality as is a result of water from the loading bay passing into the building and also through internal walls. Comparison with the existing situation also suggests a similar flood mechanism in this extreme event, with water from Edward Street flowing through the site from the north and north eastern boundary. Mitigation measures will be discussed in Section 7.

4.40 Block A has been represented as the ground floor level of 4.05m AOD rather than the basement car park level of 0.825m AOD. Although the basement car park will be protected with a flood barrier, the ground floor of Block A may experience up to 0.045m flood depth, given it is immediately adjacent to the main flow route along Edward Street.

4.41 Block C is located in the main overland flow route and as such may experience up to 0.27m water depth. As ground floor residential uses are proposed here, it is very important that robust mitigation measures are included in the development. These have been discussed in Section 7.

4.42 The area south of Block J has been modelled with an illustrative level of 3.36m AOD to 3.41m AOD. As this is the lowest external area within the site boundary, much of the overland flow would be directed here before passing out of the site and back into Magdalen Street. Depths of up to 0.10m are recorded in this area.

4.43 The ground floor of Block J does not form part of the detailed application but has been shown for the purpose of the model to be set at 4.05m AOD to the north and 3.525m AOD to the south. Although the sloping walkway has been modelled to the north and south of Block J to try and direct water away from this area where possible, flows can still enter this building since it is located at one of the lowest parts of the site.

4.44 The main flow routes through the site were via the new pedestrian walkways. Generally, on the western half of the site the centre of the walkways convey flows of up to 0.02m depth. In the east and southeastern half of the site, the walkways could convey up to 0.13m depth in this extreme event. The upper levels of the sloping walkways tied into the adjacent buildings floor levels where possible, although it was noted that there would be steps at the front of the buildings which could affect this. Typically, the invert of the walkways were based on a cross fall of 1:80. However, this was not feasible in some places (e.g. where the walkway was particularly narrow or there was a change in the floor levels of the adjacent buildings), so in these locations the shallowest slope possible was used. The results demonstrated that water was channeled effectively around the site using the method of sloping walkways, allowing existing overland flow paths to remain in a similar manner to the existing site.

4.45 Given the predicted flood depths, as part of the construction and operational phases of the development, mitigation measures and management processes must be in place, monitored, and implemented in a timely way.

Hazard Mapping

4.46 Hazard maps were produced along with the depth mapping to determine the most vulnerable parts of the site. The hazard mapping was produced based on the methodology set out in the publication by DEFRA 'Flood Risks to People' (FD2320/TR23) 1 and the May 2008 EA/HR Wallingford supplementary guidance note[2]. This classifies hazard based on the depth and velocity of flows through a site, and is defined as shown in **Table 3**.

Table 3: Flood Hazard Clarification from Supplementary Guidance Note

Degree of Flood Hazard	Description
Low (Less than 0.75)	Caution – Flood zone with shallow flowing water or deep standing water.
Moderate (0.75 to 1.25)	Danger for some (i.e. children) – Danger: Flood zone with deep or fast flowing water.
Significant (1.25 to 2.0)	Danger for most people – Danger: Flood zone with deep or fast flowing water.
Extreme (More than 2.0)	Danger for all – Extreme danger: Flood zone with deep fast flowing water.

4.47 The hazard map for the 1 in 100 year (+40%CC) rainfall event is shown in **Appendix I**. This shows that the pedestrian walkways and most of the proposed blocks remain at low hazard, or have no hazard identified. This means that pedestrians will still be able to traverse the site even in this extreme rainfall event. On the eastern half of the site, the pedestrian walkways and some of the ground floors of Blocks L and M are shown as 'Low' hazard in this scenario. Magdalen Street to the south east of the site boundary, and the area beneath the flyover, are shown as being at 'Moderate' to 'Significant' hazard.

4.48 The service yard off Edward Street is shown to be at 'Significant' hazard, as was the case for the existing scenario.

4.49 Block C is within the main flow path, and is shown to experience 'Moderate' hazard in the most extreme scenario.

4.50 A visual comparison of the existing and proposed 1 in 100 year (+40%CC) hazard maps shows that there appears to be a larger area of 'Significant' hazard onsite in the existing scenario. There are no areas of 'Extreme' hazard identified on the site in either the existing or proposed scenarios.

4.51 In the more frequent 1 in 30 year event, the site is almost entirely classed as 'No hazard', with only small pockets of 'Low' hazard shown in the south eastern part of the site. It is noted that Block C has 'No hazard' up until the 1 in 100 year (+20%CC) event, when this becomes 'Low' hazard. Similarly, the service yard is not show to be in a hazard area until the 1 in 100 year (+20%CC) event, when it becomes a 'Significant' hazard area.

4.52 Mitigation measures will be discussed in Section 7 to manage the hazard in the areas described above.

[1] DEFRA and Environment Agency (March 2006) 'Flood Risks to People', FD2321/TR2, DEFRA: London
[2] Supplementary note on flood hazard ratings and thresholds for development planning and control purpose (2008)

5 Impact Study

5.1 In the previous application, Norfolk County Council highlighted the importance of ensuring that surface water flow paths are not simply obstructed by the development and forced to flow around the site, as this could increase the flood risk to others. The Norfolk CC pre-application comments on the earlier scheme requested an assessment of changes to flood depths so that local businesses are aware of the changes and how this could impact their properties. A similar exercise has been carried out for this application.

5.2 The impact assessment was based on an extreme 1 in 100 (40%CC) surface water flooding event, so presents a 'worst case' scenario upon which to base mitigation measures for offsite impacts. Maximum depth and level grids were produced from the final model and the existing and proposed were compared. These provided a clearer visual representation of the changes in the flood levels and depths. The changes have been discussed below.

Area of Impact

5.3 Analysis of the impact of the proposed scheme was carried out to determine the area of impact and the magnitude of the impact. The 1 in 100 year (+40%CC) event maximums grids were interrogated, and the existing and proposed levels and depths were compared using the raster calculator function of QGIS. An afflux map was created out of the grid of differences between existing and proposed. Any red areas represent an increase in flood depth due to the proposed development, whereas green areas represent a decrease in flood depth due to the proposed development. Any increase or decrease of 0.02m or less is considered as 'no change' as this could simply represent rainfall on a roof so is considered to be negligible. The resulting map is included in **Appendix J**.

5.4 It is clear from the map in **Appendix J** that the main impacts are within the site boundary. Roughly half of the site experiences an increase in water depth and half experiences a reduction as a result of the development. There are increases adjacent to the flyover on the southern boundary and also the smaller land parcel to the north of the main site (Block C). The centre of the site and area just south of Block J show decreases in flood depth as a result of the scheme.

5.5 Offsite impacts appear to be restricted to the immediate area adjacent to the site. To the north west, there is an increase of up to 0.20m within New Botolph Street. This is within the highway and no properties are shown to experience an impact in this area. At the junction of Magdalen Street and Edward Street, to the north east of the site, there is an area of increased flood depth, of up to 0.05m. Again, this appears to be restricted to the highway.

5.6 There appears to be an increase of up to 0.04m to two properties immediately south of the junction of Magdalen Street and Cowgate Street. This is a small increase in depth, but it is recommended that the thresholds of these premises are surveyed to determine whether this would result in flooding of the building or whether this small increase would remain in the highway.

5.7 Finally, the building to the south of St Crispins Road and east of Calvert Street is shown to experience a decrease in flood depth of up to 0.07m.

5.8 The results show that there are a number of properties across the catchment which are predicted to be at risk of flooding in both the existing and proposed scenarios, therefore the proposed scenario would not introduce a new flood risk to these properties, but at this stage it shows that some places could result in an increase in water depth/level. A specific area where further investigation is required are the properties south of the junction of Magdalen Street and Cowgate Street. The Applicant will carry out further investigation to determine the true threshold levels at the affected properties and the additional information will be used to inform the flood modelling and mitigation measures to eb proposed.

5.9 The offsite risk was quantified across the impact area by using the grid interrogation tool in QGIS. Although it is not possible to provide levels and depths precisely for every property, the information provided indicates the likely maximum increases.

5.10 Various limitations mean that the level of flooding shown in **Appendices I** and **K** may be overestimated. Limitations are that building walls are not modelled (most buildings have flood resistance to 600mm), offsite property floor levels are consistently set at 0.10m above the ground level, and LIDAR has been used across the catchment in the absence of topographic survey data. In reality, walls could block or slow flow paths across the catchment and floor levels may be higher or lower than modelled. However, the model output provides information on the most vulnerable areas which may experience an increase in water level.

6 Other Sources of Flood Risk

Fluvial and Tidal Flooding

6.1 The Environment Agency Flood Map for Planning (**Appendix B**) shows the site is located entirely within Flood Zone 1. This indicates a probability of fluvial and tidal flooding of less than 1 in 1000 years (0.1%AEP). The historic flood map provided by the EA shows the southeastern edge of the site experienced fluvial flooding in 1912. This is before the construction of the existing Anglia Square and surrounding development (e.g. the flyover) was built. It is likely that flood defences elsewhere on the River Wensum and more recent development between the site and the river would now obstruct fluvial flows, hence the site is now located entirely in Flood Zone 1.

6.2 There are no other fluvial sources within the vicinity of the site, and the risk from the 'lost' watercourse known as the Dalymond Dyke has been considered in Section 4. Fluvial flood risk is therefore considered to be low. As the site is remote from the coast and any tidally influenced rivers, the tidal flood risk is also considered to be low.

Sewer Flooding

6.3 The Flood Investigations report for the Norwich Urban Area highlights the key issues relating to sewer flooding in Norwich, as detailed in Section 2. Although there are clearly sewer flooding issues locally, linked primarily to maintenance and insufficient capacity in the existing drainage systems, Anglian Water previously confirmed in their email of 24th March 2017 (**Appendix F**) that they do not hold any records of sewer flooding incidents on the existing site that can be attributed to capacity limitations in their public sewer network.

6.4 According to the Anglian Water DG5 database records included within the Greater Norwich SFRA, 264 sewer flooding incidents have been identified in the Greater Norwich area between 2007 and 2017. The SWMP identified Colman Road, Heigham Road, Jessopp Road and Orchard Close as areas at higher risk of sewer flooding. None of these areas are close to the site.

6.5 Given the level of surface water flooding at the site and in the local area, there is potential for sewers to surcharge in an extreme event. Assuming surface water is directed into the Anglian Water public sewer network in such event, this may become overwhelmed and result in surcharging of the system. The surface water modelling carried out as part of this FRA illustrates the likely flood extents and depths which may occur assuming the local drainage network was almost at capacity.

6.6 Although no sewer flooding has been reported locally to date, there is potential for sewer flooding in extreme events, so the risk of flooding from sewers is considered to be medium.

Groundwater

6.7 Flooding from groundwater is not specifically covered in the SFRA documents due to lack of data and the unpredictability of groundwater flooding.

6.8 Reference to the groundwater mapping on the EA website shows the site to be within Groundwater Source Protection Zone 2**.**

6.9 The EA website also classifies the entire site as a Principal Aquifer based upon the underlying bedrock. This means that the layers of rock have a high intergranular and/or fracture permeability meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. The Groundwater Vulnerability map indicates that the site is in an area defined as 'Major Aquifer – High'. This means the site is above an aquifer which is considered to be highly vulnerable to pollutants.

6.10 Groundwater is expected to be high at the site given the presence of the underlying gravels but no history of groundwater flooding at the site has been reported. The risk of surface level groundwater flooding is therefore medium. With adequate mitigation measures, this can be reduced to low.

Artificial Sources

6.11 There are no artificial sources of flooding located in the vicinity of the site. Reference to the online EA map indicates that the site is not located within an area at risk of flooding from reservoirs.

6.12 Therefore, flood risk from artificial sources is considered to be low.

7 Mitigation Measures

7.1 Much of the proposed residential accommodation across the Anglia Square development site will be located at first floor and above, so will not be at risk of flooding for the lifetime of the development. There are however several areas where ground floor residential uses are located, within Blocks A, B and C of the detailed application boundary. The mitigation measures discussed in this section will address the flood risk to these residential dwellings, along with the flood risk to the commercial and leisure premises throughout the site, to ensure the risks are managed for the lifetime of the development.

7.2 To summarise, several parts of the proposed development are at negligible or low risk in the extreme 1 in 100 year (+40%CC) event. These are:

- Block B;
- Block D;
- Block E;
- Block F;
- Block H;
- Blocks G and K.

7.3 The parts of the development at greater risk of flooding, which the mitigation measures in this section will be focussed on, are:

- Service Yard off Edward Street;
- Basement Car Park;
- East of Block H;
- Block A;
- Block C;
- Block M;
- Block L;
- Blocks J and J3.

Offsite and Onsite Flows

7.4 The LLFA previously requested that the offsite overland flows are separated from the onsite drainage system. The attenuation tanks forming the onsite drainage system have not been designed to accept offsite flows in normal circumstances, but it is acknowledged that it is impractical to prevent offsite flows entering the onsite drainage system in some areas. The drainage systems serving the sloped pedestrian walkways and hard standings will channel surface water runoff through the site and there will be slot drains in the centre of the walkways in suitable locations to discharge the water to the attenuation tanks.

7.5 The proposed locations of these tanks are shown in the drainage report prepared by EAS. Analysis demonstrated that during a 1 in 30 year rainfall event, each of these tanks would be no more than 50% full, therefore there would be some capacity for offsite flows to enter the systems if required. However, if 40% climate change is accounted for, this would mean that the 1 in 30 year event would result in the tanks being between 66% and 75% full.

7.6 The only way to prevent offsite flows entering the site would be to install barriers along the northern site boundary, along New Botolph Street and Edward Street. This would block the existing overland flow paths and further increase the risk to others. It is therefore recommended that overland flow paths remain where possible and an alarm detection system is installed onto the tanks serving the hardstandings. A proposed alarm system has been described below.

Attenuation Tank Alarm System

7.7 It is proposed that the attenuation tanks serving the external hardstanding areas/pedestrian walkways will have alarms fitted internally. As it is not possible to separate the offsite flows from the onsite runoff in these areas, it is recommended that alarm detection sensor is fitted at the 75% capacity level of the tanks serving the hardstanding areas (Systems 03 to 08). An analysis was carried out to determine the likely return period storm which would result in the tanks becoming 75% full, and it was confirmed that the tanks filled to 75% at between a 1 in 135 year and 1 in 289 year event (not including climate change). When allowing for 40% climate change, the 75% capacity storm reduces to between a 1 in 31 year and 1 in 66 year event. The 75% capacity level was considered to be acceptable as it would ensure the alarms would not be triggered in the lower return period, every day events.

7.8 Assuming the overland flows from offsite begin to fill up the onsite surface water attenuation systems, the alarm would trigger should the tanks become 75% full. The alarm would sound an alert the Anglia Square management office, and it would be the management's responsibility to distribute the warning to each of the ground floor residential, retail, commercial and leisure uses. This would allow them time to evacuate, safeguard and close their premises. The flood warning strategy has been discussed below.

Specific Flood Warning and Mitigation Measures

7.9 Hydraulic modelling has demonstrated there to be several vulnerable areas within the proposed development. These are set out in **Table 4** along with the proposed mitigation measures to reduce the risk to people and property. Each of these areas have been considered in more detail below.

Table 4: Vulnerable areas within site boundary and proposed mitigation measures

Location	Water Depth (m)	Mitigation Measures
Edward Street Service Yard	1.25	Alarm system Evacuation Waterproofing methods Sump pump Linear drain
Entrance to basement car park from Edward Street	0.20	Alarm system Linear drain Self-raising/manual flood barrier Sump pump
Block A and M	0.045 to 0.10	Waterproofing methods Evacuation Flood resilient construction
Block C	0.27	Flood resilient construction

		Alarm system Evacuation
Block L	0.04 to 0.14	Flood resilient construction Evacuation
South/South East of Block J	0.10 to 0.13	Alarm system Evacuation
External area East of Block H	0.10	Alarm system Evacuation

Structural Engineering Calculations

7.10 As the water depths in the Service Yard shown in **Table 4** are over 600mm, this will need to be considered by a structural engineer as the hydrostatic pressure on the walls and buildings could be substantial in an extreme event. A structural engineer should be consulted to ensure the correct materials are being used for the areas most vulnerable to flooding.

Edward Street Service Yard

7.11 The proposed service yard off Edward Street is predicted to flood to a depth of 1.25m during a 1 in 100 year (+40%CC) event. It is therefore recommended that a linear drain is installed across the entrance to the service yard to collect surface water runoff before it enters the lower level. As the runoff to this drain will be coming from Edward Street and not from within the site, it is not recommended that the drain discharges to the onsite drainage system, and this has not been designed to accept runoff from the service yard. Instead, the linear drain should have a direct connection to the main surface water sewer within Magdalen Street. Since high flows in the Magdalen Street sewer may back up into the site, a flap valve should be included on the outfall. In addition, a sump pump should be installed in the service yard to remove any water that enters this area, since it would not be able to drain out otherwise. The sump pump should have a new gravity connection to the Anglian Water sewer in Magdalen Street. Anglian Water will be approached for permission to connect and discharge to their surface water sewer at a later stage.

7.12 A flood warning alarm system should be installed in the service yard. This would be connected to the building management phone system to alert a member of staff if the water level in this area rose above a certain level. The alarm system could also be attached to a light or siren sounding within the service yard, to let occupants know that the area is beginning to flood. Upon receipt of an alarm, a member of the buildings management team should close the service yard until the water can be drained or pumped away. This will reduce the risk to people. An example of such an alarm system is the Wireless Flood Alarm 1 Protect-800 on the www.ultrasecuredirect.com website.

7.13 Analysis of the modelling results showed that the Edward Street service yard could be flooded up to a depth of 0.03m during a 1 in 30 year event and 0.04m during the 1 in 100 year event, i.e. water is unable to enter the service yard until the more extreme events. As this is not a publicly accessible area, it is considered that the flood warning sensor should be located at around 0.10m above ground level (i.e. at a level of 2.95m AOD). The sump pump should be triggered as soon as the service yard begins to flood, which should reduce the risk in this area.

7.14 It is not advised that vehicles can be driven into the service yard while it is flooding. This area should be closed as soon as the alarm is triggered, and not re-opened until it is drained, and has been inspected by an appropriate person, and deemed to be safe. It is recommended that another area of the site is identified for loading/unloading in the event of the Edward Street service yard being closed.

7.15 A flood warning notice should be displayed clearly in the Edward Street service yard to warn users that this area is at risk of flooding from surface water and what actions to take. An example of such a notice is shown in **Figure 5.**

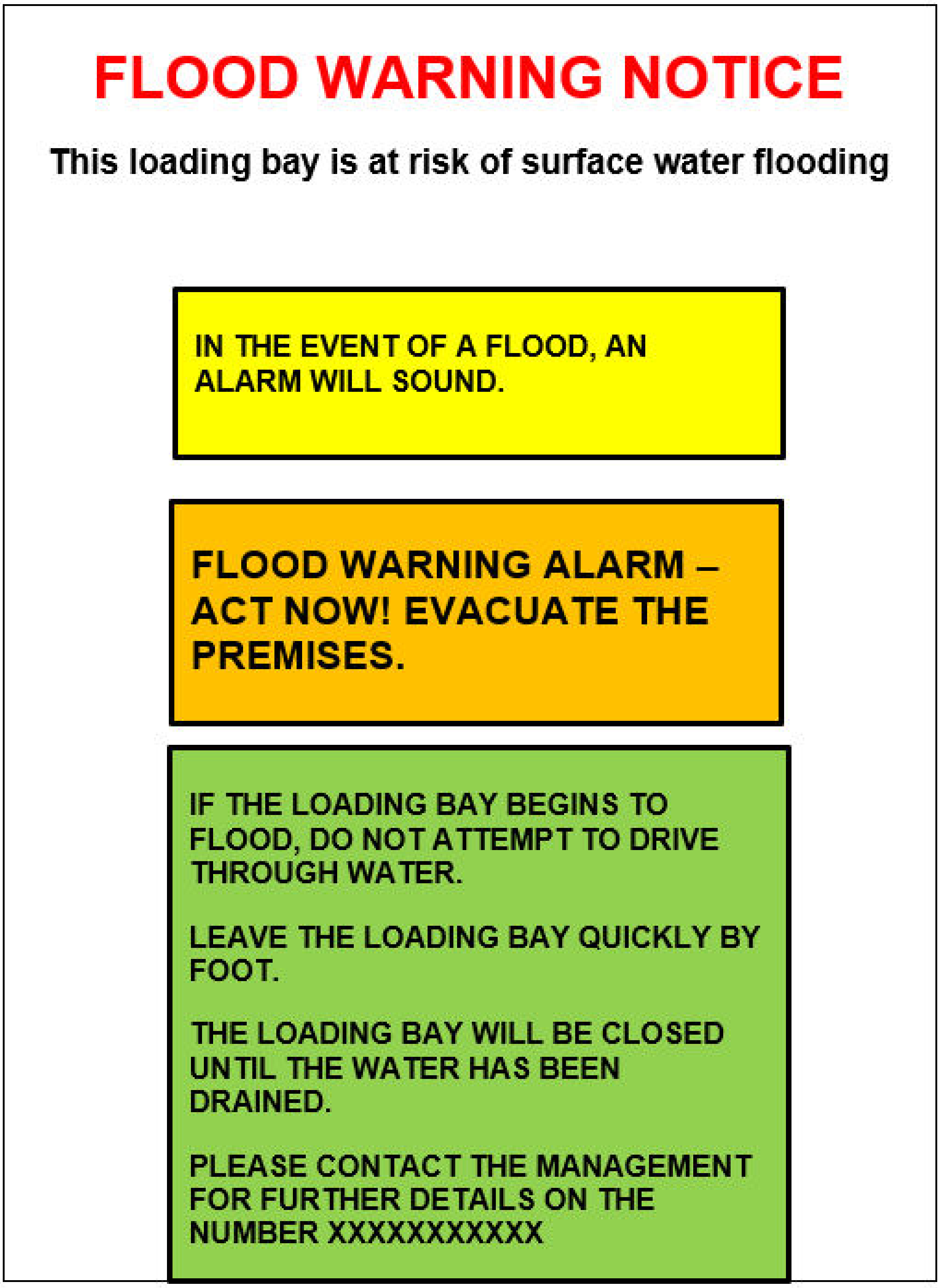


Figure 5: Example of a Flood Warning Notice

7.16 The service yard must be tanked to prevent pooling water from getting into other parts of the development (e.g. through service cable conduits or air vents). Flood resilient materials must be used in the construction of the service yard. Some examples of flood resilient construction methods, taken from the publication by DEFRA entitled 'Improving the Flood Performance of New Buildings' are:

7.17 Floors

- Concrete ground supported floors are preferred and concrete slabs of at least 100mm thickness.
- Hardcore and blinding – good compaction should be achieved to reduce the risk of settlement and cracking.
- Damp Proof Membranes – should be included in any design to minimise the passage of water through ground floors. Impermeable polythene membranes should be at least 1200 gauge to minimise ripping.
- Insulation materials – Water will lower the insulation properties of some insulation materials. Floor insulation should be the closed-cell type to minimise the impact of flood water. Insulation should be placed above the floor slab.
- Services – Under floor services using ferrous materials should be avoided.

7.18 Walls

- For masonry walls, use good quality facing bricks for the external face of cavity walls. Do not use soft bricks such as handmade clay which can easily crumble when subjected to water.
- Concrete bricks dry quicker than Aircrete blocks. However, Aircrete blocks allow less leakage, so the design of blockwork needs to be considered and the most relevant brick work should be selected.
- External renders should not be used as they provide a barrier to water penetration and could result in structural problems.
- Internal linings – Avoid internal cement renders as these can prevent effective drying.

Entrance to Basement Car Park

7.19 The basement car park finished floor level will be 0.825m AOD. As this is clearly a very vulnerable part of the development, a flood barrier will need to be installed at the top of the access ramp on Edward Street.

7.20 The flood barrier could be a self-closing barrier, which is triggered by a flood sensor either on the front of Block A or further up in the catchment (for example, on Block C which is in the main overland flow path). Alternatively, the flood sensor could be connected to an alarm in the site management office, and it will be the responsibility of the site maintenance company to respond and manually close the basement car park and install the flood barrier. This will require the site to have 24 hour maintenance, and a management company to respond quickly to an alarm.

7.21 As with the service yard, it is recommended that a linear drain is installed across the top of the ramp to catch runoff from Edward Street before it reaches the basement car park. This should discharge directly to the Anglian Water sewer in Edward Street, and a flap vale should be on the outlet to prevent water backing up. A sump pump will also be required in the car park, to pump out any water that does reach this area.

Block A, L and M

7.22 The northern boundary of Block A, adjacent to Edward Street, is shown to flood in a 1 in 100 year (+40%CC) event, as is part of Block M and Block L. As previously discussed in Section 4, in reality there would be internal walls and the Edward Street service yard would be tanked to prevent any water from passing through into Block M. It is possible that water could enter Block M through the Edward Street vehicle entrance, therefore it is recommended that the external walls facing Edward Street are constructed using flood resilient methods to prevent water ingress at this location. The raising of internal floor levels would also help to reduce the flood risk to both Block A and Block M, but it is understood that this may not be achievable when considering other requirements such as level access.

7.23 The ground floor of Block A and Block L are shown to flood in an extreme event. It is recommended that the commercial development located here is constructed using flood resilient methods based on a ‘water exclusion’ strategy. While it is understood that some mitigation methods such as flood barriers are unlikely to be achievable due to the type of construction, it is recommended that the internal layout of the commercial space considers flooding and uses ramps or raised platforms to allow the majority of the unit to remain above the flood level even though the entrance will be at ground level.

Block C

7.24 Block C is located in the main flow path from the north and could experience up to 0.27m depth of water in an extreme event. It is recommended that flood resilience measures are adopted for the ground floor of this block. Some examples of flood resilience measures taken from DEFRA’s publication entitled *'Improving the Flood Performance of New Buildings'* are:

Building Materials
- Engineering bricks, cement based materials including water retaining concrete and dense stone.
- Masonry walls – Use good quality facing bricks for the external face of cavity walls. Concrete blocks dry more quickly than Aircrete blocks.
- Clear cavity walls (i.e. no insulation) dry more quickly than filled/part filled cavity walls.
- Avoid internal cement renders beneath flood level as these can prevent effective drying.

Doors and Windows
- Raise the door threshold as high as possible to protect the site, while still complying with level access requirements.
- Use sealed PVC external framed doors rather than wood.
- Ensure adequate sealing of any PVC window/door sills to the fabric of the building.

Fixtures and Fittings

- Durable fittings should be used that are not significantly affected by floodwater and can be easily cleaned.
- Electrical appliances, gas oven etc. should be placed on plinths as high as practicable above the floor while still complying with building regulations, to ensure they are above the flood level.
- Ensure adequate sealing of joints between kitchen units and surfaces to prevent penetration of water behind fittings.
- Locate all electrical plug sockets at least 300mm higher than internal floor level.

7.25 In addition, given the depths of water in the vicinity of Block C are less than 600mm, it is recommended that removable flood barriers are used at entrances. Part of the flood warning strategy for the site should identify staff to be trained in the installation of flood barriers, in the event that high surface water levels occur at Block C.

7.26 A Flood Evacuation Plan should be provided to residents moving into Block C to inform them of the risk to this area and the actions to take in the event of a flood. This could be provided as part of the 'Welcome Pack' to new residents. It is also recommended that Flood Warning notices are displayed around the car park and in the communal entrances of Block C.

7.27 There should be a separate alarm system for Block C which is linked to water sensors on the northern face of the block. The sensors should be located at a suitable height above ground and if triggered, will send an alarm to the onsite management and maintenance company. Once this has happened, the management and maintenance team should distribute flood warnings to the residents of Block C to inform them of the impending risk to this part of the site. This will be part of the evacuation plan and residents will be told that they should prepare to evacuate the site. The alarm and distribution of warnings could be automated if necessary, depending on whether there will be 24 hour management and maintenance at the site.

South of Block J

7.28 The area to the south of Block J is shown to flood up to 0.07m during a 1 in 30 year event, and 0.10m during a 1 in 100 year (+40%CC) event. This is a very low-lying area and it is recommended that a flood detection alarm system is fitted here. It is assumed that this area may be publicly accessible, therefore it will be necessary to install the flood detection sensors at a lower level, such as 0.08m. The sensors should trigger either an alarm or flashing light to warn users that flooding has started. In addition, a flood warning notice similar to that in **Figure 5** should be displayed.

7.29 The warning should sound in the site management office and if possible, access to this area should be restricted until the flooding has stopped.

East of Block H

7.30 The external area to the east of Block H could experience depths of up to 0.10m in the 1 in 100 year (+40%CC) event. It is unlikely that this area would flood to the depths shown in **Appendix H,** as there may be obstructions to flow paths north of the site which are not picked up in the model. In addition, there would be a surface water drainage system onsite which would collect and discharge some of the surface water prior to this level of flooding being experienced. The resulting risk to people using this area is likely to be low, even in an extreme event. However, in the event of significant flooding to the site, the alarm systems serving the attenuation tanks would be triggered and the site would be evacuated. This has been discussed further below.

Site-Wide Flood Warning and Evacuation Strategy

7.31 Given the type and scale of the development, it is not possible to have raised ground floor levels within the commercial, retail and leisure units. Level access requirements mean that all door thresholds will be at ground level, and it is understood that the units will have glass windows fronting the walkways. This means that finished floor levels raised 300mm above the flood level, are not achievable.

7.32 In some areas where there are ground floor residential dwellings, it is understood that these will have steps down to the pedestrian walkways. This would provide another level of protection for the residential elements.

7.33 It should be recognised that the flood maps depicted in **Appendices I** and **J** indicate the likely depths and hazards assuming there are no drainage systems on site, or the drainage systems have exceeded capacity. In reality, the site drainage systems would manage some of this water and this level of flooding is unlikely to be experienced. It is however recommended that a site-wide flood warning and evacuation strategy is in place, which details the access and evacuation routes in a significant flood.

7.34 When offsite overland flows enter the site at the northern boundary, the attenuation tanks will begin to fill up and trigger an alarm. When this happens, the site management will be alerted to the location where the alarm has been triggered. It is likely that the northernmost attenuation tank (serving Block D hardstandings) would trigger first, as this would be in the main flow route. It is also likely that other specific flood warning alarms within the site boundary may have triggered prior to this, such as the alarm at Block C and the Edward Street service yard. The site management would therefore be prepared to receive an alarm alerting them that the attenuation tanks are filling up.

7.35 Upon receipt of the alarm, it is recommended that the site management inspects the area where the alarm was triggered in the first instance to ensure it was due to surface water entering the tank and no other reason (such as a burst water main, or fire-fighting run-off). Assuming the flood mechanism is surface water from offsite, this would indicate that the site could begin to flood. At this stage, a conservative approach should be taken to ensure that the ground floor commercial development and those using the site are aware of the risk and can safeguard their premises. In addition, the management should distribute an alert via a text message to the residents of the site, to warn them of the risk.

7.36 It will be the responsibility of the site manager to alert the managers of each of the ground floor commercial and retail units to the potential flood risk. The managers of the commercial units should receive a Flood Warning and Evacuation pack when they move into their units, which will outline the actions they will need to take. It is recommended that a general Flood Warning and Evacuation Strategy is prepared at a later stage of the planning process and distributed to the individual units. Specific flood warning and evacuation packs (e.g. for the proposed service yard and Block C) should be compiled separately.

7.37 The flood warning strategy for the public and commercial areas would be as follows. Upon receipt of a flood warning from the site management office, the managers of the individual units should close their premises. If possible it is advised that items are moved away from the doors and windows and located at higher levels (e.g. if part of the unit is on a raised platform). It is understood that demountable barriers and the like may not be possible on glass fronted units; however if it is possible to use barriers at the doors and windows then this would be advised and once the units have been closed, the barriers should be installed.

7.38 Once the premises have been safeguarded and secured, it is necessary to leave the site. It is recommended that residents, staff and customers evacuate the site either to the west towards Pitt Street or the south towards St Crispins Road, as shown in **Figure 6.** These evacuation routes are away from the higher risk areas. People should evacuate via the safest route possible and it is not advised to drive through floodwater.

7.39 A publicly accessible area has been identified in Block D which can be accessed in an emergency. This is above ground floor level and should provide a safe place of refuge for customers or staff who are unable to leave the site through the evacuation route detailed above. The Block D emergency refuge area is circled in red in **Figure 6**.

7.40 It should be noted that if there is an immediate danger to life the emergency services should be contacted, and their advice should be followed.

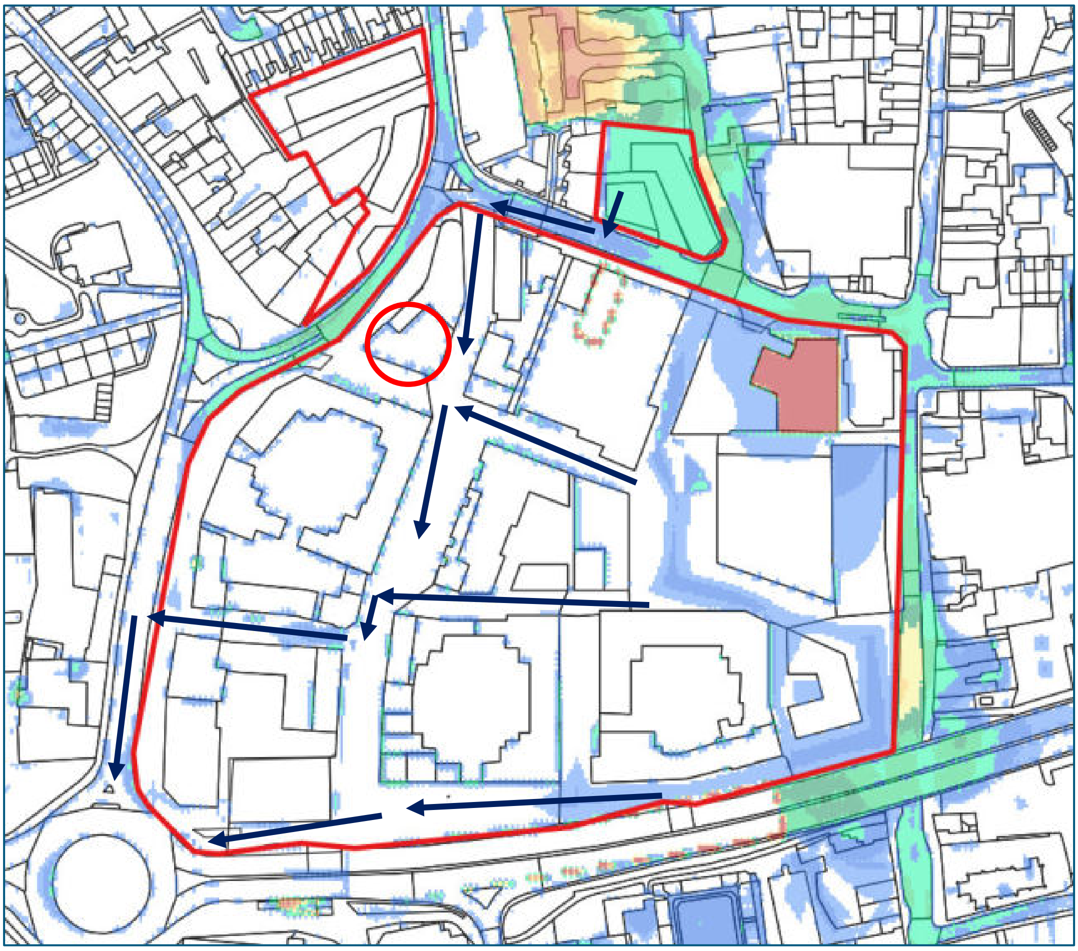


Figure 6: Evacuation routes offsite

7.41 Further details on the flood warning strategy for the commercial units and the residential areas will be confirmed post planning, and an emergency plan will be provided for the site as a standalone document.

Commercial Units

7.42 It is recommended that the final occupants of the commercial units install flood resilience methods. Some examples of the types of methods used are detailed in the publication by DEFRA entitled 'Improving the Flood Performance of New Buildings.' Some specific flood resistant methods, taken from the DEFRA publication, are summarised below:

7.43 Fixtures and Fittings

- Electrical sockets should be located above ground level and above the flood level where possible.

- Durable fittings should be used that are not significantly affected by floodwater and can be easily cleaned.

- Electrical appliances should be placed on plinths as high as practicable above the floor to ensure they are above the flood level.
- Ensure adequate sealing of joints between kitchen units and surfaces to prevent penetration of water behind fittings.

- Provide means for effective drainage and cleaning e.g. gaps behind kitchen units will facilitate drainage and will allow access for forced drying, if proved to be necessary.

7.44 Some of the commercial units will have a first floor or mezzanine level. These areas will remain above the flood level even during a 1 in 100 year (+40%CC) event so it would not be necessary to use flood resilient construction measures here.

7.45 It is recommended that threshold drains are installed along the entrances of each unit to collect surface water. The threshold drains will have a connection to the attenuation tanks serving the adjacent hardstandings. A no-return valve should be used on the connections to prevent water backing up into the threshold drains.

Residential Units

7.46 Most of the residential units are at first floor level and above. However, as previously noted, there are some ground floor residential dwellings, the majority of which will be set at least 300mm higher than the adjacent pedestrian walkways. This should help to direct surface water along the walkways and away from the buildings. In the event of a flood, the site management will distribute a flood alert to the residents. Those living above the ground floor will have the option to remain in their homes which will be safe and dry for the events considered. Residents living at ground floor level will be advised to evacuate their homes in an extreme event. The flood warning and evacuation procedure will be set out in the Flood Warning and Evacuation Strategy provided to them when they move in.

7.47 The safest route offsite will be via the main pedestrian walkways to the west and southwest, as these are away from the main overland flow paths. The evacuation routes would be the same as that proposed for the commercial premises at **Figure 6**.

7.48 A visual comparison between the ground floor plan (**Appendix D**) and the modelled depth maps (**Appendix H**) shows the residential lobbies in the eastern sections of Block A, western side of Block M and those in Block L may be flooded in a 1 in 100 year (+40%CC) event. It is not possible to include raised floor levels in these areas due to level access requirements, although it is advised that sealed door thresholds should be used if possible to provide some protection to these areas. It should be noted that in the 1 in 30 year event, the depths in these areas are very low and unlikely to pose a significant risk.

Utility Plants

7.49 Electrical substations and plant rooms throughout the site are identified at ground floor level in **Figure 7**.

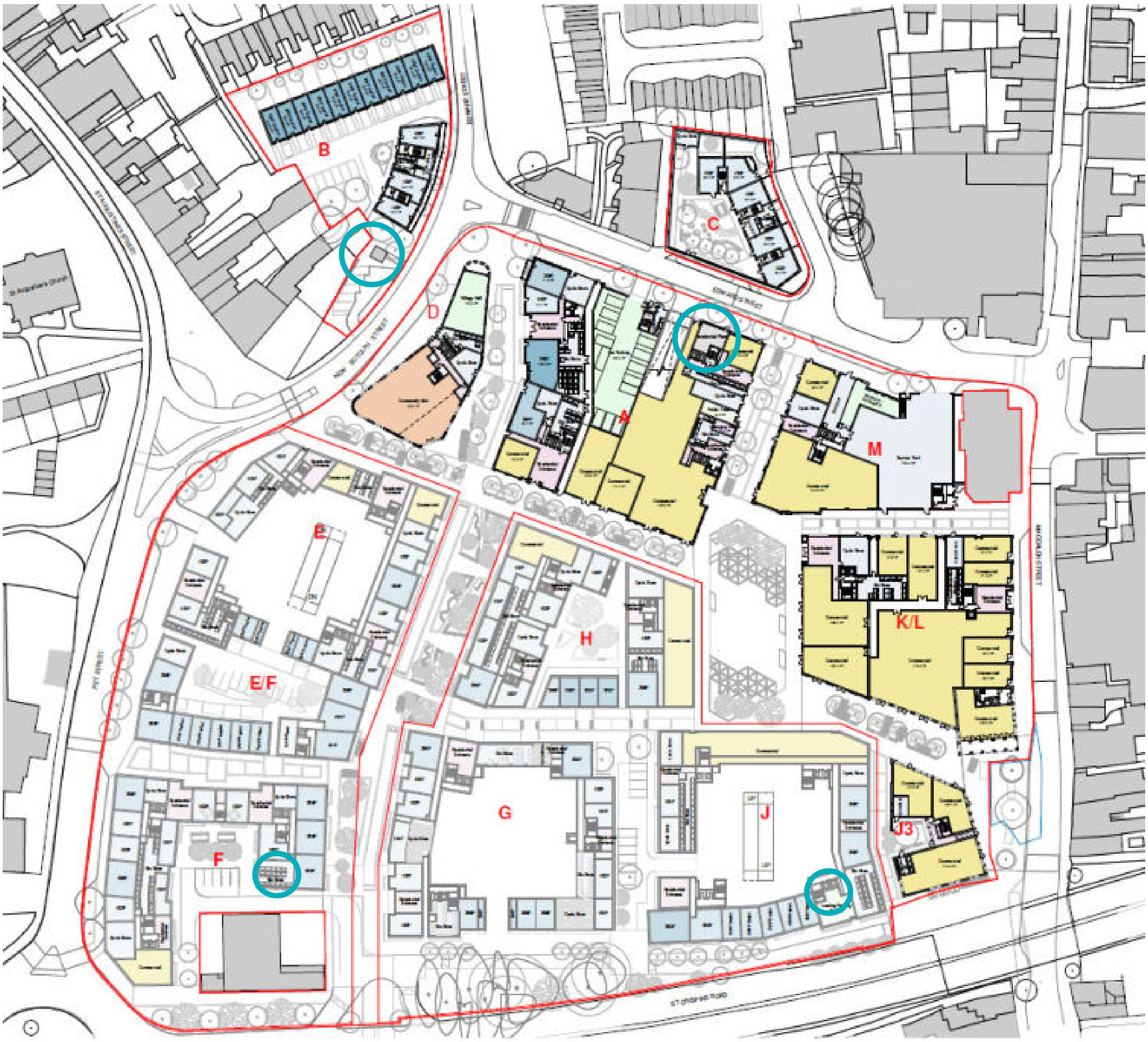


Figure 7: Locations of electrical substations

7.50 Norfolk CC commented in their previous pre-application response that utility plants should be considered during a 1 in 100 year (+40%CC) flood event, so that the site can remain operational even during a flood. A visual comparison with the 1 in 100 year (+40%CC) depth map indicates that it is unlikely that any of the substations would be flooded in an extreme event.

7.51 As a precautionary measure, it is recommended that any substations and utility plant apparatus is located individually on plinths above the ground floor level.

Groundwater

7.52 As indicated in Sections 3 and 6 of this report, groundwater levels could potentially be high beneath the site due to the chalk geology. It is recommended that the lowest areas within the development (such as the basement car park in Block A and the service yard off Edward Street) are tanked to ensure there is no groundwater ingress. Similarly, any subsurface surface water drainage must be designed with high groundwater levels in mind at the detailed design stage.

7.53 If groundwater is encountered during construction, mitigation measures should be implemented in accordance with the advice of a Geo-Technical Engineer experienced in hydro-geological processes.

7.54 In the unlikely event of groundwater emerging within the main Anglia Square site boundary, it is noted that all residential dwellings are typically set higher than ground level up a number of steps so it is highly unlikely they would be impacted by groundwater flooding. Groundwater flooding occurs slowly so there would be ample time for ground level commercial uses to prepare for flooding and implement measures to prevent significant damage.

Residual Flood Risk

7.55 Mitigation measures have been provided to reduce the potential risk of flooding from surface water and groundwater. However, in the event of a rainfall event greater than that considered in this assessment, the ground floor and external areas may experience some flooding. The likely exceedance routes in this event have been considered in the drainage report, prepared by EAS. However, even in these extreme circumstances, it is likely that the residential units would remain safe and dry.

7.56 There remains a residual risk of exceedance and blockage of the designed drainage system. Maintenance measures should be carried out regularly to ensure the surface water drainage system is effective for the lifetime of the development. Suitable maintenance measures have been considered in the drainage report.

7.57 The drainage systems serving the proposed development will be managed by the managers/owners of the site, and it is recommended that regular inspections of the surface water drainage systems are carried out to ensure that they continue to work effectively.

8 Summary and Conclusions

8.1 This Flood Risk Assessment has been prepared for the proposed mixed-use development at Anglia Square, Norwich. The proposed development would provide residential, commercial, retail, and leisure uses across the site, along with car and cycle parking. The site is currently occupied by the Anglia Square shopping precinct, a disused multi-storey car park and office blocks which are not in permanent use.

8.2 The LLFA provided comments during their pre-application review of the hydraulic model and a follow-up meeting. Their flood risk comments have been addressed in this report and the accompanying hydraulic modelling report.

8.3 The Environment Agency's Flood Map for Planning illustrates that the site is located entirely within Flood Zone 1 and therefore deemed to be at a low risk of fluvial and tidal flooding. The local geology and location in Source Protection Zone 2 suggests that groundwater may be relatively high. However, there is no evidence of groundwater flooding and the existing site is almost entirely impermeable, which would prevent groundwater emergence at the site.

8.4 The Flood Risk from Surface Water mapping indicates that the risk of surface water flooding is medium/high. This is most likely due to the presence of the Dalymond/ Dalimond ditch, a "lost" river which is likely to have been incorporated into the public sewer networks. Due to the generalised methodology used for modelling surface water, it is likely that the risk is overestimated. The existing surface water model for Norwich City Centre has been updated, amended and re-run for several existing and proposed scenarios. This process has helped to determine the most vulnerable parts of the proposed development, and to quantify the risks to the development. This also helped to compare the existing and proposed risks offsite to determine whether there would be a significant increase in flows as a result of the proposed development.

8.5 The areas at highest surface water risk have been identified as the Edward Street service yard, basement car park in Block A, part of the ground floor of Block A, Block C, Block L and the area south of Block J. A number of mitigation measures were discussed which included installing flood sensors and alarms in vulnerable areas, having a flood warning and evacuation system across the site, using flood resilient construction methods and tanking the low-lying areas of the site.

8.6 It is not possible to prevent offsite flows from entering the onsite drainage system, so separate alarms fitted to the attenuation tanks serving the pedestrian walkways/hardstandings are proposed. These would alert the site management who would then send out a warning to the residents and staff of the individual ground floor units.

8.7 The lowering of part of the pedestrian walkways has the benefit of directing runoff away from the proposed buildings while also routing surface water through the site, and maintaining the existing flow routes. It is acknowledged that the central sections of the pedestrian walkways may flood in places, but an evacuation route has been identified to guide people offsite to the west and southwest, away from the main overland flow paths.

8.8 An offsite impact study indicated the area where the proposed development would increase flood levels. Most of the areas identified would already be classified as being at risk of flooding in the present day scenario, however there was a section of the road in New Botolph Street which could experience an increase in flood depth as a result of the development. Further investigation will be carried out on the property thresholds close to the junction of Cowgate Street and Magdalen

Street, to determine the impact of increased flood depths in this area. Several areas, such as the area south of St Crispins Road, also experience a reduction in flood depth as a result of the development.

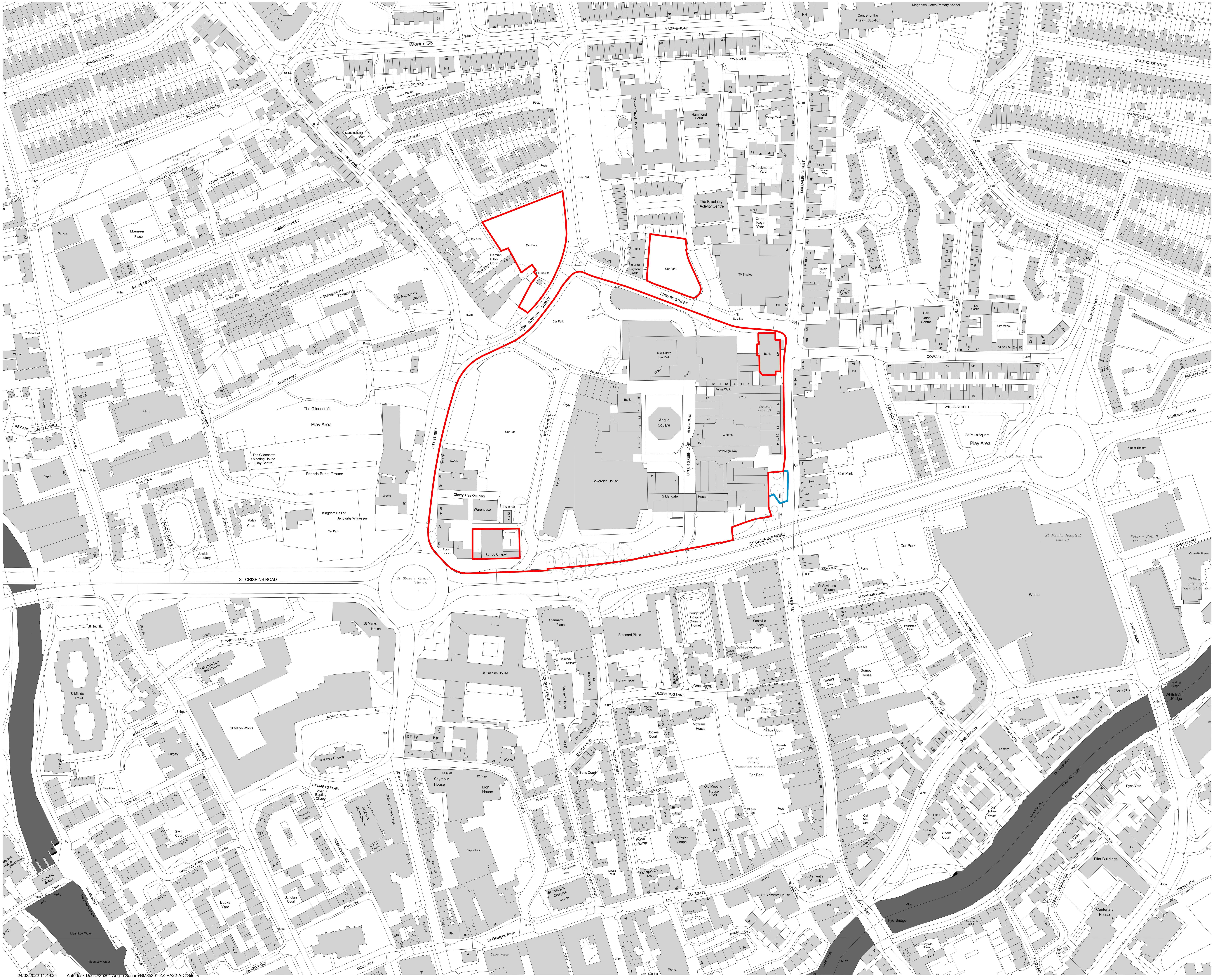
8.9 Areas where residential lobbies and utility plants are located were compared to the depth maps. Mitigation measures are proposed where possible.

8.10 A flood warning and evacuation strategy for the site has been outlined and it is expected that a more detailed flood warning strategy will be provided at a later design stage.

8.11 We believe that the development proposals comply with the guidance provided in the NPPF, and with the recommendations of Anglian Water and Norwich City Council, and that no reason exists to object to the proposals in terms of flood risk or drainage.

8.12 Pre-application comments provided by Norfolk County Council (the LLFA) have been considered and addressed, although it is acknowledged that in some cases further details will need to be supplied at a later stage of the design process.

Appendix A Location Plan



Contractors and consultants are not to scale dimensions from this drawing

The survey information shown on this drawing is based on a topographical survey prepared by a third party and Broadway Malyan Limited accept no responsibility for the accuracy or completeness of the survey.

Drawings to be read in conjunction with the associated Design & Access Statement, associated consultant desin team documents & reports and landscape information

Landscape shown is for illustrative purposes only. For detailed landscape information, please refer to the landscape information & documents.

0m 62.5m 125m

N

General Notes

All figures and areas are approximate only and subject to statutory constraints, detail design & design development

Structural Design: Subject to structural input & coordination

Services Design: Subject to services input & coordination

Fire Strategy: Subject to fire input & coordination

Application Boundary

Land Ownerd by CT to be subject to separate application for part of the Mobility Hub

Revision	Date	Drawn By	Description
D0-1	31.03.22		Issued For Planning

BroadwayMalyanBM

4 Pear Place
London
SE1 8BT

T: +44 (0)20 7261 4200
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E: Lon@BroadwayMalyan.com

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Client
Weston Homes

Project
Anglia Square
Norwich

Description
Hybrid Application - Location Plan on Existing OS Base

Status
For Planning

Scale	Drawn By	Date
1:1250@A1	BM	31.03.22
Job Number	**Drawing Number**	**Revision**
35301	ZZ-00-DR-A-01-1000	D0-1

Appendix B EA Floodmap for Planning

Flood Map for Planning

At: 623056, 309335 Created: 24/01/202 Ref: EAN/2022/248079

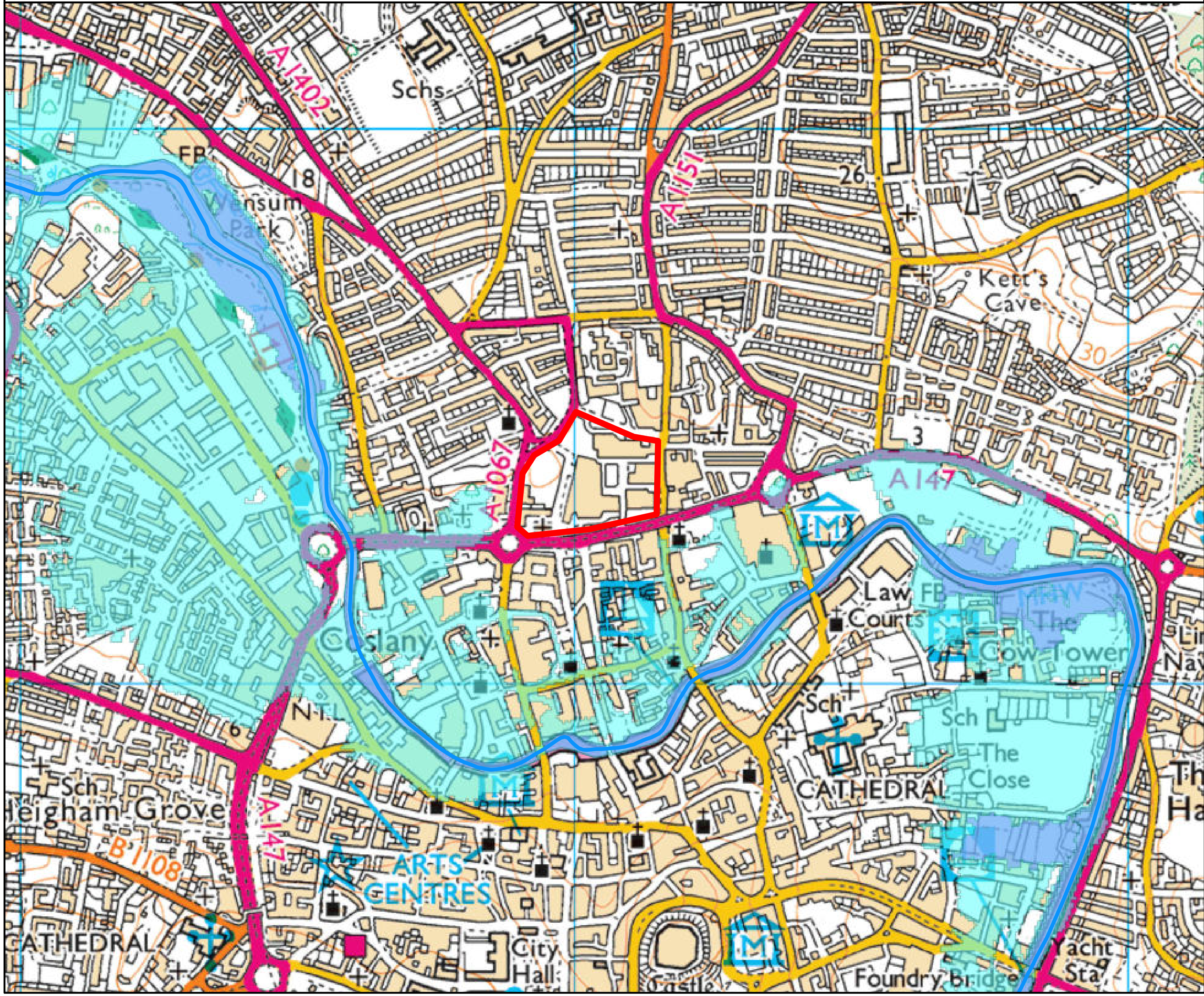
Environment Agency

Environment Agency
Iceni House
Cobham Road
Ipswich
Suffolk
IP3 9JD

N

0 120 240 480
Metres

1:10,000



Legend

- Site Location
- Main Rivers
- Flood Zone 3
- Flood Zone 2

Flood Map for Planning (assuming no defences)

Flood Zone 3 shows the area that could be affected by flooding:
- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

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East Anglia: Essex, Norfolk & Suffolk

Historic flooding

This map is an indicative outline of areas that have previously flooded. Remember that:

- our records are incomplete, so the information here is based on the best available data
- it is possible not all properties within this area will have flooded
- other flooding may have occurred that we do not have records for
- flooding can come from a range of different sources - we can only supply flood risk data relating to flooding from rivers or the sea

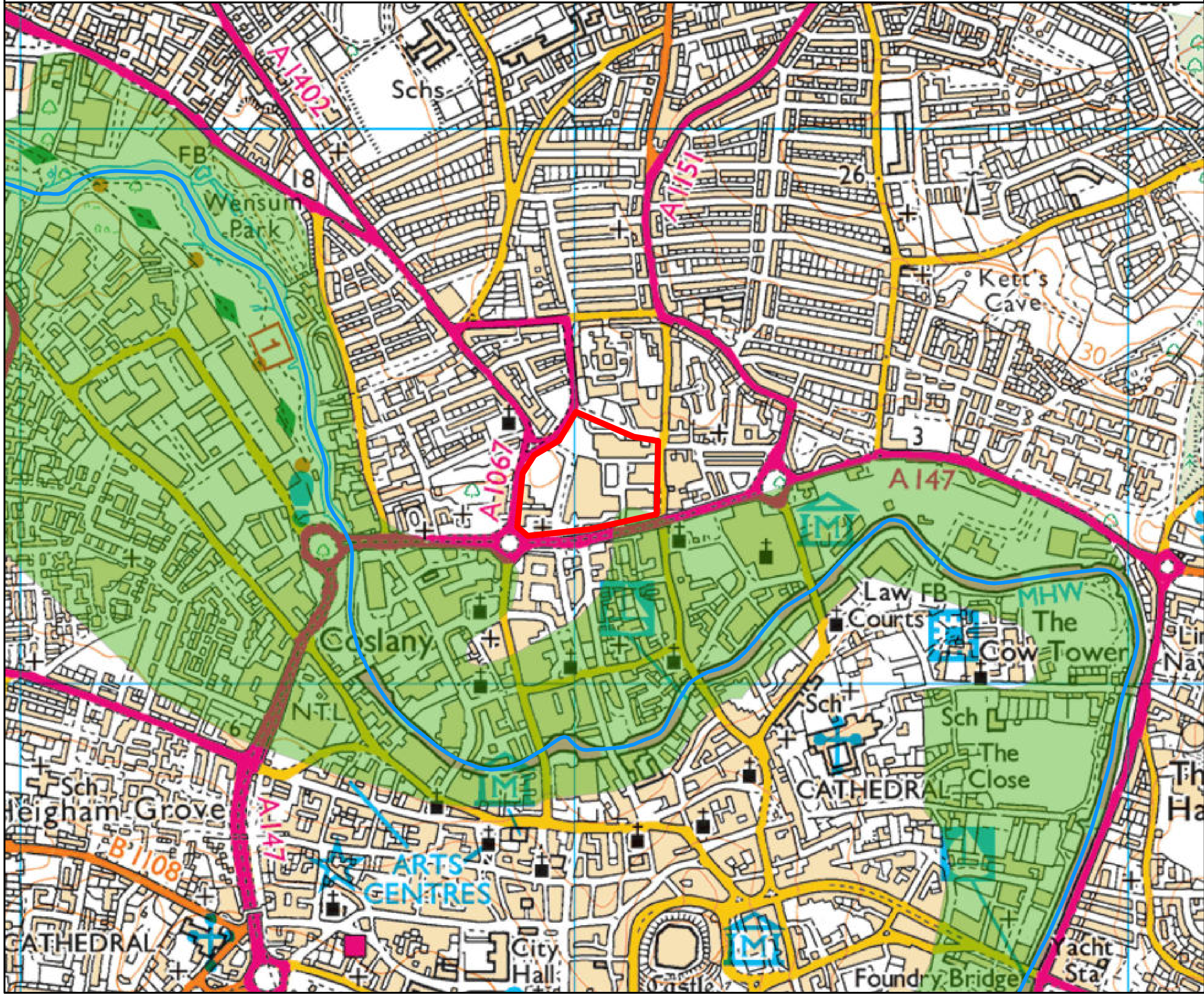
You can also contact your Lead Local Flood Authority or Internal Drainage Board to see if they have other relevant local flood information. Please note that some areas do not have an Internal Drainage Board.

Download recorded flood outlines in GIS format

Recorded Flood Outlines

At: 623056, 309335 Created: 24/01/202 Ref: EAN/2022/248079

Environment Agency



Environment Agency
Iceni House
Cobham Road
Ipswich
Suffolk
IP3 9JD

N

0 120 240 480
Metres
1:10,000

Legend

- Site Location
- Main Rivers
- 1912 Flood Outline

The historic flood event outlines are based on a combination of anecdotal evidence, Environment Agency staff observations and survey.
Our historic flood event outlines do not provide a definitive record of flooding.
It is possible that there will be an absence of datain places where we have not been able to record the extent of flooding.
It is also possible for errors occur in the digitisation of historic records of flooding.

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East Anglia: Essex, Norfolk & Suffolk

Historic flood event data

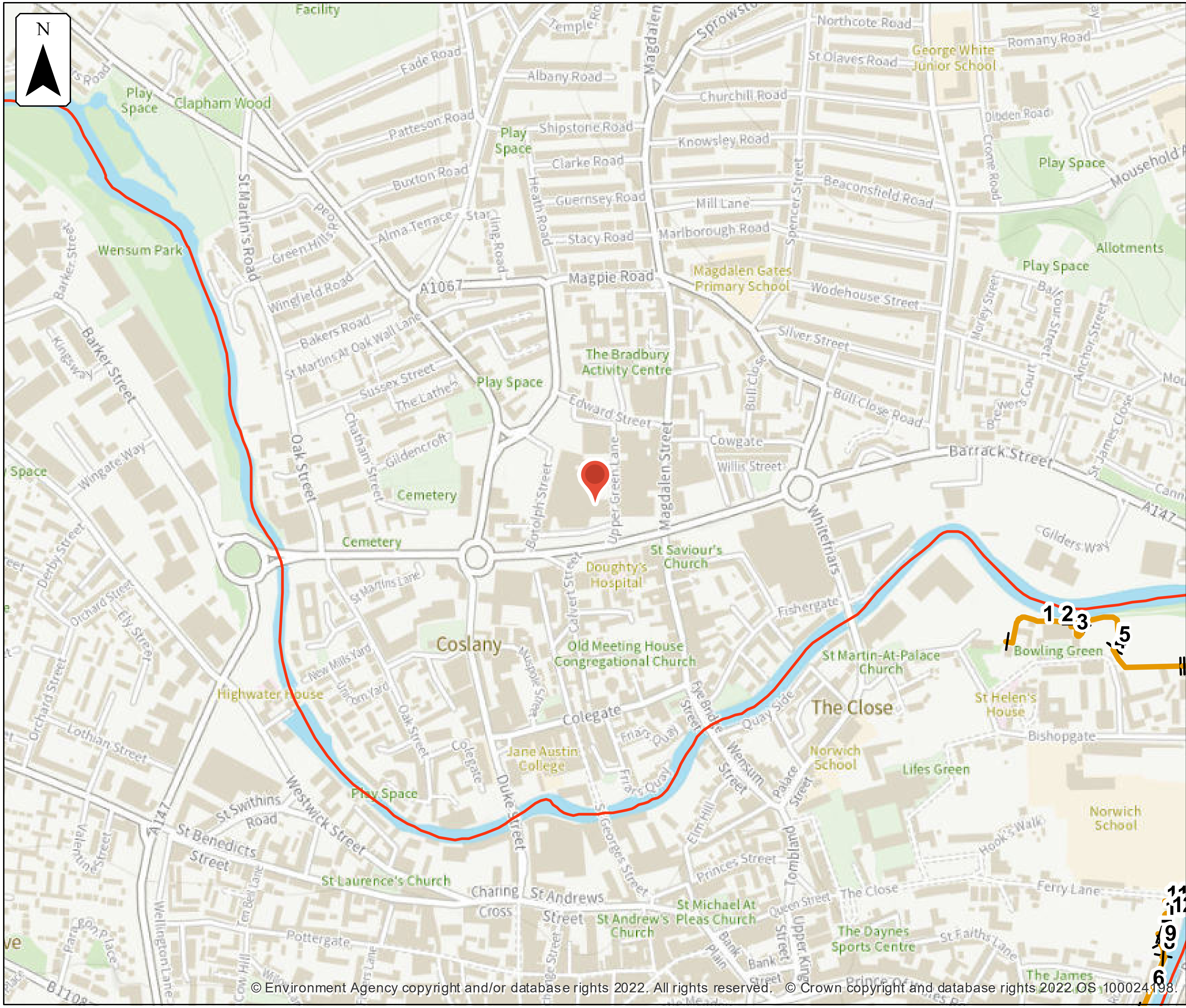
Start date	End date	Source of flood	Cause of flood	Affects location
27 September 1912	28 September 1912	main river	unknown	No

Flood defences and attributes

The flood defences map shows the location of the flood defences present.

The flood defences data table shows the type of defences, their condition and the standard of protection. It shows the height above sea level of the top of the flood defence (crest level). The height is In mAOD which is the metres above the mean sea level at Newlyn, Cornwall.

It's important to remember that flood defence data may not be updated on a regular basis. The information here is based on the best available data.



Environment Agency

Flood defences

Location (easting/northing)
623056/309335

Scale
1:7,500

Created
24 Jan 2022

Selected location

Main river

Flood defence

0 100 200 300
metres

Flood defences data

Label	Asset ID	Asset Type	Standard of protection (years)	Current condition	Downstream actual crest level (mAOD)	Upstream actual crest level (mAOD)	Effective crest level (mAOD)
1	185573	wall	100	Good	3.65	4.71	2.45
2	333453	demountable defence		Fair	3.65	3.65	3.65
3	185572	wall	100	Good	2.62	2.41	2.45
4	332179	flood gate		Good	2.79	2.79	2.79
5	185571	wall	100	Good	2.72	3.56	2.45
6	184354	wall	100		2.30	2.30	2.30
7	184357	wall	100	Good	2.46	2.47	2.48
8	184355	wall	100	Good	2.47	2.48	2.48
9	184356	wall	100	Fair	2.35	2.35	2.42
10	332189	demountable defence			2.40	2.40	2.40
11	332191	demountable defence			2.40	2.40	2.40
12	332190	demountable defence			2.40	2.40	2.40

Any blank cells show where a particular value has not been recorded for an asset.

Modelled data

This section provides details of different scenarios we have modelled and includes the following (where available):

- outline maps showing the area at risk from flooding in different modelled scenarios
- modelled node point map(s) showing the points used to get the data to model the scenarios and table(s) providing details of the flood risk for different return periods
- map(s) showing the approximate water levels for the return period with the largest flood extent for a scenario and table(s) of sample points providing details of the flood risk for different return periods

Climate change

The climate change data included in the models may not include the latest flood risk assessment climate change allowances. Where the new allowances are not available you will need to consider this data and factor in the new allowances to demonstrate the development will be safe from flooding.

The Environment Agency will incorporate the new allowances into future modelling studies. For now, it's your responsibility to demonstrate that new developments will be safe in flood risk terms for their lifetime.

Modelled scenarios

The following scenarios are included:

- Defended modelled fluvial: risk of flooding from rivers where there are flood defences
- Defences removed modelled fluvial: risk of flooding from rivers where flood defences have been removed
- No defences exist modelled fluvial: risk of flooding from rivers where there are no flood defences
- Defended climate change modelled fluvial: risk of flooding from rivers where there are flood defences, including estimated impact of climate change
- Defences removed climate change modelled fluvial: risk of flooding from rivers where flood defences have been removed, including estimated impact of climate change

Modelled (Defended) Outlines

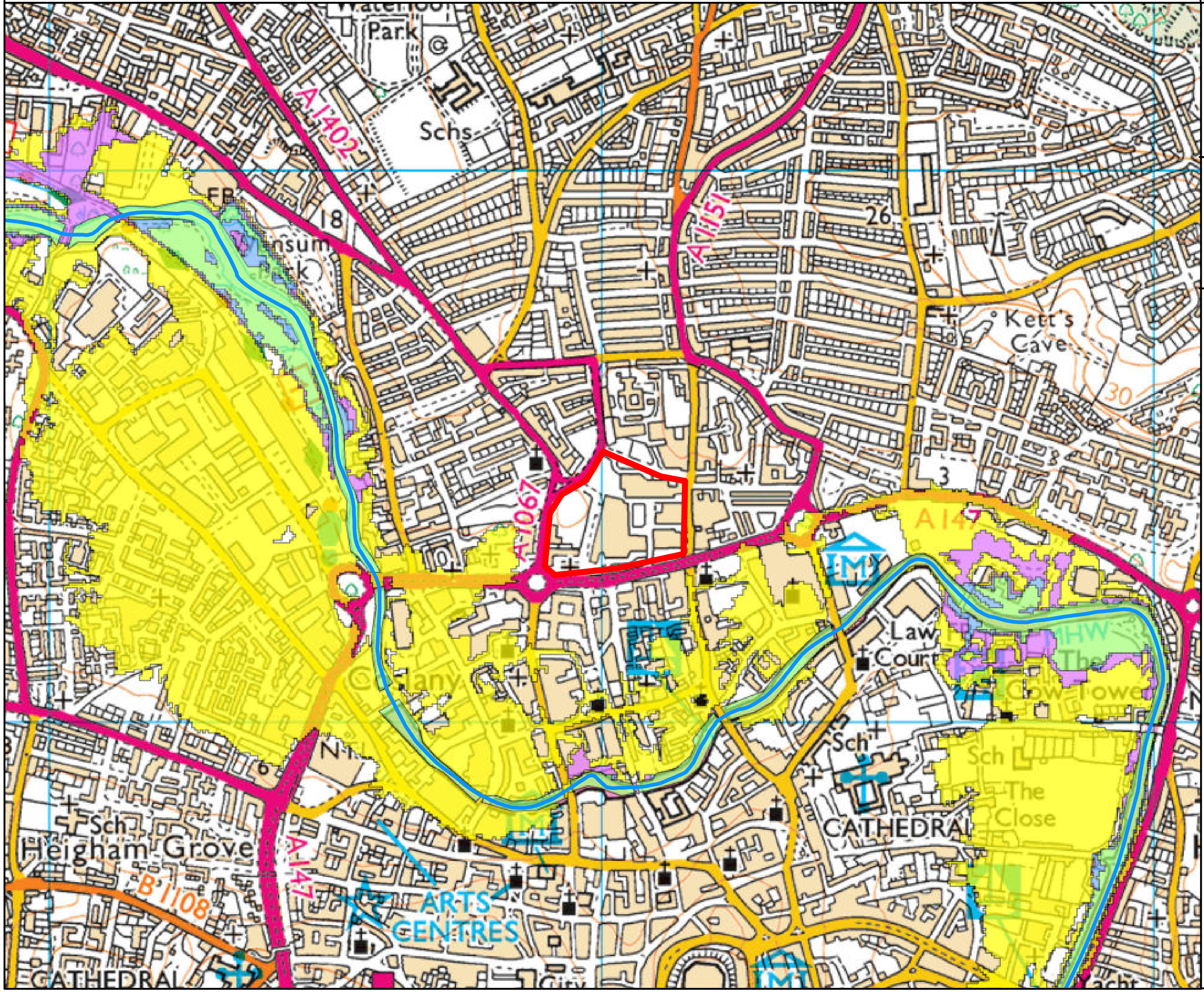
At: 623056, 309335 Created: 24/01/2022 Ref: EAN/2022/248079

Environment Agency

Environment Agency
Iceni House
Cobham Road
Ipswich
Suffolk
IP3 9JD

N

0 120 240 480
Metres
1:10,000



Legend

- Site Location
- Main Rivers
- 1 in 20 (5%)
- 1 in 100 (1%)
- 1 in 200 (0.5%)
- 1 in 1000 (0.1%)

This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences if present.

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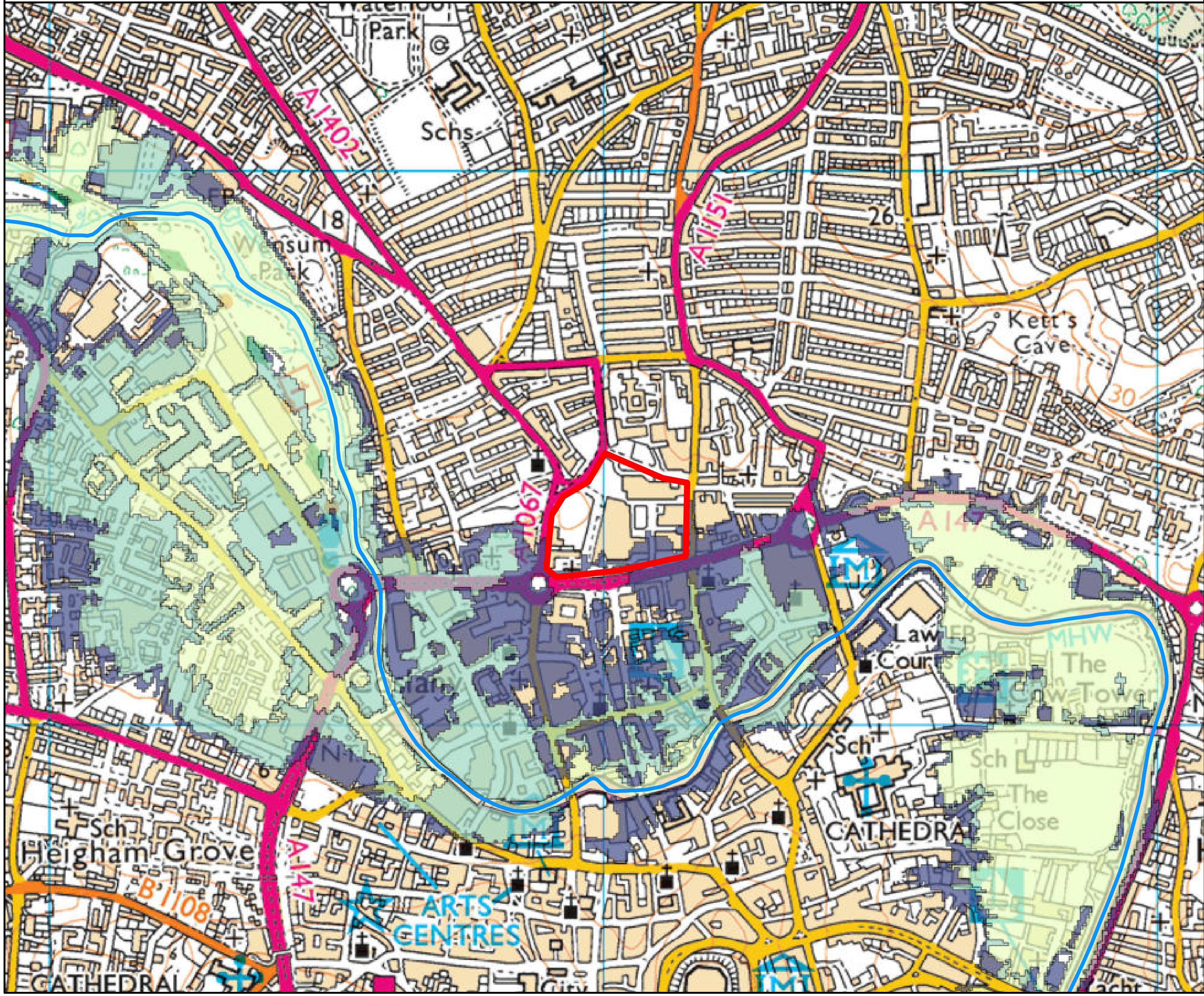
East Anglia: Essex, Norfolk & Suffolk

Modelled (Defended) Climate Change Outlines

At: 623056, 309335 Created: 24/01/2022 Ref: EAN/2022/248079



Environment Agency
Iceni House
Cobham Road
Ipswich
Suffolk
IP3 9JD

0 120 240 480
Metres
1:10,000

Legend

- Site Location
- Main Rivers
- 1 in 100 + 25% (*CC)
- 1 in 200 + 25% (* CC)
- 1 in 1000 + 25% (*CC)

This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences if present.

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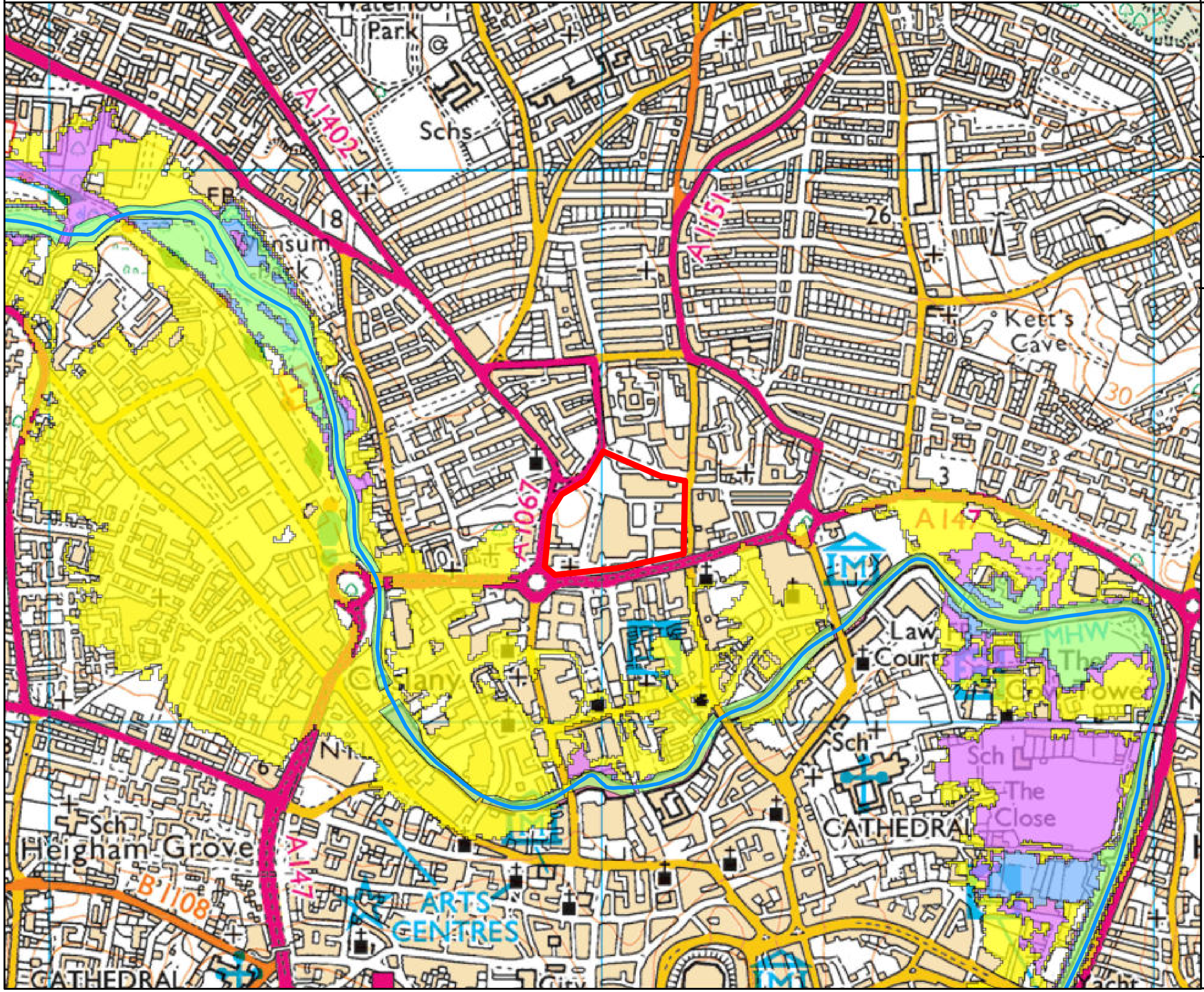
Modelled (Undefended) Outlines

At: 623056, 309335 Created: 24/01/2022 Ref: EAN/2022/248079

Environment Agency

Environment Agency
Iceni House
Cobham Road
Ipswich
Suffolk
IP3 9JD



N

0 120 240 480

Metres

1:10,000

Legend

- Site Location
- Main Rivers
- 1 in 20 (5%)
- 1 in 100 (1%)
- 1 in 200 (0.5%)
- 1 in 1000 (0.1%)

This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences if present.

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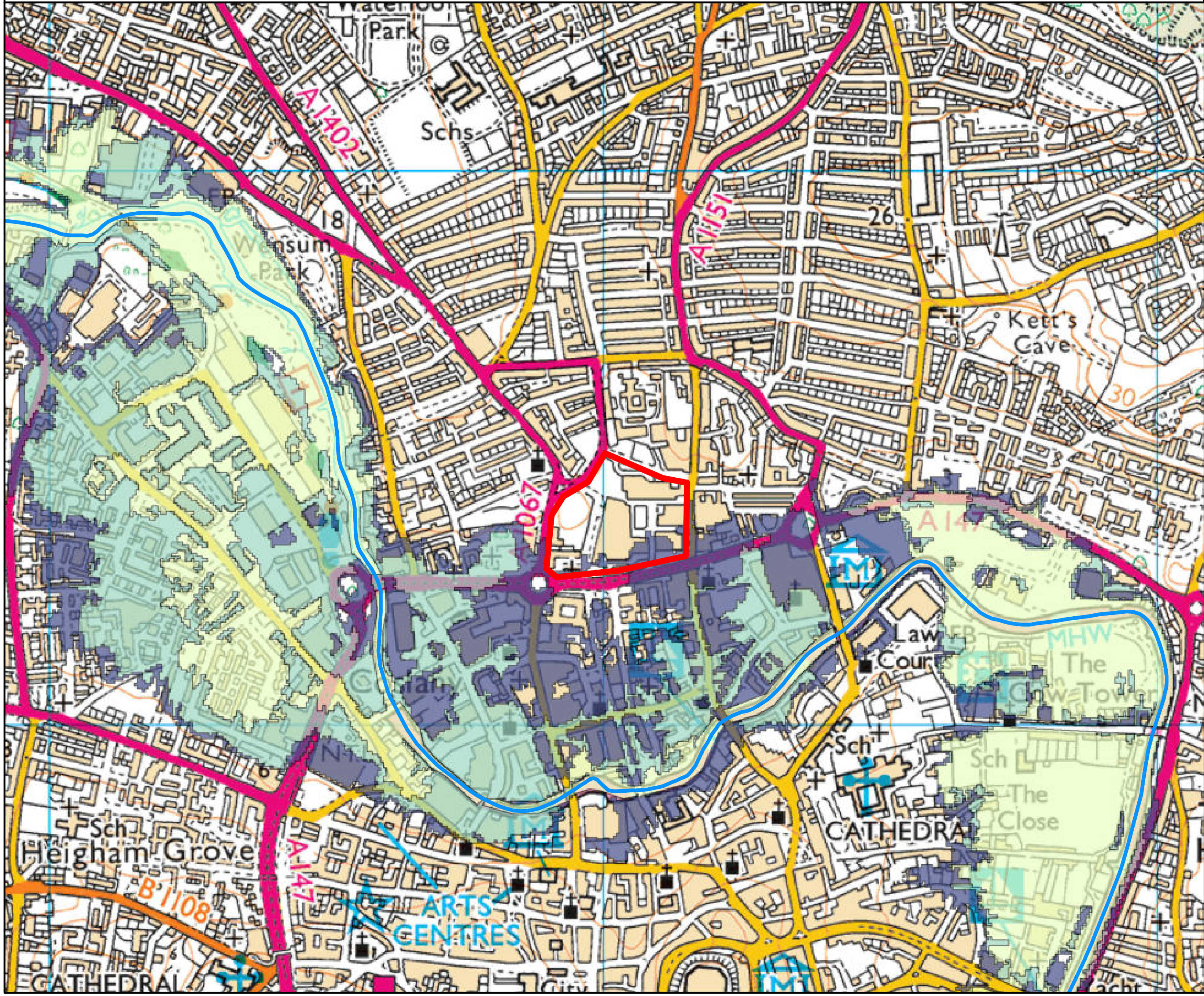
Modelled (Undefended) Climate Change Outlines At:
623056, 309335 Created: 24/01/2022 Ref: EAN/2022/248079

Environment Agency



Environment Agency
Iceni House
Cobham Road
Ipswich
Suffolk
IP3 9JD

N

0 120 240 480
Metres
1:10,000

Legend

- Site Location
- Main Rivers
- 1 in 100 +25% (*CC)
- 1 in 200 + 25% (*CC)
- 1 in 1000 + 25% (*CC)

This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences if present.

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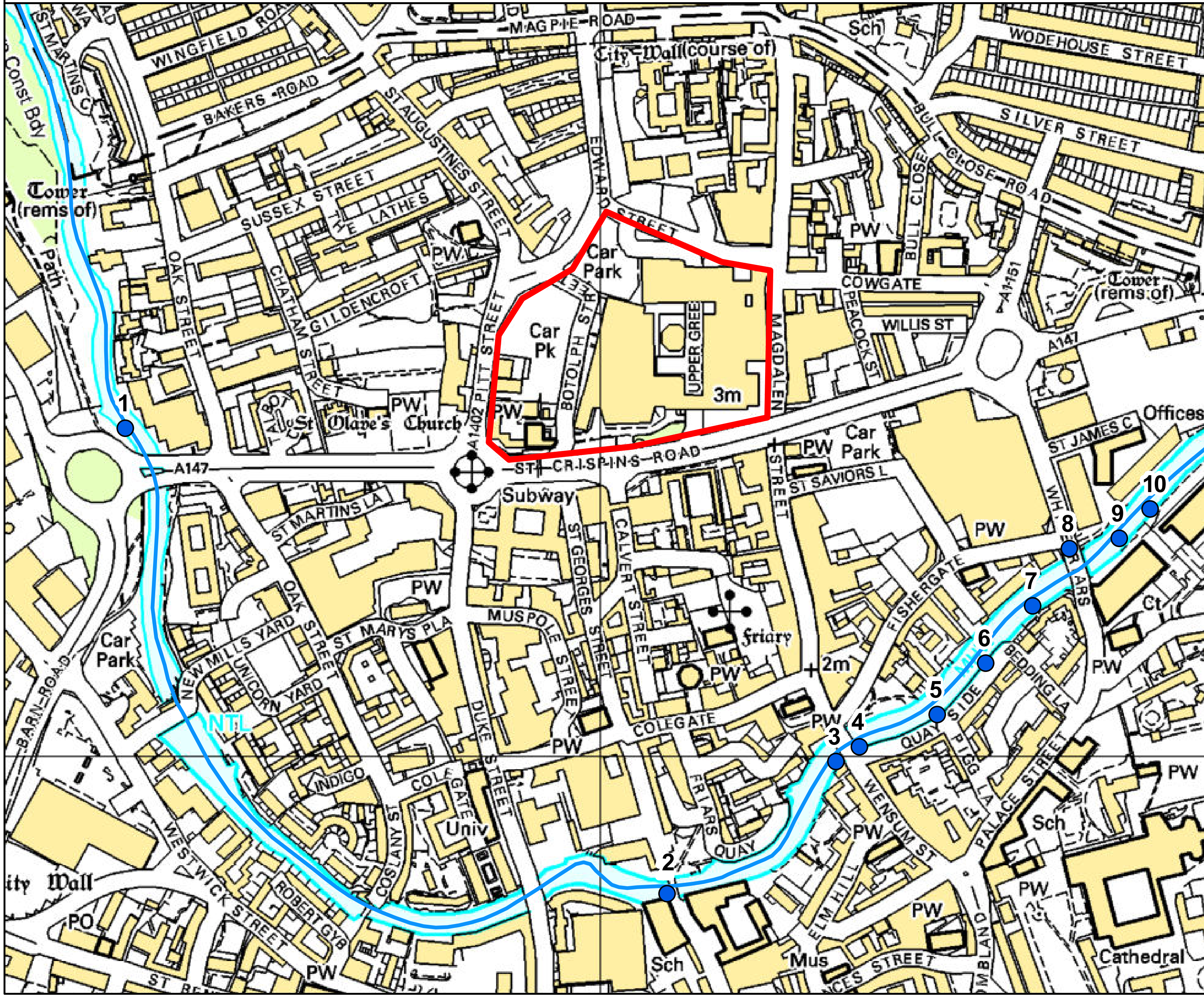
Modelled Node Locations 1D Levels

At: 623056, 309335 Created: 24/01/2022 Ref: EAN/2022/248079

Environment Agency



Environment Agency
Iceni House
Cobham Road
Ipswich
Suffolk
IP3 9JD

N

0 60 120 240
Metres
1:5,000

Legend

Site Location

Main Rivers

Node Location

This model has been designed for catchment wide flood risk mapping.
It should be noted that it was not created to produce flood levels for specific development sites within the catchment.
Modelled outlines take into account catchment wide defences if present.

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East Anglia: Essex, Norfolk & Suffolk

Modelled node locations data

Defended

Label	Modelled location ID	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
				Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow
1	919031	622571	309299	2.44	NoData	2.72	NoData	2.87	NoData	2.94	NoData	2.44	NoData	4.51	NoData
2	919234	623060	308880	2.03	NoData	2.20	NoData	2.32	NoData	2.38	NoData	1.47	NoData	1.52	NoData
3	919143	623212	308999	1.38	NoData	2.14	NoData	2.24	NoData	2.30	NoData	1.46	NoData	3.16	NoData
4	919104	623233	309012	1.96	NoData	2.13	NoData	2.24	NoData	2.29	NoData	1.46	NoData	1.51	NoData
5	919149	623303	309042	1.38	NoData	2.11	NoData	2.22	NoData	2.27	NoData	1.46	NoData	1.50	NoData
6	919260	623347	309088	1.94	NoData	2.10	NoData	2.21	NoData	2.26	NoData	2.60	NoData	3.06	NoData
7	919282	623390	309139	1.93	NoData	2.10	NoData	2.20	NoData	2.25	NoData	1.46	NoData	1.50	NoData
8	919202	623423	309190	1.38	NoData	2.09	NoData	2.19	NoData	2.25	NoData	2.58	NoData	3.04	NoData
9	919165	623466	309201	1.92	NoData	2.08	NoData	2.18	NoData	2.23	NoData	1.46	NoData	2.99	NoData
10	919191	623494	309227	1.38	NoData	2.05	NoData	2.15	NoData	2.20	NoData	1.46	NoData	2.95	NoData

Data in this table comes from the River Wensum, Norwich, Norfolk, 2017 model.
Level values are shown in mAOD, and flow values are shown in cubic metres per second.
Any blank cells show where a particular scenario has not been modelled for this location.

Modelled node locations data

Defences removed

Label	Modelled location ID	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
				Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow
1	919031	622571	309299	2.57	NoData	2.72	NoData	2.87	NoData	2.94	NoData	3.41	NoData	4.50	NoData
2	919234	623060	308880	2.03	NoData	2.20	NoData	2.32	NoData	2.38	NoData	2.76	NoData	1.52	NoData
3	919143	623212	308999	1.97	NoData	2.13	NoData	2.24	NoData	2.30	NoData	2.63	NoData	3.14	NoData
4	919104	623233	309012	1.96	NoData	2.13	NoData	2.23	NoData	2.29	NoData	2.62	NoData	3.09	NoData
5	919149	623303	309042	1.95	NoData	2.11	NoData	2.22	NoData	2.27	NoData	2.60	NoData	3.07	NoData
6	919260	623347	309088	1.94	NoData	2.10	NoData	2.20	NoData	2.26	NoData	2.58	NoData	3.05	NoData
7	919282	623390	309139	1.38	NoData	2.09	NoData	2.20	NoData	2.25	NoData	2.57	NoData	3.03	NoData
8	919202	623423	309190	1.93	NoData	2.09	NoData	2.19	NoData	2.24	NoData	1.46	NoData	3.02	NoData
9	919165	623466	309201	1.92	NoData	2.07	NoData	2.18	NoData	2.23	NoData	2.54	NoData	2.98	NoData
10	919191	623494	309227	1.90	NoData	2.05	NoData	2.15	NoData	2.20	NoData	2.51	NoData	2.93	NoData

Data in this table comes from the River Wensum, Norwich, Norfolk, 2017 model.
Level values are shown in mAOD, and flow values are shown in cubic metres per second.
Any blank cells show where a particular scenario has not been modelled for this location.

Modelled node locations data

Defended climate change

Label	Modelled location ID	Easting	Northing	1.0% AEP (+20%)		1.0% AEP (+25%)		1.0% AEP (+35%)		1.0% AEP (+65%)		0.5% AEP (+20%)		0.5% AEP (+25%)		0.5% AEP (+35%)		0.5% AEP (+65%)		0.1% AEP (+20%)		0.1% AEP (+25%)	
				Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow
1	919031	622571	309299	3.53	NoData	3.73	NoData	3.90	NoData	4.69	NoData	4.27	NoData	4.40	NoData	4.66	NoData	5.0	NoData	4.84	NoData	4.89	NoData
2	919234	623060	308880	2.89	NoData	3.02	NoData	3.08	NoData	3.82	NoData	3.27	NoData	3.37	NoData	3.76	NoData	4.30	NoData	4.03	NoData	4.14	NoData
3	919143	623212	308999	2.76	NoData	2.88	NoData	2.93	NoData	3.42	NoData	3.06	NoData	3.12	NoData	3.37	NoData	3.91	NoData	3.58	NoData	3.72	NoData
4	919104	623233	309012	2.75	NoData	2.86	NoData	2.91	NoData	3.32	NoData	3.03	NoData	3.08	NoData	3.28	NoData	3.74	NoData	3.44	NoData	3.55	NoData
5	919149	623303	309042	2.73	NoData	2.84	NoData	2.89	NoData	3.30	NoData	3.0	NoData	3.06	NoData	3.26	NoData	3.71	NoData	3.41	NoData	3.52	NoData
6	919260	623347	309088	2.71	NoData	2.82	NoData	2.88	NoData	3.28	NoData	2.99	NoData	3.04	NoData	3.24	NoData	3.69	NoData	3.39	NoData	3.50	NoData
7	919282	623390	309139	2.70	NoData	2.81	NoData	2.87	NoData	3.26	NoData	2.98	NoData	3.02	NoData	3.22	NoData	3.66	NoData	3.37	NoData	3.48	NoData
8	919202	623423	309190	2.70	NoData	2.81	NoData	2.86	NoData	3.26	NoData	2.97	NoData	3.02	NoData	3.22	NoData	3.65	NoData	3.36	NoData	3.47	NoData
9	919165	623466	309201	2.67	NoData	2.78	NoData	2.83	NoData	3.21	NoData	2.93	NoData	2.98	NoData	3.17	NoData	3.58	NoData	3.30	NoData	3.41	NoData
10	919191	623494	309227	2.64	NoData	2.75	NoData	2.80	NoData	3.16	NoData	2.89	NoData	2.94	NoData	3.12	NoData	3.52	NoData	3.25	NoData	3.35	NoData

Data in this table comes from the River Wensum, Norwich, Norfolk, 2017 model.
Level values are shown in mAOD, and flow values are shown in cubic metres per second.
Any blank cells show where a particular scenario has not been modelled for this location.

Modelled node locations data

Defences removed climate change

Label	Modelled location ID	Easting	Northing	1.0% AEP (+25%)		1.0% AEP (+35%)		1.0% AEP (+65%)		0.5% AEP (+25%)		0.5% AEP (+65%)		0.1% AEP (+20%)		0.1% AEP (+25%)	
				Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow
1	919031	622571	309299	3.72	NoData	3.88	NoData	4.69	NoData	4.39	NoData	5.0	NoData	5.08	NoData	4.89	NoData
2	919234	623060	308880	3.01	NoData	3.07	NoData	3.82	NoData	3.35	NoData	4.30	NoData	4.42	NoData	4.14	NoData
3	919143	623212	308999	2.86	NoData	2.92	NoData	3.42	NoData	3.11	NoData	3.91	NoData	4.05	NoData	3.72	NoData
4	919104	623233	309012	2.85	NoData	2.90	NoData	3.32	NoData	3.07	NoData	3.74	NoData	3.88	NoData	3.55	NoData
5	919149	623303	309042	2.83	NoData	2.88	NoData	3.30	NoData	3.04	NoData	3.70	NoData	3.84	NoData	3.52	NoData
6	919260	623347	309088	2.81	NoData	2.87	NoData	3.28	NoData	3.03	NoData	3.68	NoData	3.82	NoData	3.50	NoData
7	919282	623390	309139	2.80	NoData	2.86	NoData	3.26	NoData	3.02	NoData	3.66	NoData	3.79	NoData	3.48	NoData
8	919202	623423	309190	2.80	NoData	2.85	NoData	3.25	NoData	3.01	NoData	3.64	NoData	3.77	NoData	3.47	NoData
9	919165	623466	309201	2.77	NoData	2.82	NoData	3.20	NoData	2.97	NoData	3.58	NoData	3.70	NoData	3.41	NoData
10	919191	623494	309227	2.73	NoData	2.79	NoData	3.15	NoData	2.93	NoData	3.52	NoData	3.63	NoData	3.35	NoData

Data in this table comes from the River Wensum, Norwich, Norfolk, 2017 model.
Level values are shown in mAOD, and flow values are shown in cubic metres per second.
Any blank cells show where a particular scenario has not been modelled for this location.

Modelled (Defended) 2D Levels

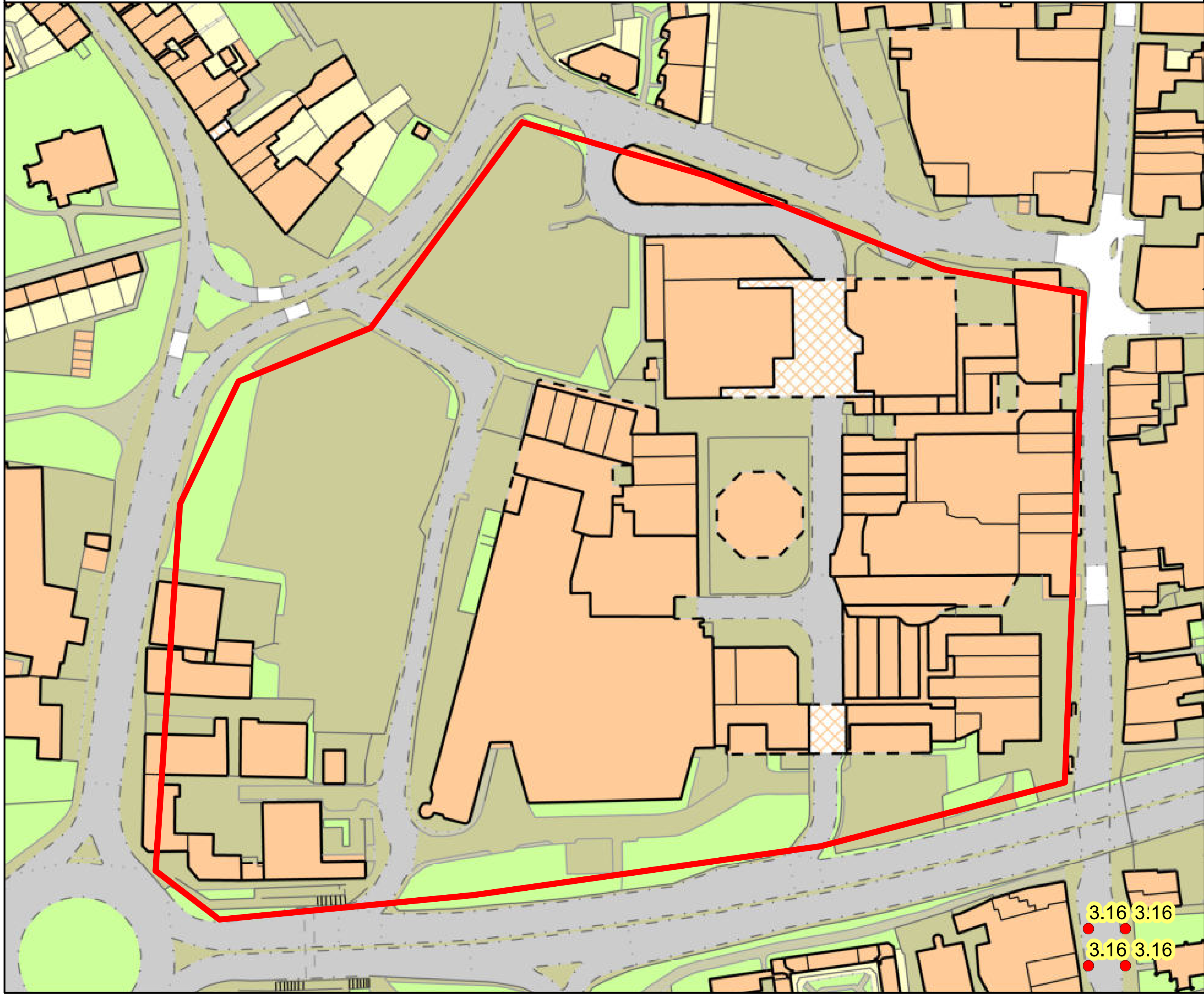
At: 623056, 309335 Created: 24/01/2022 Ref: EAN/2022/248079

Environment Agency

Environment Agency
Iceni House
Cobham Road
Ipswich
Suffolk
IP3 9JD

N

0 15 30 60
Metres
1:1,500



Legend

- Site Location
- Main Rivers
- 1 in 1000 (0.1%)

This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences if present.

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

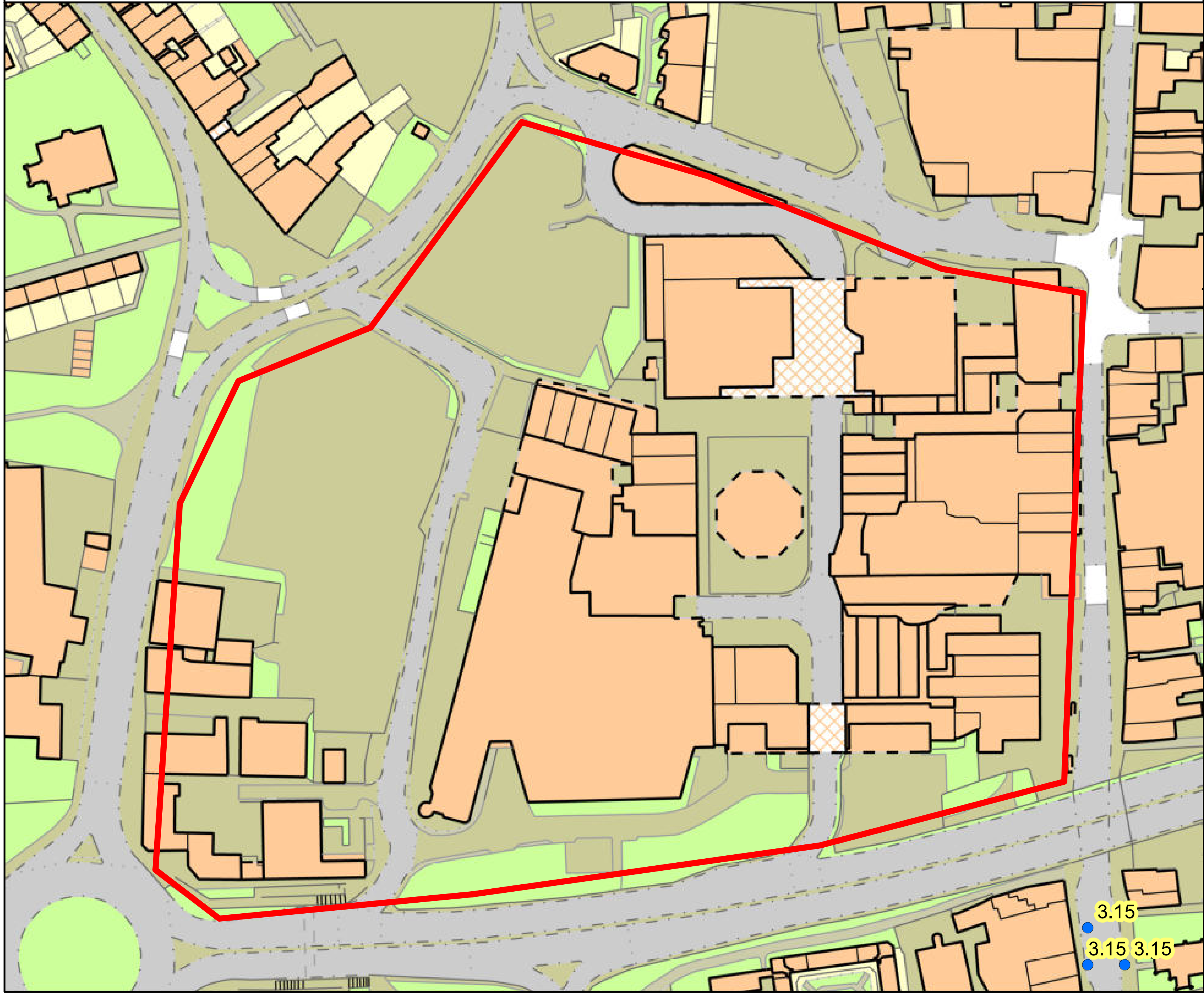
Produced by: Partnership & Strategic Overview
East Anglia: Essex, Norfolk & Suffolk

Modelled (Undefended) 2D Levels

At: 623056, 309335 Created: 24/01/2022 Ref: EAN/2022/248079

Environment Agency

Environment Agency
Iceni House
Cobham Road
Ipswich
Suffolk
IP3 9JD



1:1,500

Legend

Site Location

Main Rivers

1 in 1000 (0.1%)

This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences if present.

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Produced by: Partnership & Strategic Overview East Anglia: Essex, Norfolk & Suffolk

Modelled (Defended) 2D Levels

At: 623056, 309335 Created: 24/01/2022 Ref: EAN/2022/248079

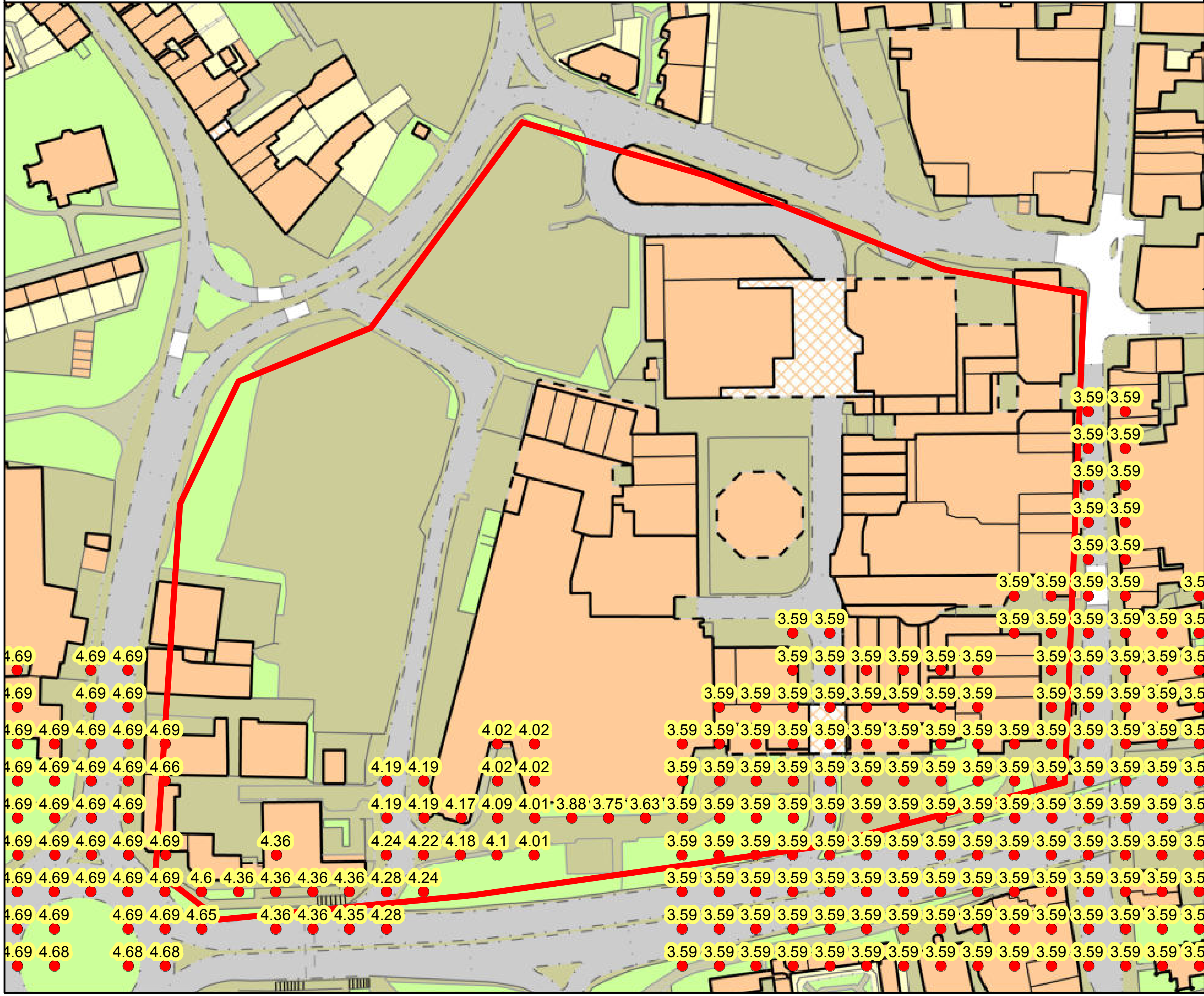
Environment Agency

Environment Agency
Iceni House
Cobham Road
Ipswich
Suffolk
IP3 9JD

N

0 15 30 60
Metres

1:1,500



Legend

- Site Location
- Main Rivers
- 1 in 1000+25%(*CC)

This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences if present.

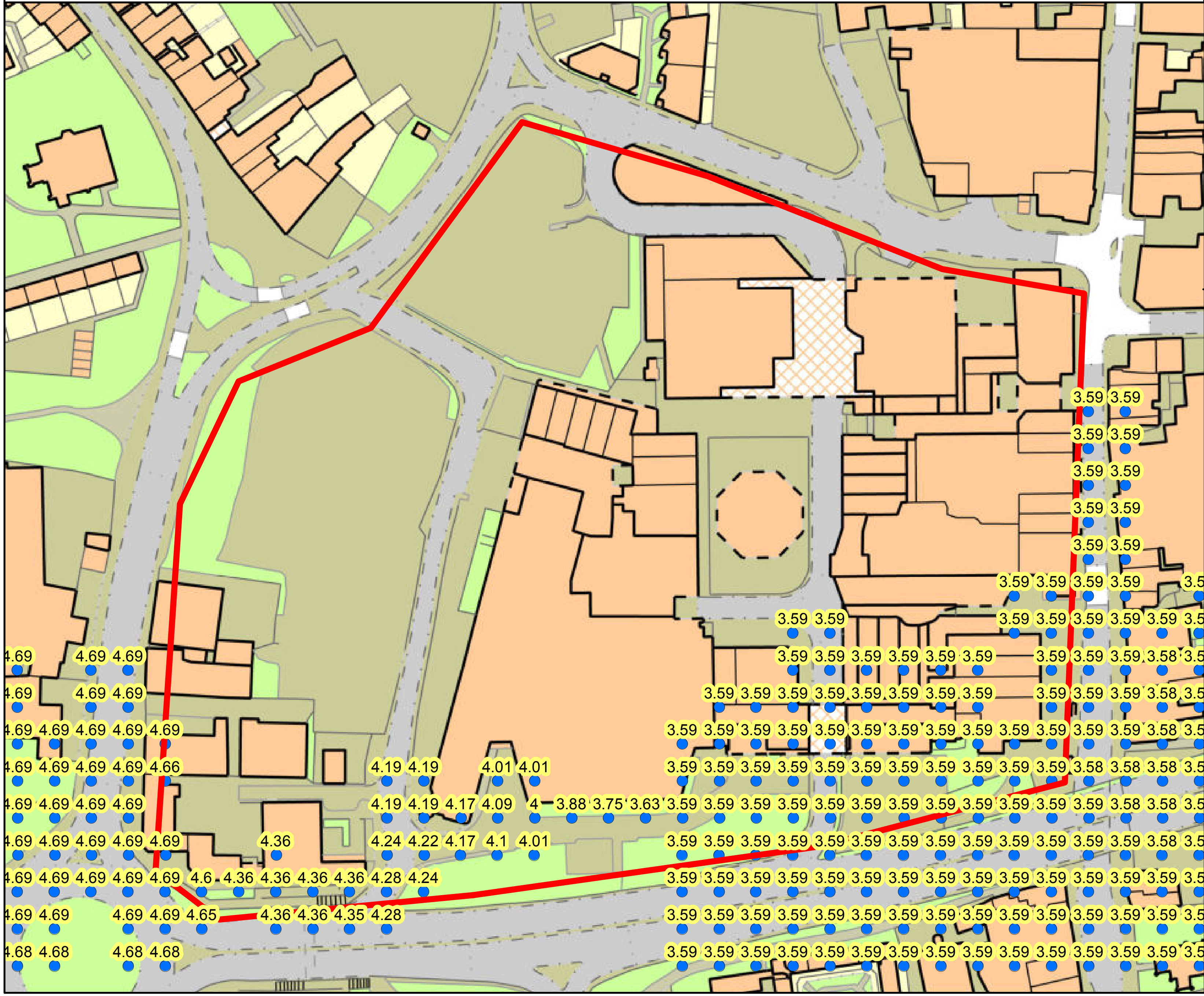
Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Produced by: Partnership & Strategic Overview
East Anglia: Essex, Norfolk & Suffolk

Modelled (Undefended) 2D Levels

At: 623056, 309335 Created: 24/01/2022 Ref: EAN/2022/248079

Environment Agency



Environment Agency
Iceni House
Cobham Road
Ipswich
Suffolk
IP3 9JD

N

0 15 30 60
Metres
1:1,500

Legend

Site Location

Main Rivers

1 in 1000+25%(*CC)

This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences if present.

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Produced by: Partnership & Strategic Overview
East Anglia: Essex, Norfolk & Suffolk

Appendix C Norfolk County Council Pre-Application Comments

Norfolk County Council

Community and Environmental Services
County Hall
Martineau Lane
Norwich
NR1 2SG

NCC contact number: 0344 800 8020
Textphone: 0344 800 8011

via e-mail
Louisa Wade
Royal HaskoningDHV UK LTD
Burns House
Harlands Road
Haywards Heath
West Sussex
RH16 1PG

Your Ref:	PC3230-WM-CO-220210-1516	My Ref:	FW2021_1109
Date:	14th March 2022	Tel No:	0344 800 8020
		Email:	llfa@norfolk.gov.uk

Dear Ms Wade

Pre-application Advice for the hydraulic modelling of redevelopment at Anglia Square, Norwich

Thank you for your pre-application advice request in relation to the hydraulic modelling for the redevelopment of Anglia Square in Norwich that we received on 11 February 2022.

Previously, the LLFA were consulted on several occasions for a development at Anglia Square between 2016 and 2019. The LLFA are aware that the previous development proposal was unsuccessful and since then there have been updates to both National Planning Policy Framework (NPPF) and the LLFA Developer Guidance. Therefore, as both the site plan and the policy environment has changed significantly the LLFA will treat this as a new application and advice will be provided in accordance with the current policies. We note the intention of the applicant to submit a hybrid planning application for the proposed development. Therefore, as the hydraulic model will support a full application further refinement of the hydraulic model will be required as an effective evidence base for this aspect of the application.

The documents provided for review are:

- Email received from Louisa Wade on 11 February 2022 titled "Anglia Square Norwich – Flood Risk Pre-Application Advice Request" with the following attachments
    - 20220210 - Pre-Application Request - Anglia Square Norwich.pdf
    - FIG 1_ EXISTING 1 IN 100 YR (PLUS 40_CC).pdf
    - Ground Floor Master Plan - Application Boundary.pdf
    - Pre App Form - ANGLIA SQUARE NORWICH.pdf
    - FEH Hydrology.zip
- Hydraulic model received via Royal HaskoningDHV UK Ltd's internal share site on 28 February 2022
- Additional information provided by email on 3 March 2022

Continued…/

We wish to make the following comments on the data provided as follows.

Modelling Approach

Model Hydrology

The updating of the model hydrology to use FEH2013 and REFH2 to generate updated rainfall is welcomed by the LLFA. The LLFA will expect documentation to be provided in support of the planning application detailing the hydrological parameters including those used within the REFH software.

We note that 2d_bc inflow boundaries have been used from the Norwich Surface Water Management Plan (SWMP) Model with 20% climate change allowance. These originated from the broadscale model used for the SWMP that covers the whole of Norwich. The LLFA has provided the model build report for reference and use. The LLFA does not consider it acceptable to use the 20% climate change values for these flows. It expects the model to be extended, based on the local topography, to ensure all upstream flows are covered by the direct rainfall boundary as per LLFA Developer Guidance .

The information provided by the applicant states that a peak storm duration of 3 hours has been used. Evidence to demonstrate should be provided that the critical storm duration is 3 hours. Section 10.2.3 of the LLFA Developer Guidance states that

> "storm durations for the critical storm, 1hr and 3hr should be run."

Therefore, a 1 hour duration storm should also be simulated. Additionally, both the summer and winter storm profiles should be tested to determine the critical event type for the catchment.

An infiltration rate of 7mm per hour has been applied across the catchment to represent flows to the sewer network and infiltration. The SWMP model build report, paragraph 2.5, states that the capacity of the drainage system varies across the catchment. The Anglian Water surface water system is likely to influence the flooding locations local to the site. Additionally, where drainage carrying onsite flows is connecting to the Anglian Water sewer, water levels in the sewer may prevent discharge from the site at the agreed design flow and consequently cause additional flooding to the site. Therefore, Anglian Water should be consulted regarding the capacity of their system local to the site. It is also recommended that the Anglian Water sewer system is included in the model. The LLFA will require evidence of consultation with Anglian Water within any planning submission.

We would encourage the applicant's early engagement with regards to anything being proposed for adoption by Anglian Water, who offer a free service. These gives both the developer and Anglian Water an early opportunity to develop a design as it comes through planning and align with both your requirements as well as adoptable standards and encourage good SuDS designs. Anglian Water have developed a form for developers to submit information that they request to support developers in their design development process which can be found at https://www.anglianwater.co.uk/developing/planning--capacity/planning-and-capacity/.

Model Geometry

We welcome the inclusion of the latest Environment Agency LiDAR to update the model . The LLFA Developer Guidance in section 10.2.3 states

> "Ground truthing checks should be undertaken to understand and improve accuracy of any base digital terrain model such as artificial ground height at tops of trees, creating cuttings in linear features to represent culverts or bridges etc"

The LLFA queries whether ground truthing checks been undertaken for this model?

The LLFA is concerned that the representation of the St Crispins Road flyover that is indicated to be enforced at a level of 8m. The considers that the current representation may not accurately reflect the surface water flow paths across the road at the western end where finished road and ground levels are lower. We recommend this is enforced using variable levels to represent the road as it rises steadily toward St Magdalen Street.

The LLFA note that a 1d_nwk_NOR2_culverts layer is included in the hydraulic model that represents culverts across the catchment. A review of this layer shows only one culvert included, which represents a subway under St Crispins Road near the Cherry Lane exit. This subway was infilled in 2018 and should be removed from the model. Further details and confirmation of these works can be found at https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/norwich/city-centre-improvements/improvement-projects/recently-completed/st-crispins-road-crossing

We understand the building thresholds have been included in the model at a standard threshold level of 100mm. We note that the road level was lowered by 125mm to allow for the street kerbs to be represented. However, it is observed that many properties on Magdalen Street, both adjacent to the development and to the south of the development, have thresholds level with the existing pavement. The LLFA expects a suitable level survey should be undertaken along key flow routes impacting the proposed site and the offsite area to ensure that the assumed 100mm threshold level is appropriate for use.

Model Proving
In the information provided to date, there are no details of model calibration. The LLFA Developer Guidance confirms in section 10.2.3 that

> "Calibration modelling scenarios should be run using historic flooding information to the actual recorded rainfall event return period."

A significant rainfall event occurred in the catchment in 2014, after the SWMP model was developed. This event is detailed in Flood Investigation Report FIR008 (https://www.norfolk.gov.uk/-/media/norfolk/downloads/rubbish-recycling-planning/flood-and-water-management/flood-investigation-reports/norwich-and-broadland-2014.pdf). The model should be run for this event and flooding locations compared.

Sensitivity testing should also be undertaken on key parameters. These should include as a minimum sensitivity on inflows, roughness, blockage of any culverts or structures, losses applied to the model and boundary conditions. Please see Environment Agency hydraulic modelling best practice guidance at https://www.gov.uk/government/publications/river-modelling-technical-standards-and-assessment/hydraulic-modelling-best-practice-model-approach for further information.

In addition, model stability checks should be undertaken on the finished model runs to ensure the mass balance is acceptable and erratic flow profiles are not seen within the results. These should be reported upon within the hydraulic modelling report accompanying the application. Where a mass balance of <1% cannot be achieved in both the time varying and overall mass balance outputs the report should provide evidence that this is not impacting predicted flooding.

Post Scheme
At present, the post scheme model has not been reviewed as your letter indicates it is not yet finalised. However, the LLFA would be concerned about the proposal to channel overland flow through the site as this may result in an increase in peak flows from the site causing offsite impacts. Any modelling would need to demonstrate no increase in flood risk elsewhere as per paragraph 164 of NPPF. The site drainage should be included in the model as per design.

Local Flood Risk
For details on particular flood risk or drainage issues relating to the site or surrounding area please see attached desktop study.

Offsite Impacts
The LLFA would expect to see no increase in flood risk as per paragraph 164 of NPPF. Where an increase in flood depths occur the LLFA will require an explanation for the increase with an accompanying hazard assessment and details of impacted receptors.

Flood Risk Management Approach
With regard to your proposed details of the attenuation tanks flood warning system, we are unable to provide any meaningful comment at this time due to a lack of appropriate information that demonstrates the appropriateness for this system. In order to provide further comment on this we will require full context of flood risk on site. The applicant should confirm that the development has been designed appropriately and according to latest LLFA Developer Guidance. Prior to consideration of flood warning systems we would require evidence that:

- Flood risk has been appropriately assessed. We would require the above updates to the hydraulic model to be undertaken to ensure flood risk has been assessed accurately.
- Following the above assessment a masterplan should be developed that takes into account land use vulnerability and the modelled future flood risk. For example, more vulnerable development should be placed outside of the surface water flood risk area for the 1% AEP event plus climate change where possible (See Section 10.2.1 of LLFA developer guidance). Some key things to consider are
    - The below ground carpark in Block A is in an area of known flood risk and therefore should be situated at or above ground level. At a minimum any opening to the carpark should be 300mm above the 1% AEP event plus climate change level as per policy box 9 in Section 20 of the LLFA guidance.
    - Site drainage has been designed in line with Section 11 of the LLFA developer guidance which outlines drainage hierarchies in policy boxes 2 and 3. In particular rainwater harvesting should be included in the design where there is a demand for non-potable water.

We remind the applicant that avoidance of risk should always be the starting point of any design. A flood warning system would be considered to a last resort management option. Therefore, an evidence base that demonstrates and supports the design decisions will be required.

Should you have any further questions then please contact us by email at llfa@norfolk.gov.uk. Alternatively further guidance on the information required by the LLFA from applicants can be found at https://www.norfolk.gov.uk/rubbish-recycling-and-planning/flood-and-water-management/information-for-developers.

Yours sincerely,

Sarah

Sarah Sims
Flood Risk Officer

Lead Local Flood Authority

Disclaimer
We have relied on the accuracy and completeness of the information supplied to us in providing the above advice and can take no responsibility for incorrect data or interpretation, or omissions, in such information. If we have not referred to a particular issue in our response, it should not be assumed that there is no impact associated with that issue.

Appendix D Proposed Development Plans

Contractors and consultants are not to scale dimensions from this drawing

The survey information shown on this drawing is based on a topographical survey prepared by a third party and Broadway Malyan Limited accept no responsibility for the accuracy or completeness of the survey.

Drawings to be read in conjunction with the associated Design & Access Statement, associated consultant desin team documents & reports and landscape information

Landscape shown is for illustrative purposes only. For detailed landscape information, please refer to the landscape information & documents.

0m 25m 50m

N

General Notes

All figures and areas are approximate only and subject to statutory constraints, detail design & design development

Structural Design: Subject to structural input & coordination

Services Design: Subject to services input & coordination

Fire Strategy: Subject to fire input & coordination

Land Owned by CT to be subject to separate application for part of the Mobility Hub

Detail Application Boundary

- Site B - Area 0.27 ha
- Site C - Area 0.13 ha
- Applcation Boundary (All Blocks) and public realm - Area 4.65ha
- Detailed Application (Block A,B,C,D,M,KL & J3) and public realm - Area 2.25ha

Revision	Date	Drawn By	Description

BroadwayMalyanBM

4 Pear Place
London
SE1 8BT

T: +44 (0)20 7261 4200
F: +44 (0)20 7261 4300
E: Lon@BroadwayMalyan.com

www.BroadwayMalyan.com

Client
Weston Homes

Project
Anglia Square
Norwich

Description
Detailed Application Plan
Block plan on proposed layout

Status
For Planning

Scale	Drawn By	Date
1:500@A1	BM	31.03.22

Job Number	Drawing Number	Revision
35301	ZZ-00-DR-A-01-0301	

Contractors and consultants are not to scale dimensions from this drawing

The survey information shown on this drawing is based on a topographical survey prepared by a third party and Broadway Malyan Limited accept no responsibility for the accuracy or completeness of the survey.

Drawings to be read in conjunction with the associated Design & Access Statement, associated consultant desin team documents & reports and landscape information

Landscape shown is for illustrative purposes only. For detailed landscape information, please refer to the landscape information & documents.

0m 25m 50m

N

General Notes

All figures and areas are approximate only and subject to statutory constraints, detail design & design development

Structural Design: Subject to structural input & coordination

Services Design: Subject to services input & coordination

Fire Strategy: Subject to fire input & coordination

Application Boundary
Detail Application Boundary

Revision	Date	Drawn By	Description
D0-1	31.03.22		Issued for Planning

BroadwayMalyan BM

4 Pear Place
London
SE1 8BT

T: +44 (0)20 7261 4200
F: +44 (0)20 7261 4300
E: Lon@BroadwayMalyan.com

www.BroadwayMalyan.com

Client
Weston Homes

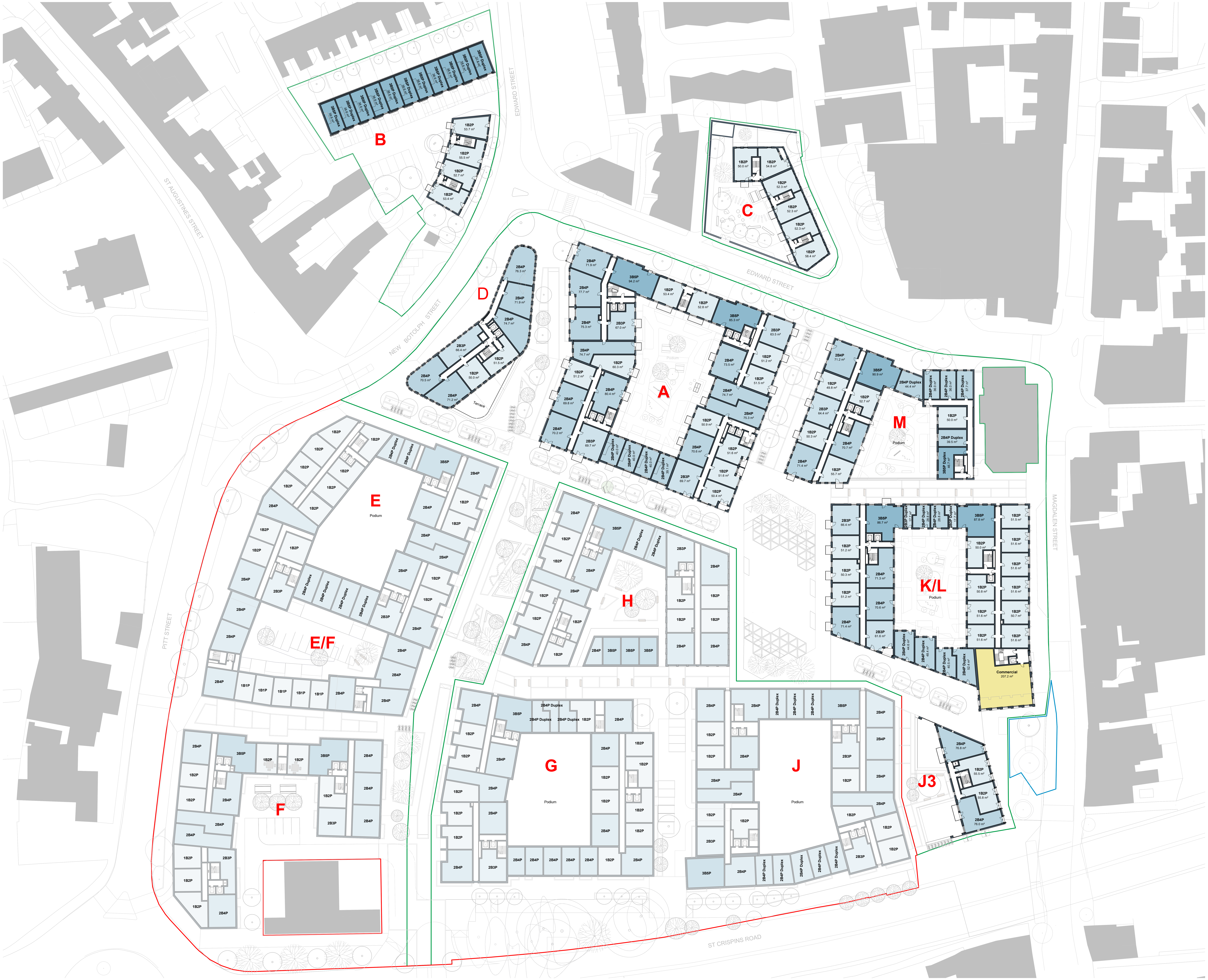
Project
Anglia Square
Norwich

Description
Masterplan
Level 00

Status
WORK-IN-PROGRESS

Scale	Drawn By	Date
1:500@A1	BM	26.01.22
Job Number	**Drawing Number**	**Revision**
35301	ZZ-00-DR-A-01-0100	D0-1


B
C
D
A
M
E
E/F
F
G
H
J
J3
K/L
EDWARD STREET
NEW BOTOLPH STREET
ST AUGUSTINES STREET
PITT STREET
MAGDALEN STREET
ST CRISPINS ROAD
Community Hub
Podium
Terrace
Terrace



B
C
D
A
M
E
E/F
H
K/L
F
G
J
J3
EDWARD STREET
ST AUGUSTINES STREET
NEW BOTOLPH STREET
PITT STREET
MAGDALEN STREET
ST CRISPINS ROAD
Podium
Terrace
Commercial

Appendix E Topographic Survey


Barclays Bank
SERVICE LEGEND
FOUL DRAINAGE
SURFACE WATER DRAINAGE
WATER
GAS
ELECTRICITY
TELEPHONE
CABLE TV
MERCURY
TRAFFIC SIGNAL
OIL
UNKNOWN SERVICE
NEW DETAIL
UNDERGROUND CHAMBER

Appendix F Anglian Water Sewer Records and Confirmation of No Historick Sewer Flooding

 Date: 16/01/17 Scale: 1:1250 Map Centre: 623007,309342 Data updated: 24/10/16 Our Ref: 210177 - 1 Wastewater Plan A1

Foul Sewer
Surface Sewer
Combined Sewer
Final Effluent
Rising Main (Colour denotes effluent type)
Private Sewer (Colour denotes effluent type)
Decommissioned Sewer (Colour denotes effluent type)
Outfall (Colour denotes effluent type)
Inlet (Colour denotes effluent type)
Manhole (Colour denotes effluent type)
Sewage Treatment Works
Pumping Station

louisa.wade@eastp.co.uk

Anglia Square Norwic

love every drop
anglianwater

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert
0002	623050	309027	C	2.96	-0.98	3.94
0008	623008	309060	C	3.23	0.28	2.95
0010	623023	309019	C	2.94	-0.87	3.81
0101	623023	309178	C	4	1.85	2.15
0104	623025	309161	C	3.95	1.74	2.21
0105	623036	309101	C	3.43	0.14	3.29
0107	623073	309110	C	3.64	2.28	1.36
0201	623015	309237	C	4.34	2.12	2.22
0202	623010	309274	C	-	-	-
0604	623030	309667	C	-	-	2.4
1006	623105	309035	C	2.71	-1.26	3.97
1015	623192	309077	C	-	-	-
1112	623120	309178	C	3.874	1.179	2.695
1114	623189	309114	C	2.742	1.072	1.67
1201	623196	309247	C	3.13	1.38	1.75
1203	623162	309240	C	3.147	1.647	1.5
1204	623103	309267	C	3.55	1.18	2.37
1205	623147	309279	C	3.38	1.17	2.21
1213	623155	309280	C	3.347	1.747	1.6
1214	623169	309204	C	-	-	-
1215	623159	309280	C	-	-	-
1313	623160	309375	C	-	-	-
1407	623164	309465	C	-	-	-
1504	623169	309561	C	-	-	-
1505	623169	309559	C	5.342	1.407	3.935
2003	623246	309077	C	-	-	4.3
2017	623248	309069	C	-	-	-
2018	623248	309047	C	-	-	-
2019	623206	309033	C	3.107	-1.663	4.77
2101	623281	309151	C	2.47	1	1.47
2103	623255	309184	C	2.99	1.86	1.13
2104	623261	309115	C	-	-	3.95
2201	623212	309251	C	3.28	0.13	3.15
2203	623269	309260	C	-	-	3.275
2205	623294	309270	C	3.02	1.29	1.73
2207	623298	309210	C	-	-	3.1
2208	623207	309272	C	-	-	-
2209	623223	309253	C	-	-	-
2301	623230	309388	C	3.63	1.64	1.99
2305	623256	309366	C	3.4	2.21	1.19
2308	623244	309350	C	3.26	1.24	2.02
2402	623262	309409	C	3.48	1.1	2.38
2403	623210	309430	C	3.88	1.66	2.22
2404	623221	309431	C	3.85	1.59	2.26
2405	623226	309407	C	3.81	1.79	2.02
2407	623280	309471	C	4.32	2.09	2.23
2408	623275	309425	C	-	-	2.35
2502	623285	309527	C	5.82	2.93	2.89
2503	623273	309540	C	6.32	4.95	1.37
2505	623282	309594	C	-	-	-
2506	623229	309537	C	-	-	-
3001	623313	309032	C	2.21	0.6	1.61
3004	623370	309098	C	2.79	0.24	2.55
3006	623394	309092	C	3.5	1.97	1.53
3007	623351	309067	C	-	-	-
3101	623307	309165	C	2.449	0.349	2.1
3102	623319	309175	C	2.406	0.456	1.95
3106	623372	309187	C	-	-	3.48
3107	623337	309129	C	1.76	0.28	1.48
3109	623389	309118	C	-	-	-
3305	623393	309368	C	2.81	0.04	2.77
3306	623387	309387	C	3.16	0.32	2.84
3401	623327	309425	C	3.4	0.67	2.73
3404	623376	309422	C	3.58	0.54	3.04
3405	623318	309407	C	3.47	1.79	1.68
3406	623381	309405	C	3.31	0.45	2.86
3407	623362	309407	C	-	-	2.02
3506	623383	309536	C	-	-	-
3602	623321	309637	C	-	-	-
3611	623383	309669	C	-	-	-
4002	622496	309090	C	-	-	-
4002	623413	309054	C	4.17	2.26	1.91
4005	623430	309037	C	4.96	2.08	2.88
4108	623405	309104	C	3.44	1.23	2.21
4109	623422	309107	C	3.73	2.25	1.48
4110	623416	309115	C	3.36	1.78	1.58
4111	623452	309112	C	3.837	-	-
4201	623410	309220	C	-	-	3.275
4301	623455	309386	C	-	-	-
4509	623455	309579	C	8.19	6.92	1.27
4510	623497	309538	C	-	-	1.7
4511	623471	309527	C	-	-	-
4512	623494	309522	C	-	-	0.62
4513	623490	309568	C	-	-	-
5101	623506	309141	C	-	-	3.125
5405	623513	309401	C	-	-	-
5507	622598	309555	C	-	-	8
5509	622598	309537	C	-	-	-
5510	622584	309590	C	-	-	4.61
5510	623501	309552	C	-	-	1.05
5511	623504	309565	C	-	-	1.42
5608	622573	309651	C	-	-	2.3
5612	622583	309620	C	-	-	1.62
6304	622635	309360	C	-	-	2.62
6351	622654	309301	C	-	-	1.82
6401	622616	309454	C	-	-	3.2
6402	622689	309483	C	-	-	3.82
6506	622664	309587	C	-	-	1.07
6507	622634	309532	C	-	-	1
6508	622669	309584	C	-	-	2.845
6605	622689	309658	C	-	-	1.9
6608	622634	309659	C	-	-	1.67
6612	622651	309618	C	-	-	1.35

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert
6613	622670	309643	C	-	-	1.63
6615	622699	309655	C	-	-	1.42
6622	622655	309668	C	-	-	-
7001	622773	309039	C	-	-	2.72
7107	622799	309154	C	-	-	2.58
7201	622736	309218	C	-	-	2.71
7202	622765	309219	C	-	-	1.74
7203	622791	309228	C	-	-	2.83
7210	622706	309269	C	-	-	1.4
7301	622731	309382	C	-	-	1.37
7302	622732	309351	C	-	-	1.43
7303	622737	309356	C	-	-	1.5
7401	622758	309486	C	-	-	2.69
7402	622760	309472	C	-	-	2.015
7403	622761	309469	C	-	-	1.98
7502	622750	309506	C	-	-	3.56
7606	622783	309629	C	10.756	8.12	2.636
7608	622798	309609	C	9.754	7.196	2.558
7611	622793	309607	C	-	-	0.83
8003	622851	309031	C	-	-	1.7
8004	622832	309063	C	-	-	1.92
8103	622872	309129	C	4.18	1.44	2.74
8107	622873	309126	C	4.19	0.94	3.25
8203	622889	309284	C	-	-	2.21
8302	622898	309366	C	-	-	2.565
8303	622892	309327	C	-	-	2.16
8402	622845	309436	C	-	-	2.24
8403	622805	309417	C	-	-	2
8404	622896	309451	C	-	-	2.6
8502	622826	309579	C	7.483	3.292	4.191
8503	622868	309585	C	-	-	2.011
8504	622857	309549	C	7.483	3.292	4.191
8508	622842	309544	C	-	-	1.93
8601	622891	309623	C	-	-	0.84
8606	622899	309648	C	-	-	1.3
8607	622819	309612	C	-	-	0.915
8612	622817	309622	C	-	-	-
8613	622815	309623	C	-	-	-
9101	622981	309175	C	-	-	2.51
9102	622990	309126	C	3.65	1.26	2.39
9103	622995	309110	C	3.6	1.04	2.56
9104	622990	309108	C	3.63	1.43	2.2
9203	622972	309226	C	4.29	1.82	2.47
9207	622939	309245	C	4.76	2.73	2.03
9305	622974	309354	C	-	-	2.77
9306	622985	309400	C	-	-	2.87
9424	622941	309494	C	-	-	2.745
9426	622917	309445	C	-	-	2.92
9427	622906	309403	C	-	-	3.02
9501	622912	309579	C	-	-	1.04
9502	622929	309545	C	-	-	0.915
9503	622993	309573	C	-	-	1.725
9507	622995	309546	C	5.15	3.49	1.66
9508	622997	309522	C	5.09	3.31	1.78
9509	622955	309591	C	-	-	-
9510	622964	309593	C	-	-	0.8
9511	622975	309595	C	-	-	-
9512	622986	309589	C	-	-	-
9515	622949	309535	C	-	-	-
9516	622941	309587	C	-	-	0.5
9601	622900	309629	C	-	-	0.99
9602	622981	309617	C	6.248	4.328	1.92
9605	622925	309601	C	-	-	1.525
9606	622977	309661	C	6.111	4.023	2.088
9610	622904	309648	C	-	-0.61	0.61
0003	623032	309020	F	2.91	-2.59	5.5
0007	623073	309023	F	2.89	-0.28	3.17
0301	623059	309354	F	3.99	0.33	3.66
0302	623080	309355	F	4	0.22	3.78
0303	623060	309310	F	3	1.36	1.64
0304	623060	309304	F	3.23	1.45	1.78
0401	623099	309460	F	4.22	1.41	2.81
0402	623066	309471	F	4.41	1.72	2.69
0403	623025	309487	F	4.65	2.04	2.61
0404	623008	309493	F	4.91	2.36	2.55
0405	623005	309415	F	4.5	1.92	2.58
0406	623033	309408	F	3.98	1.36	2.62
0407	623035	309401	F	3.97	1.14	2.83
0408	623056	309401	F	3.96	0.9	3.06
0409	623001	309497	F	-	-	-
0603	623029	309669	F	-	-	-
0606	623046	309644	F	-	-	-
0607	623086	309645	F	-	-	-
0617	623042	309644	F	-	-	-
0618	623086	309660	F	-	-	-
0619	623099	309645	F	-	-	-
1001	623158	309073	F	2.81	2.04	0.77
1003	623184	309067	F	2.55	-2.02	4.57
1005	623118	309038	F	2.59	-2.14	4.73
1014	623190	309074	F	2.56	0.8	1.76
1107	623171	309190	F	2.826	-0.934	3.76
1211	623153	309285	F	3.42	0.59	2.83
1303	623143	309320	F	3.47	0.99	2.48
1306	623107	309356	F	3.91	-0.02	3.93
1307	623119	309355	F	3.61	-	-
1308	623131	309356	F	-	-	3.35
1309	623160	309343	F	3.18	-0.2	3.38
1310	623152	309346	F	-	-	3.5
1312	623158	309390	F	3.42	1.81	1.61
1401	623118	309453	F	4.1	1.25	2.85
1403	623156	309429	F	3.75	0.25	3.5
1406	623159	309451	F	4.07	1.96	2.11
1502	623163	309525	F	4.558	1.203	3.355

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert
1503	623163	309559	F	4.558	1.203	3.355
1614	623161	309637	F	-	-	-
1617	623116	309645	F	7.333	5.473	1.86
2004	623241	309035	F	2.946	-3.864	6.81
2007	623206	309020	F	3.35	1.76	1.59
2008	623204	309029	F	3.01	1.62	1.39
2303	623249	309333	F	3.22	1.1	2.12
2304	623265	309338	F	3.37	1.57	1.8
2307	623257	309307	F	2.917	0.918	1.999
2504	623287	309589	F	-	-	2.5
3008	623347	309072	F	-	-	-
3009	623393	309074	F	-	-	-
3010	623380	309064	F	-	-	-
3011	623364	309049	F	-	-	-
3012	623358	309040	F	-	-	-
3013	623352	309024	F	-	-	-
3014	623351	309017	F	-	-	-
3302	623371	309359	F	2.57	-0.08	2.65
3501	623391	309509	F	-	-	2.1
3502	623332	309534	F	-	-	2.2
3503	623309	309556	F	-	-	2.3
3504	623395	309520	F	-	-	-
3505	623326	309587	F	-	-	-
3601	623306	309624	F	-	-	2.5
3603	623334	309655	F	-	-	2.4
3604	623301	309629	F	-	-	1.2
3605	623360	309651	F	-	-	-
3607	623356	309615	F	-	-	-
3608	623358	309635	F	-	-	-
3609	623364	309603	F	-	-	-
4001	622495	309082	F	-	-	6.045
4003	623433	309080	F	3.95	0.15	3.8
4101	623421	309189	F	-	-	3.455
4401	623479	309476	F	-	-	2.86
4402	623469	309476	F	-	-	2.8
4501	623412	309565	F	-	-	-
4502	623446	309557	F	-	-	-
4503	623457	309594	F	-	-	1.52
4504	623408	309588	F	-	-	-
4505	623413	309587	F	-	-	-
4506	623420	309585	F	-	-	-
4507	623438	309513	F	-	-	-
4508	623445	309538	F	-	-	-
4602	623482	309633	F	-	-	-
4603	623402	309605	F	-	-	-
4604	623406	309670	F	-	-	-
4605	623406	309667	F	-	-	-
5004	622557	309020	F	3.12	-1.53	4.65
5006	622514	309079	F	3.38	-1.95	5.33
5201	622581	309267	F	-	-	-
5301	622563	309365	F	-	-	-
5302	622564	309357	F	-	-	-
5401	622547	309454	F	-	-	-
5402	622563	309412	F	-	-	-
5409	623516	309464	F	-	-	3.265
5501	622529	309569	F	3.08	-	-
5502	622542	309519	F	3.69	-	-
5507	623516	309585	F	-	-	-
5511	622586	309593	F	-	-	8.36
5512	622575	309590	F	-	-	3.886
5513	622570	309586	F	-	-	1.855
5514	622580	309555	F	-	-	0.915
5515	622549	309525	F	-	-	-
5604	622563	309647	F	-	-	9.13
5607	622554	309626	F	-	-	1.22
6000	622669	309095	F	4.042	2.39	1.652
6001	622684	309069	F	4.125	2.591	1.534
6002	622658	309054	F	4.3	2.792	1.508
6003	622700	309044	F	4.117	2.407	1.71
6102	622695	309188	F	-	-	3.4
6103	622699	309193	F	-	-	6.4
6104	622698	309110	F	-	-	1.14
6105	622673	309147	F	-	1.5	-
6106	622660	309127	F	-	1.75	-
6107	622643	309126	F	-	1.95	-
6108	622666	309159	F	-	1.8	-
6109	622667	309183	F	-	2.2	-
6110	622656	309121	F	4	1.966	2.034
6201	622657	309265	F	-	1.411	-
6204	622664	309262	F	-	-	-
6205	622617	309252	F	-	1.643	-
6302	622634	309356	F	-	-	5.82
6404	622614	309454	F	-	-	7
6504	622609	309558	F	-	-	9.45
7002	622744	309099	F	-	-	3.66
7005	622751	309098	F	-	-	6.8
7007	622756	309072	F	3.583	0.51	3.073
7008	622752	309070	F	3.603	2.015	1.588
7009	622727	309058	F	4.04	2.202	1.838
7010	622711	309024	F	4.15	2.557	1.593
7101	622708	309166	F	-	-0.04	-
7104	622720	309122	F	-	-	1.17
7105	622703	309194	F	-	-	2.7
7106	622799	309115	F	-	-	3
7108	622703	309164	F	-	1.1	-
7205	622712	309284	F	-	-	1.845
7206	622782	309285	F	-	-	-
7207	622753	309285	F	-	-	1.635
7404	622758	309477	F	-	-	-
7405	622704	309466	F	-	-	-
7406	622720	309473	F	-	-	-
7501	622718	309599	F	-	-	11.75
7602	622773	309641	F	10.67	8	2.67

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert
8001	622884	309059	F	4.27	0.55	3.72
8102	622874	309170	F	4.32	1.71	2.61
8104	622811	309104	F	-	-	1.3
8204	622881	309211	F	-	-	-
8405	622862	309430	F	-	-	-
8509	622892	309570	F	-	-	-
8604	622816	309660	F	-	-	-
8611	622812	309662	F	10.267	7.147	3.12
8614	622811	309625	F	-	-	-
8615	622824	309616	F	-	-	-
8616	622818	309623	F	-	-	-
9001	622961	309099	F	3.87	1.77	2.1
9002	622979	309048	F	3.46	1.44	2.02
9202	622969	309245	F	-	-	2.6
9206	622966	309292	F	-	-	2.185
9208	622967	309283	F	4.3	2.13	2.17
9209	622986	309290	F	-	-	-
9301	622967	309310	F	4.37	2.25	2.12
9401	622973	309428	F	-	-	2.36
9414	622911	309475	F	-	-	2.845
9423	622945	309444	F	-	-	2.59
9425	622921	309458	F	-	-	2.615
9428	622929	309471	F	-	-	-
9429	622935	309475	F	-	-	-
9504	622992	309546	F	-	-	-
9513	622944	309573	F	-	-	-
9514	622905	309577	F	-	-	-
9607	622998	309664	F	5.447	3.487	1.96
9608	622902	309655	F	-	-	1.6
9609	622922	309660	F	6.1	0.176	5.924
9613	622935	309623	F	-	-	-
9614	622948	309627	F	-	-	0.5
9616	622962	309630	F	-	-	-
0251	623009	309263	S	4.47	3.05	1.42
0252	623039	309294	S	3.64	2.03	1.61
0253	623052	309269	S	-	4.66	-
0351	623078	309356	S	3.97	1.07	2.9
0352	623062	309309	S	3.05	1.74	1.31
0353	623062	309303	S	3.28	1.83	1.45
0354	623061	309356	S	4.01	1.03	2.98
0451	623036	309480	S	4.57	2.02	2.55
0452	623004	309492	S	5.01	2.2	2.81
0453	623005	309417	S	4.49	1.32	3.17
0454	623035	309410	S	3.95	1.21	2.74
0455	623046	309404	S	3.98	1.08	2.9
0456	623057	309404	S	3.96	1.08	2.88
0457	623087	309499	S	3.99	2.46	1.53
0458	623095	309478	S	4.19	2.23	1.96
0459	623097	309459	S	4.23	1.85	2.38
1051	623153	309091	S	2.83	1.69	1.14
1057	623187	309075	S	-	-	-
1153	623168	309191	S	-	-	2.49
1251	623156	309286	S	3.51	-0.55	4.06
1252	623103	309279	S	-	7.21	-
1351	623157	309346	S	3.23	0.79	2.44
1352	623108	309357	S	3.88	1.04	2.84
1353	623133	309357	S	-	-	2.45
1355	623145	309319	S	3.49	-0.26	3.75
1357	623156	309388	S	-	-	-
1451	623118	309451	S	4.09	1.64	2.45
1452	623158	309447	S	-	-	-
1453	623154	309427	S	3.78	1.02	2.76
1454	623168	309430	S	-	-	-
1459	623168	309427	S	3.8	2.16	1.64
1553	623167	309558	S	-	-	-
1651	623150	309668	S	-	-	5.73
2051	623206	309030	S	-	-	-
2351	623263	309338	S	-	-	1.93
2352	623207	309309	S	8.37	7.18	1.19
2354	623272	309315	S	3.09	1.29	1.8
2355	623250	309387	S	3.65	2.32	1.33
2361	623258	309307	S	2.918	1.168	1.75
2362	623250	309334	S	-	-	1.93
2363	623265	309326	S	-	4.11	-
2452	623274	309428	S	-	-	-
2552	623282	309589	S	-	-	2.2
3050	623390	309075	S	-	-	-
3051	623378	309064	S	-	-	-
3052	623364	309051	S	-	-	-
3053	623355	309039	S	-	-	-
3054	623350	309025	S	-	-	-
3055	623349	309018	S	-	-	-
3351	623326	309343	S	3.29	1.24	2.05
3352	623321	309343	S	3.38	1.56	1.82
3353	623370	309348	S	2.54	0.65	1.89
3357	623382	309316	S	2.801	0.251	2.55
3358	623368	309351	S	-	-	-
3359	623365	309359	S	-	-	-
3360	623338	309352	S	-	-	-
3361	623346	309384	S	-	-	1.93
3457	623366	309424	S	-	-	3.04
3458	623386	309493	S	-	-	-
3551	623387	309506	S	-	-	2.1
3552	623330	309532	S	-	-	1.8
3553	623305	309554	S	-	-	1.9
3554	623392	309521	S	-	-	-
3555	623324	309590	S	-	-	-
3651	623303	309624	S	-	-	2.1
3652	623332	309659	S	-	-	2.1
3653	623359	309654	S	-	-	-
4051	623435	309080	S	3.97	1.56	2.41
4052	623433	309042	S	4.9	4.9	-
4157	623423	309190	S	-	-	2.77

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert
4453	623468	309472	S	-	-	2.7
4551	623409	309568	S	-	-	-
4552	623449	309558	S	-	-	-
4651	623413	309644	S	-	-	-
4652	623468	309633	S	-	-	-
5051	622516	309094	S	3.62	1.01	2.61
5059	622506	309077	S	-	-	3.075
5151	622555	309171	S	4.32	1.38	2.94
5251	622521	309268	S	-	-	2.4
5252	622556	309212	S	5.07	1.53	3.54
5555	622569	309584	S	-	-	-
5556	622558	309579	S	-	-	1.168
6051	622647	309029	S	3.865	2.485	1.38
6052	622678	309021	S	4.255	1	3.255
6053	622699	309042	S	4.15	1.245	2.905
6054	622694	309051	S	4.022	1.333	2.689
6055	622667	309095	S	4.04	1.834	2.206
6056	622642	309083	S	4.319	2.634	1.685
6151	622671	309148	S	-	1.8	-
6152	622659	309129	S	-	2.05	-
6153	622643	309128	S	-	2.2	-
6154	622664	309160	S	-	2.1	-
6155	622665	309185	S	-	2.5	-
6156	622698	309187	S	-	-	1.2
6251	622666	309241	S	-	-	1.83
6252	622660	309259	S	-	1.548	-
6253	622657	309260	S	-	1.829	-
6254	622611	309258	S	-	2.999	-
6551	622622	309568	S	9.29	2.49	6.8
6552	622688	309590	S	10.73	7.65	3.08
6652	622644	309634	S	-	-	1.27
7050	622702	309038	S	4.19	1.449	2.741
7051	622712	309020	S	4.12	1.671	2.449
7052	622725	309056	S	4.102	1.861	2.241
7053	622749	309067	S	3.721	2.26	1.461
7152	622710	309169	S	-	1.3	-
7153	622703	309166	S	-	1.4	-
7154	622737	309117	S	-	-	2.9
7155	622748	309094	S	-	-	-
7156	622771	309107	S	-	-	-
7157	622798	309118	S	-	-	-
7251	622714	309285	S	-	-	1.575
7252	622788	309259	S	-	-	-
7253	622707	309257	S	-	1.734	-
7254	622745	309258	S	-	1.893	-
7351	622780	309326	S	-	-	1.83
7352	622745	309333	S	-	-	1.6
7354	622797	309321	S	-	-	1.3
7451	622760	309476	S	-	-	1.15
7652	622779	309637	S	-	-	3.81
7653	622788	309632	S	-	-	7.77
8151	622873	309169	S	4.32	1.96	2.36
8152	622802	309153	S	-	-	-
8153	622861	309166	S	-	-	-
8253	622833	309254	S	-	2.548	-
8254	622879	309213	S	-	-	-
8255	622882	309233	S	-	-	-
8452	622807	309490	S	-	-	1.38
8557	622860	309511	S	-	-	-
8653	622810	309662	S	10.267	7.447	2.82
9252	622971	309247	S	-	-	2.25
9253	622970	309284	S	-	-	3.99
9254	622973	309261	S	-	-	-
9255	622973	309295	S	-	-	-
9256	622982	309292	S	-	-	-
9351	622973	309312	S	-	-	-
9459	622975	309422	S	-	-	3
9460	622930	309452	S	-	-	3.15
9462	622912	309477	S	-	-	3.48
9465	622991	309411	S	-	-	-

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

Louisa Wade

From: Anglian Water <planningliaison@anglianwater.co.uk>
Sent: 24 March 2017 14:51
To: Louisa Wade
Cc: orders@argyllenviro.com
Subject: Anglia Square, Norwich NR3 1DY, NORWICH - Mancroft Flood Risk Query Response

Louisa Wade,

Thank you for your Flood Risk Query you submitted for Anglia Square, Norwich NR3 1DY, NORWICH - Mancroft.

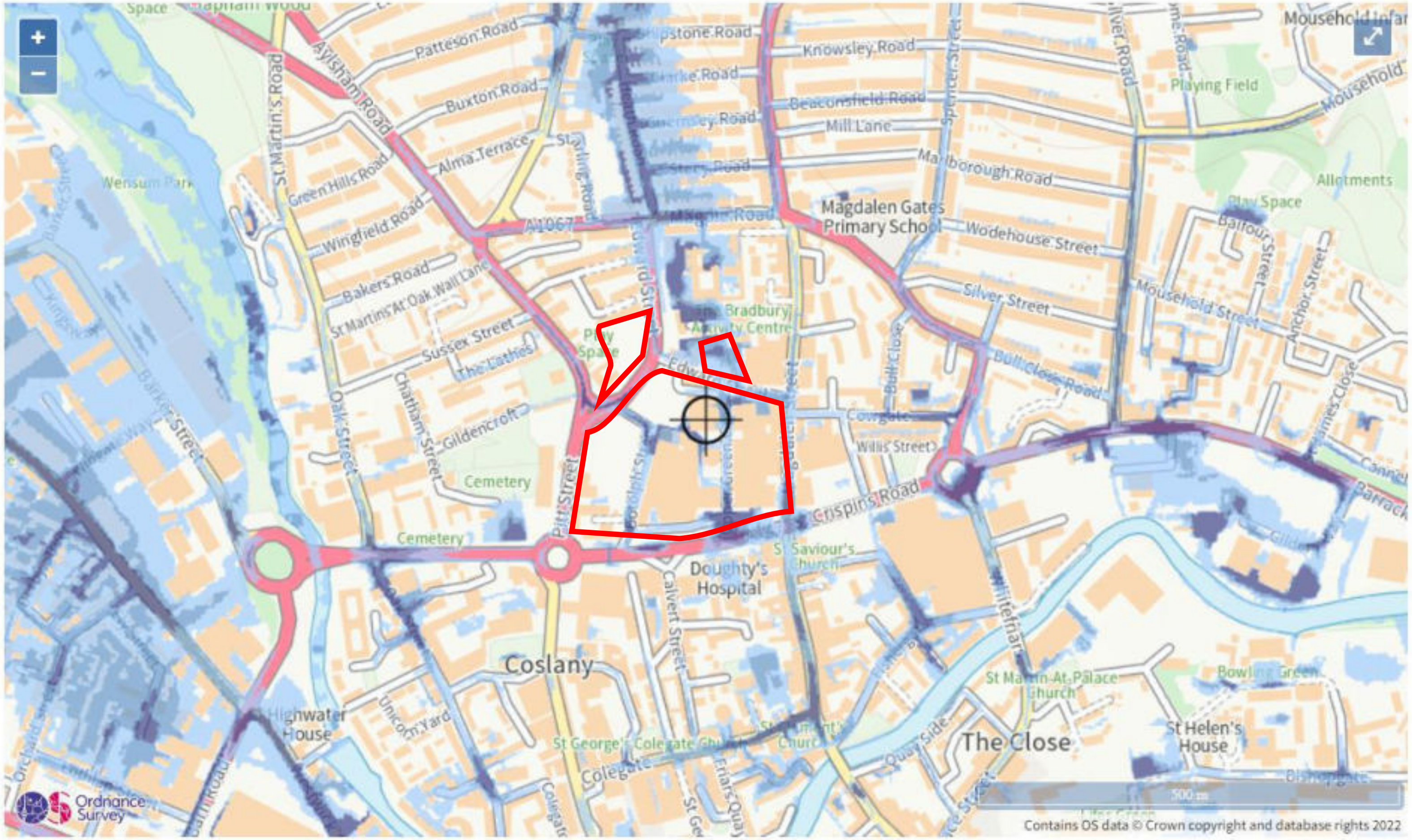
Our response to this is: Anglian Water is able to confirm that we have no records of flooding in the vicinity that can be attributed to capacity limitations in the public sewerage system. It is possible that other flooding may have occurred that we do not have records of, other organisations such as the Local Authority, Internal Drainage Board or the Environment Agency may have records.

Should you have any questions relating to this please contact 0345 0265 458. Your reference for this enquiry is 00020764.

Kind Regards
Growth and Planning Services Team

Appendix G Surface Water Flood Maps

Long Term Surface Water Flood Risk Map Extents

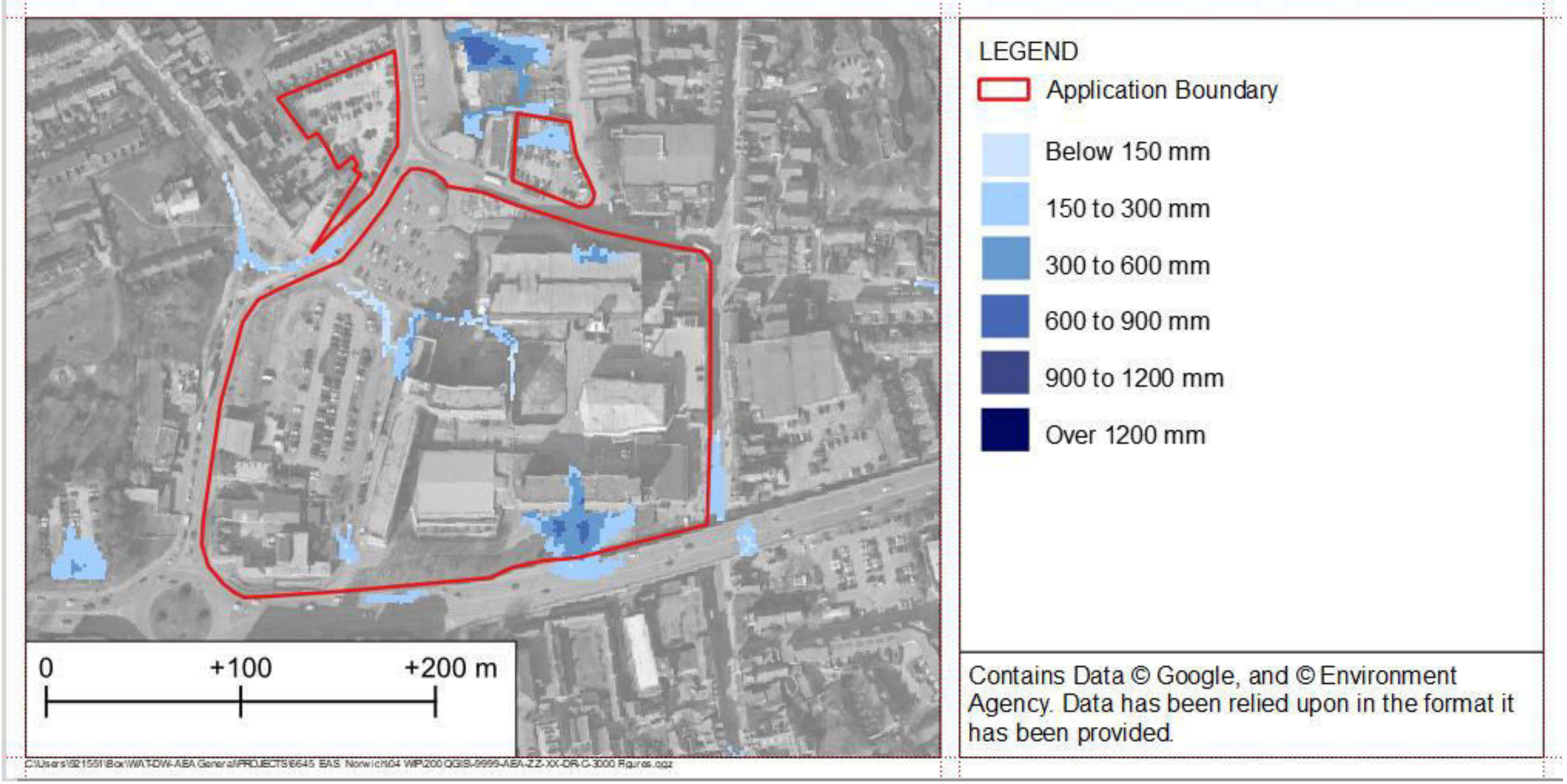


Extent of flooding from surface water

High Medium Low Very low Location you selected

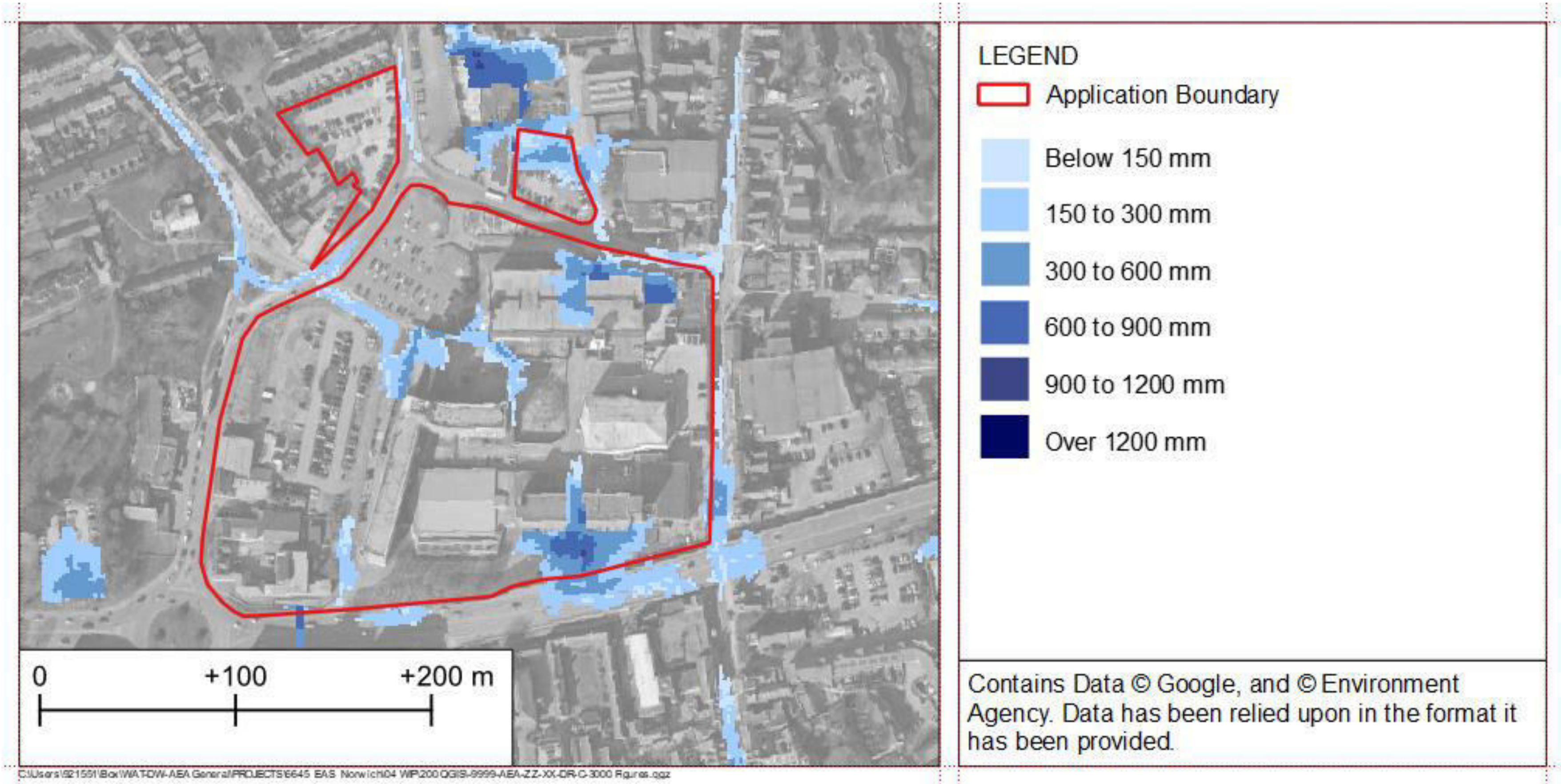
Source: https://check-long-term-flood-risk.service.gov.uk/map?easting=623059&northing=309421&map=SurfaceWater

Long Term Surface Water Flood Risk Map Depths – High Risk



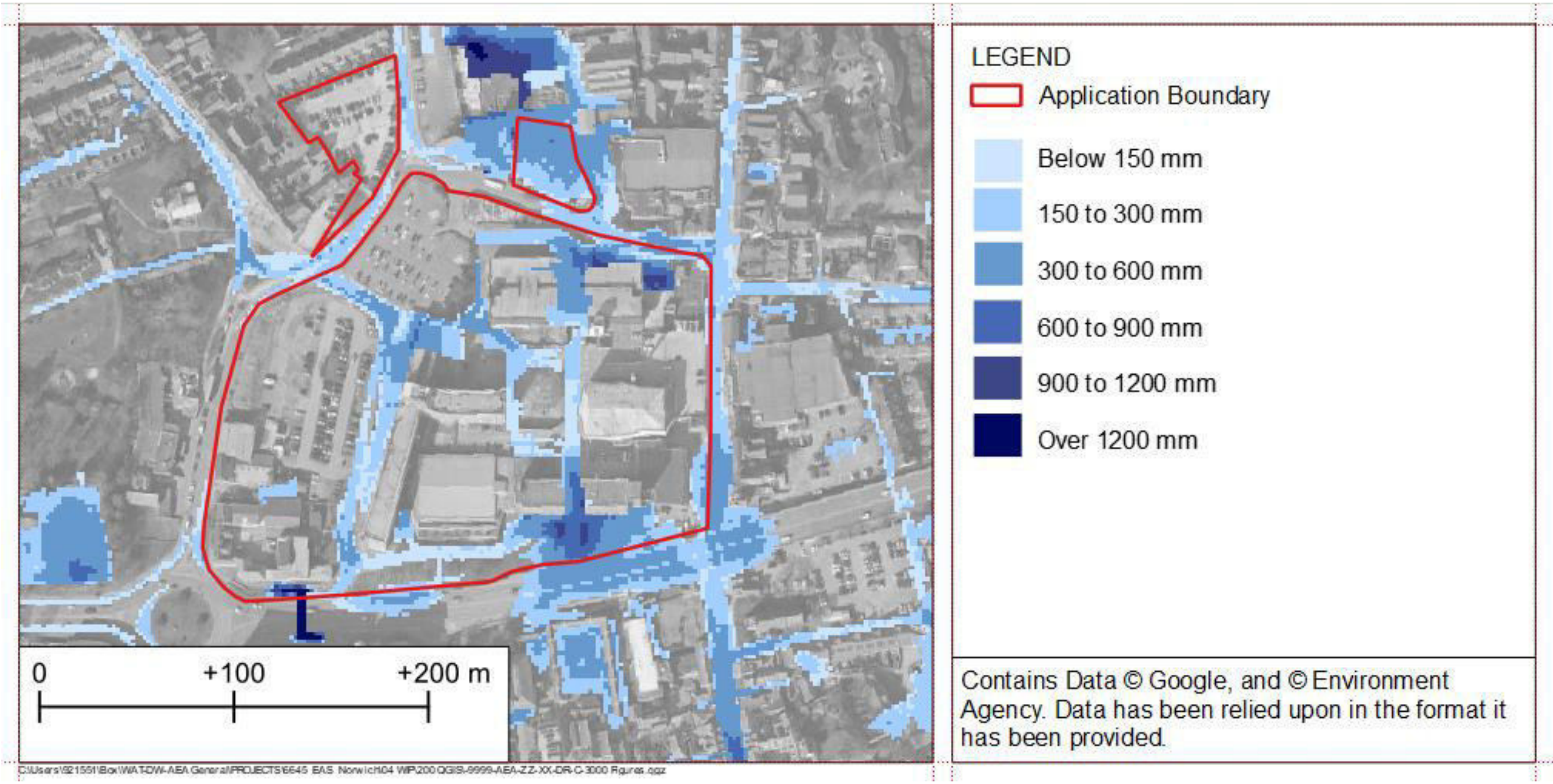
Source: https://check-long-term-flood-risk.service.gov.uk/map?easting=623059&northing=309421&map=SurfaceWater

Long Term Surface Water Flood Risk Map Depths – Medium Risk



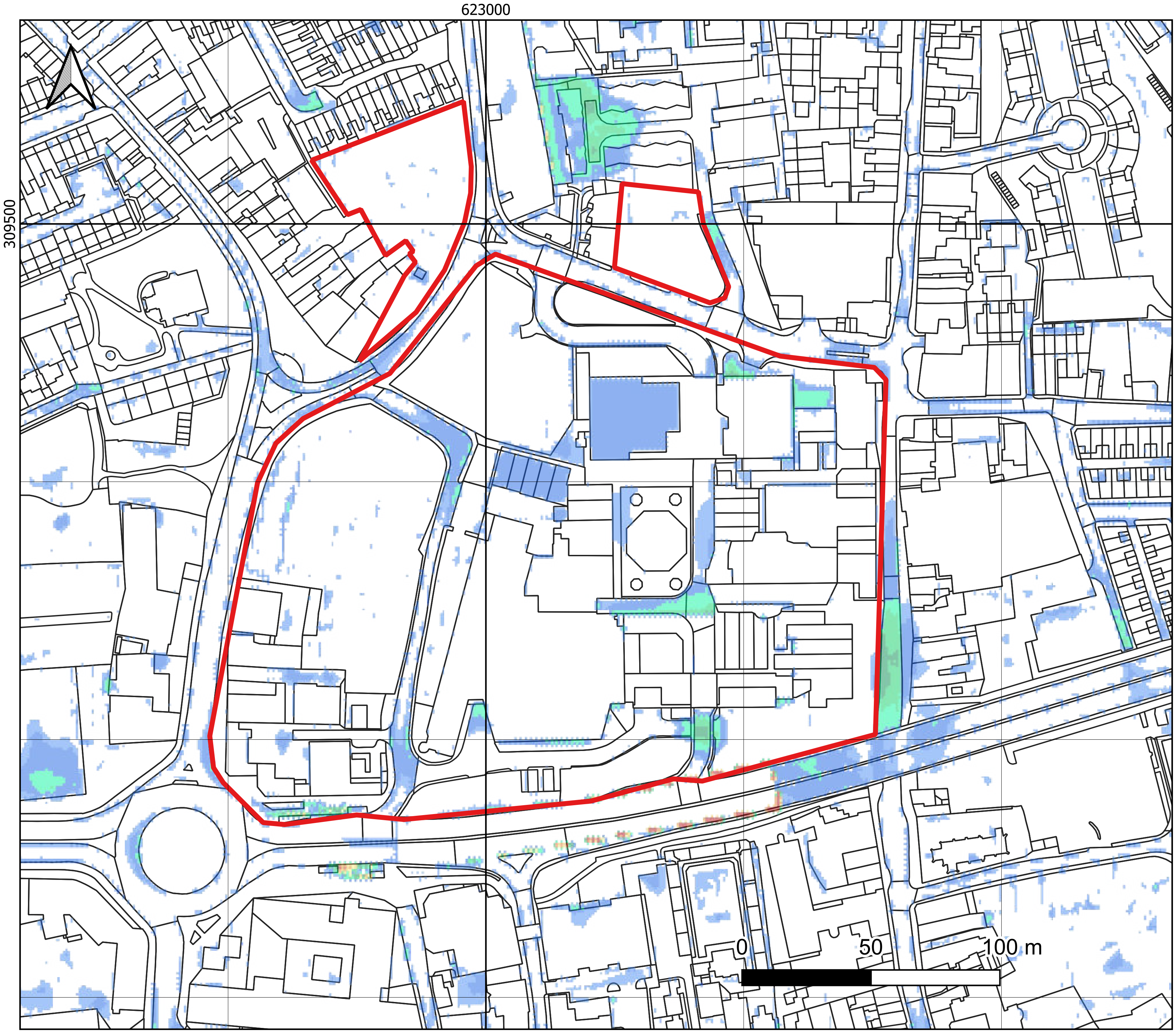
Source: https://check-long-term-flood-risk.service.gov.uk/map?easting=623059&northing=309421&map=SurfaceWater

Long Term Surface Water Flood Risk Map Depths – Low Risk



Source: https://check-long-term-flood-risk.service.gov.uk/map?easting=623059&northing=309421&map=SurfaceWater

Appendix H Modelled Surface Water Flood Depth and Level Maps



Key

Site Boundary

Depth (m)

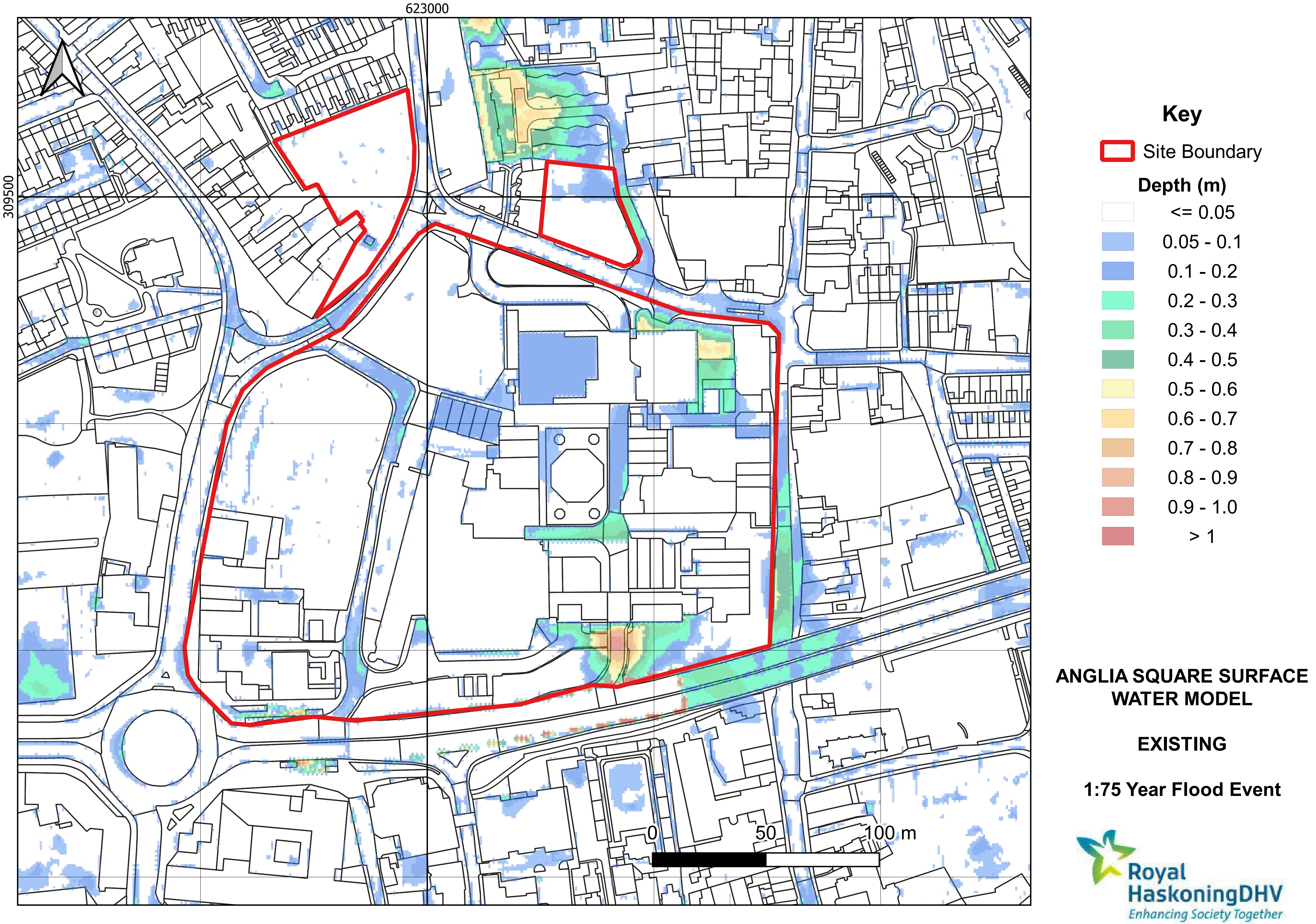
<= 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
0.5 - 0.6
0.6 - 0.7
0.7 - 0.8
0.8 - 0.9
0.9 - 1.0
> 1

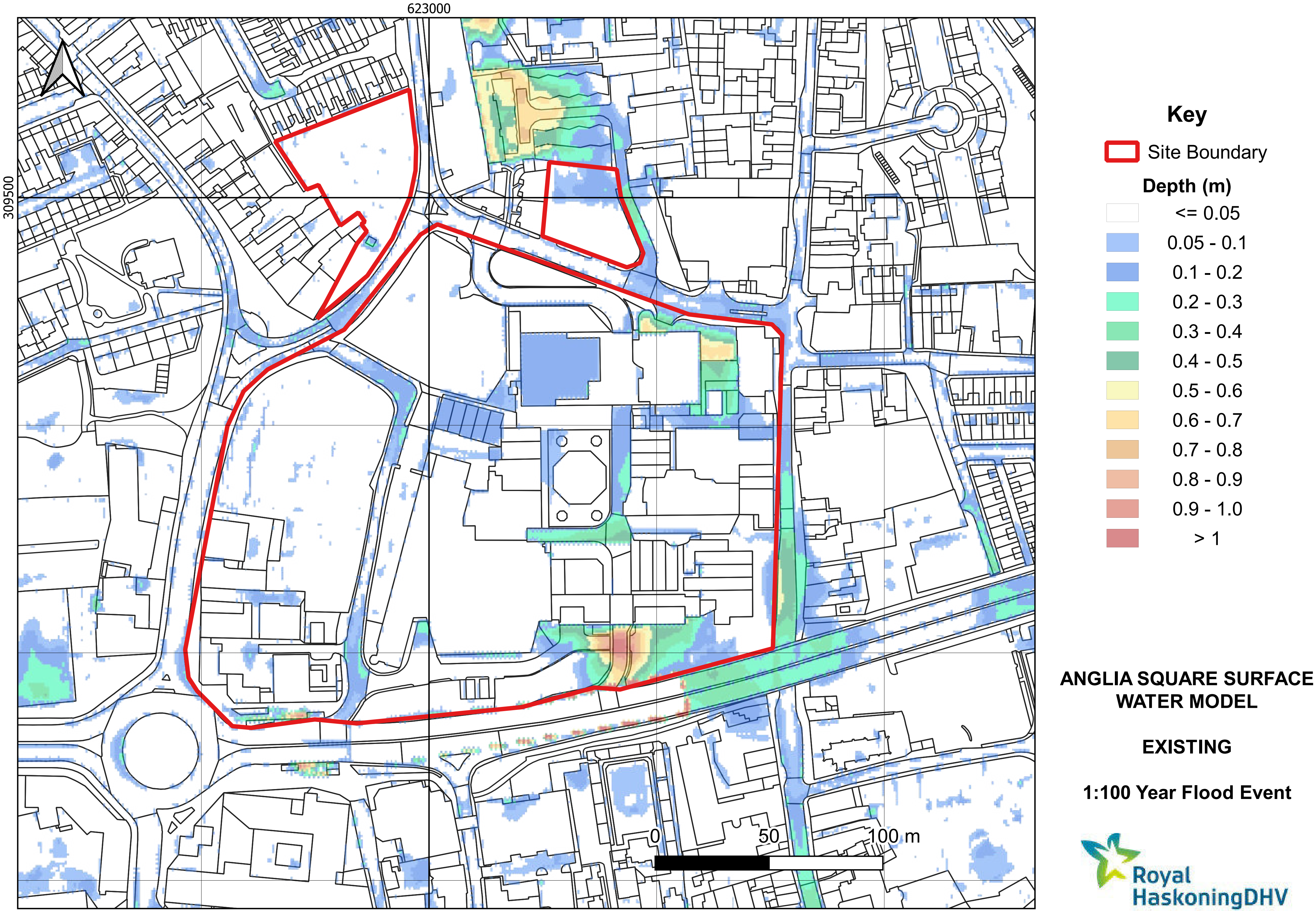
ANGLIA SQUARE SURFACE WATER MODEL

EXISTING

1:30 Year Flood Event

Royal HaskoningDHV
Enhancing Society Together


623000
309500
0
50
100 m
Key
Site Boundary
Depth (m)
<= 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
0.5 - 0.6
0.6 - 0.7
0.7 - 0.8
0.8 - 0.9
0.9 - 1.0
> 1
ANGLIA SQUARE SURFACE WATER MODEL
EXISTING
1:75 Year Flood Event
Royal HaskoningDHV
Enhancing Society Together

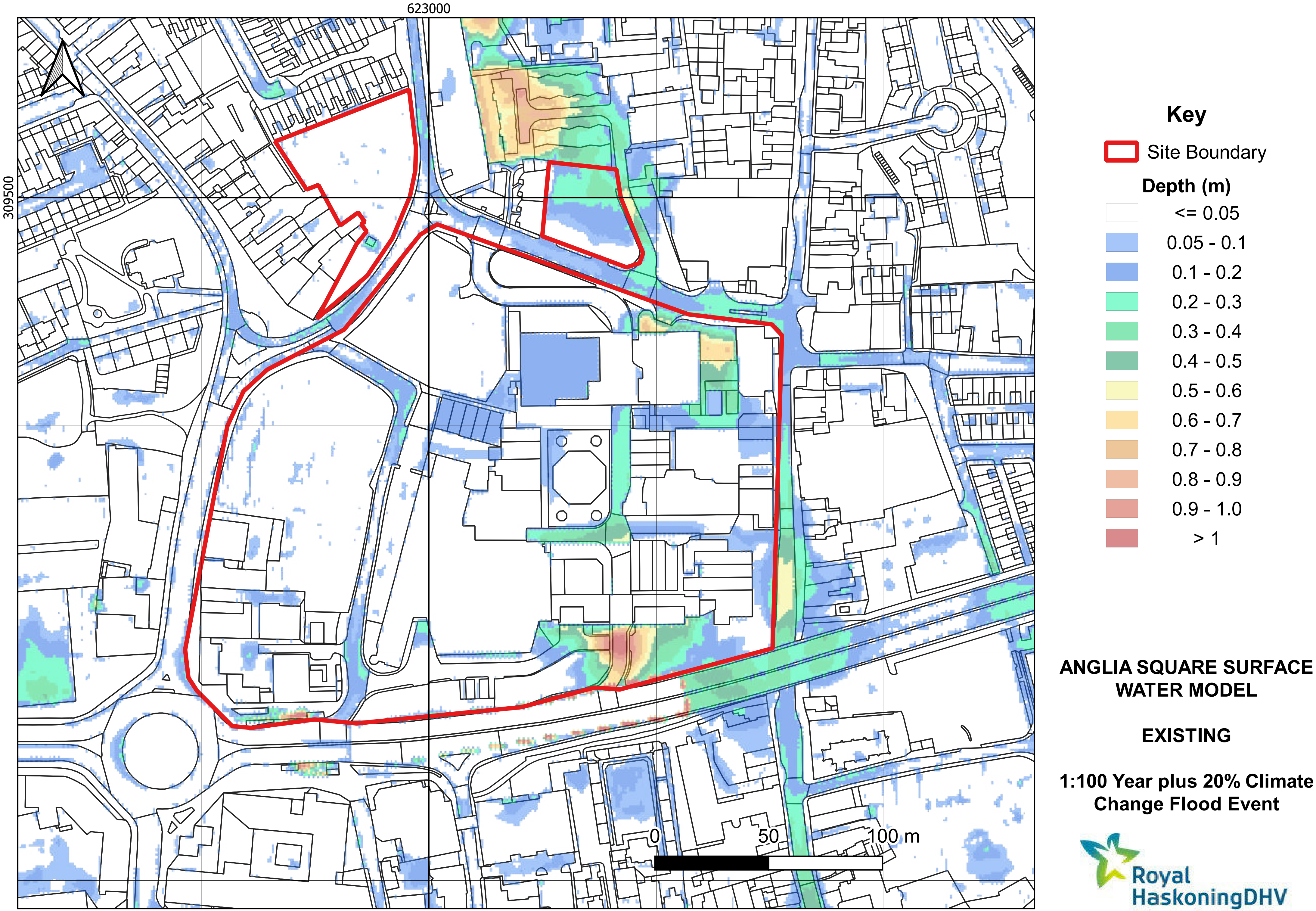


ANGLIA SQUARE SURFACE WATER MODEL

EXISTING

1:100 Year Flood Event

Royal HaskoningDHV
Enhancing Society Together

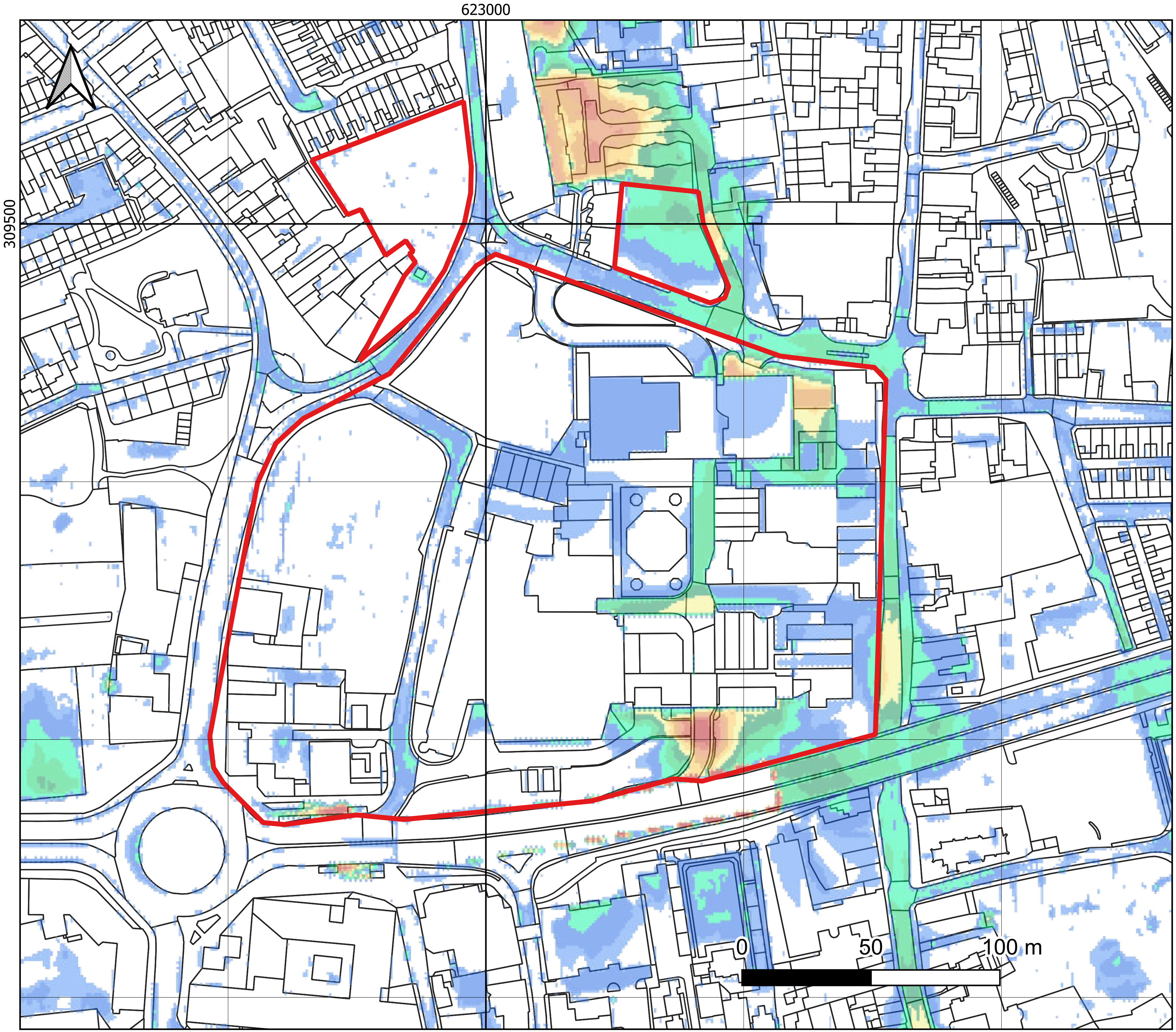


ANGLIA SQUARE SURFACE WATER MODEL

EXISTING

1:100 Year plus 20% Climate Change Flood Event

Royal HaskoningDHV
Enhancing Society Together



Key

Site Boundary

Depth (m)

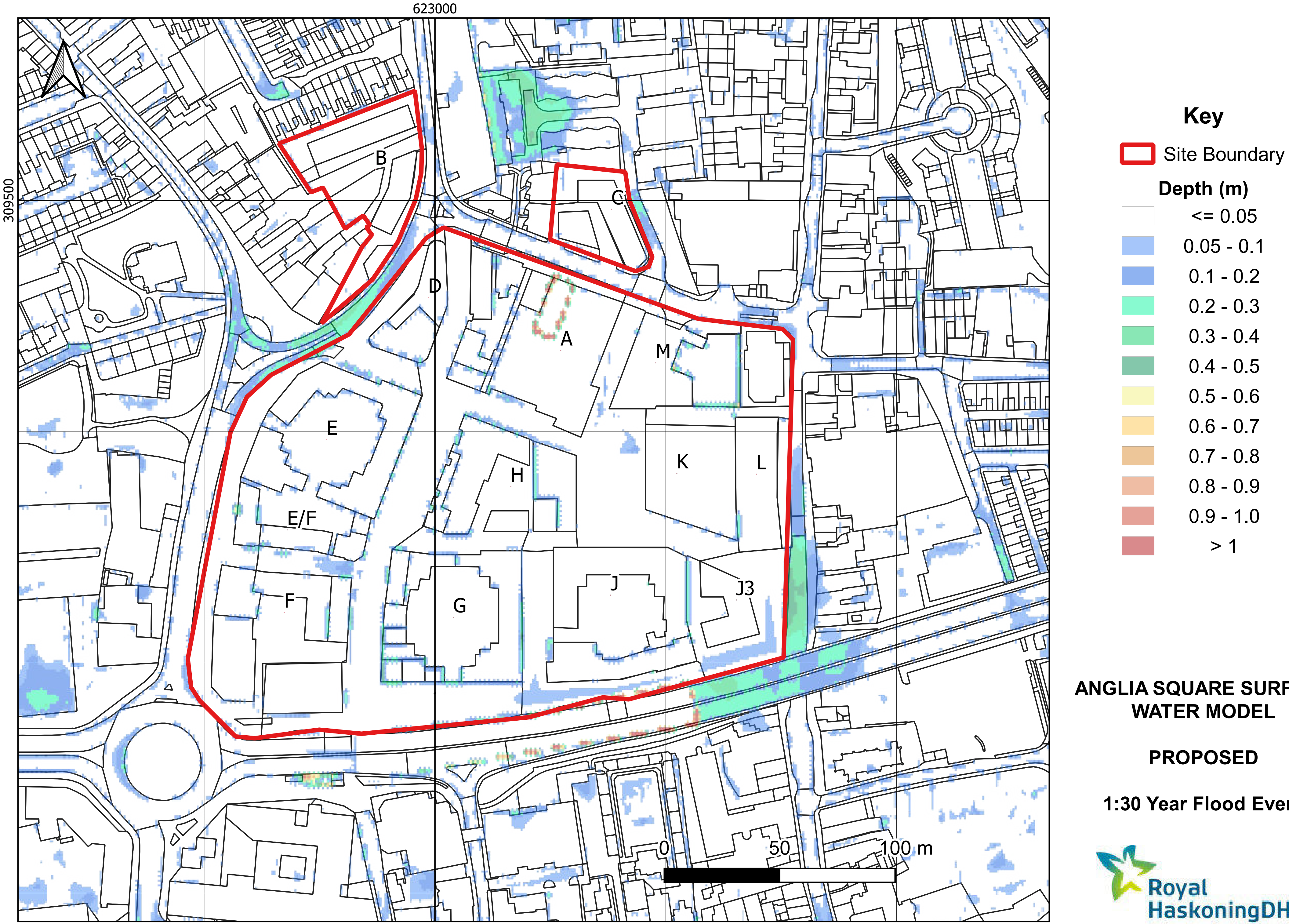
<= 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
0.5 - 0.6
0.6 - 0.7
0.7 - 0.8
0.8 - 0.9
0.9 - 1.0
> 1

ANGLIA SQUARE SURFACE WATER MODEL

EXISTING

1:100 Year plus 40% Climate Change Flood Event

Royal HaskoningDHV
Enhancing Society Together

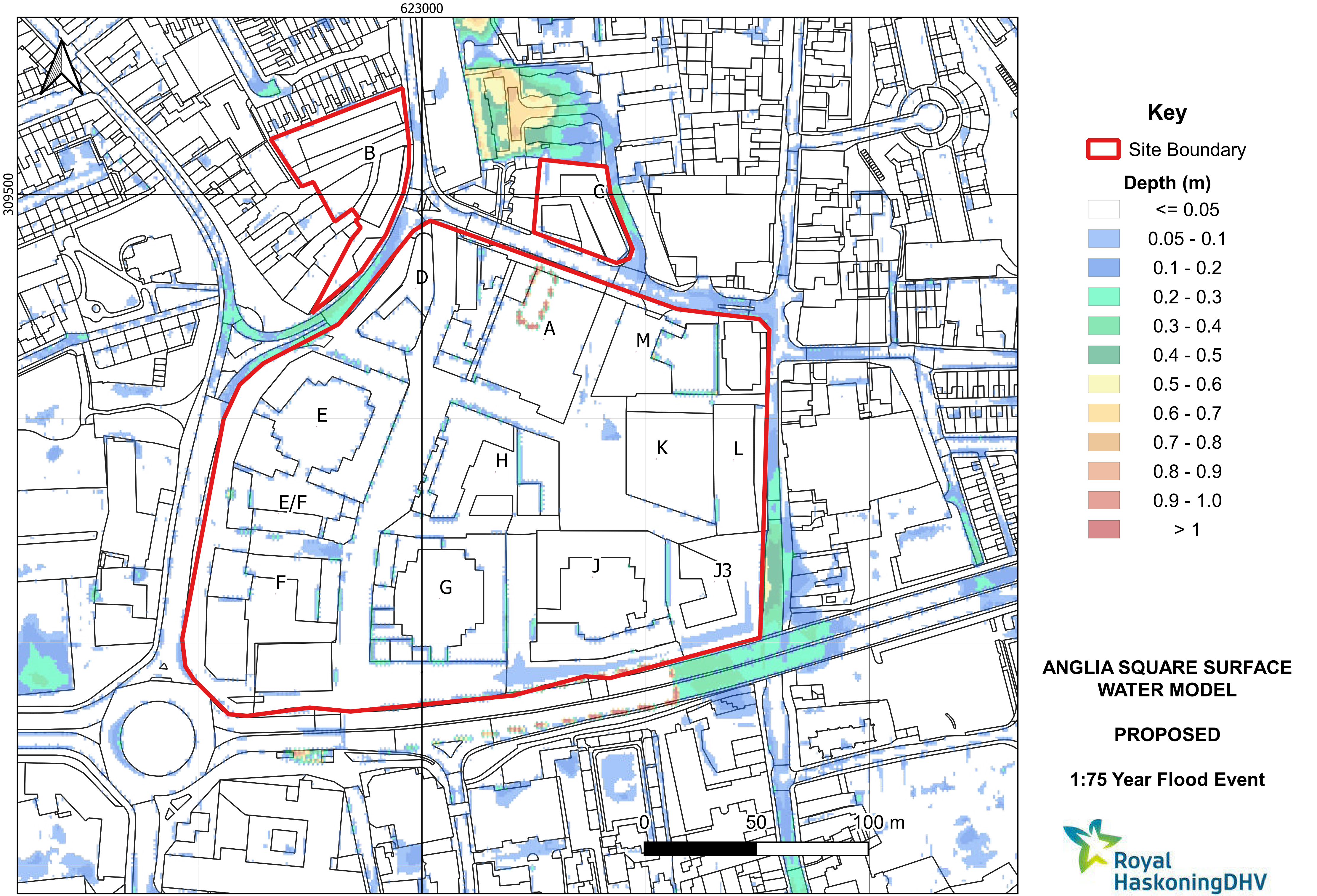


ANGLIA SQUARE SURFACE WATER MODEL

PROPOSED

1:30 Year Flood Event

Royal HaskoningDHV
Enhancing Society Together

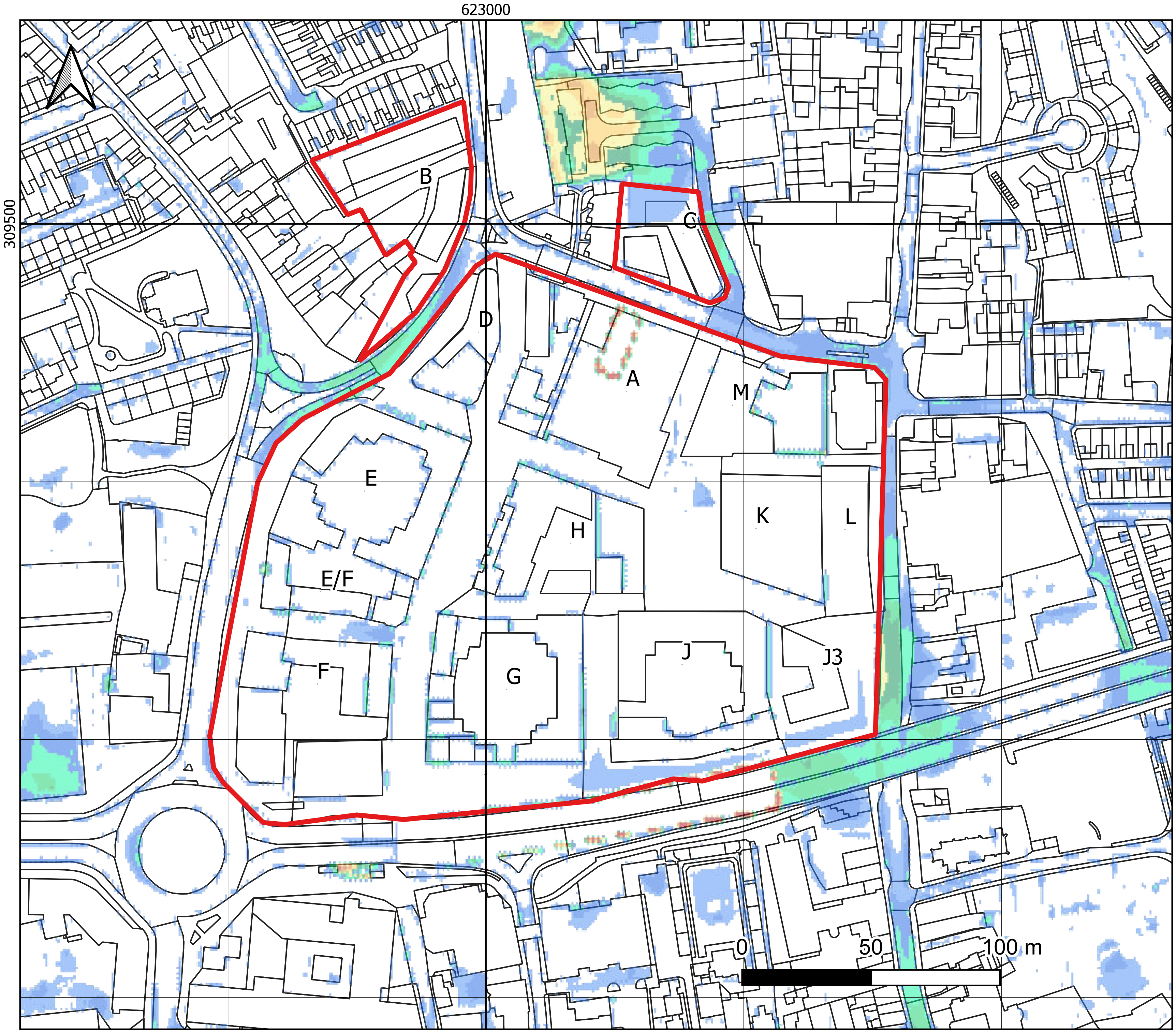


ANGLIA SQUARE SURFACE WATER MODEL

PROPOSED

1:75 Year Flood Event

Royal HaskoningDHV
Enhancing Society Together



Key

Site Boundary

Depth (m)

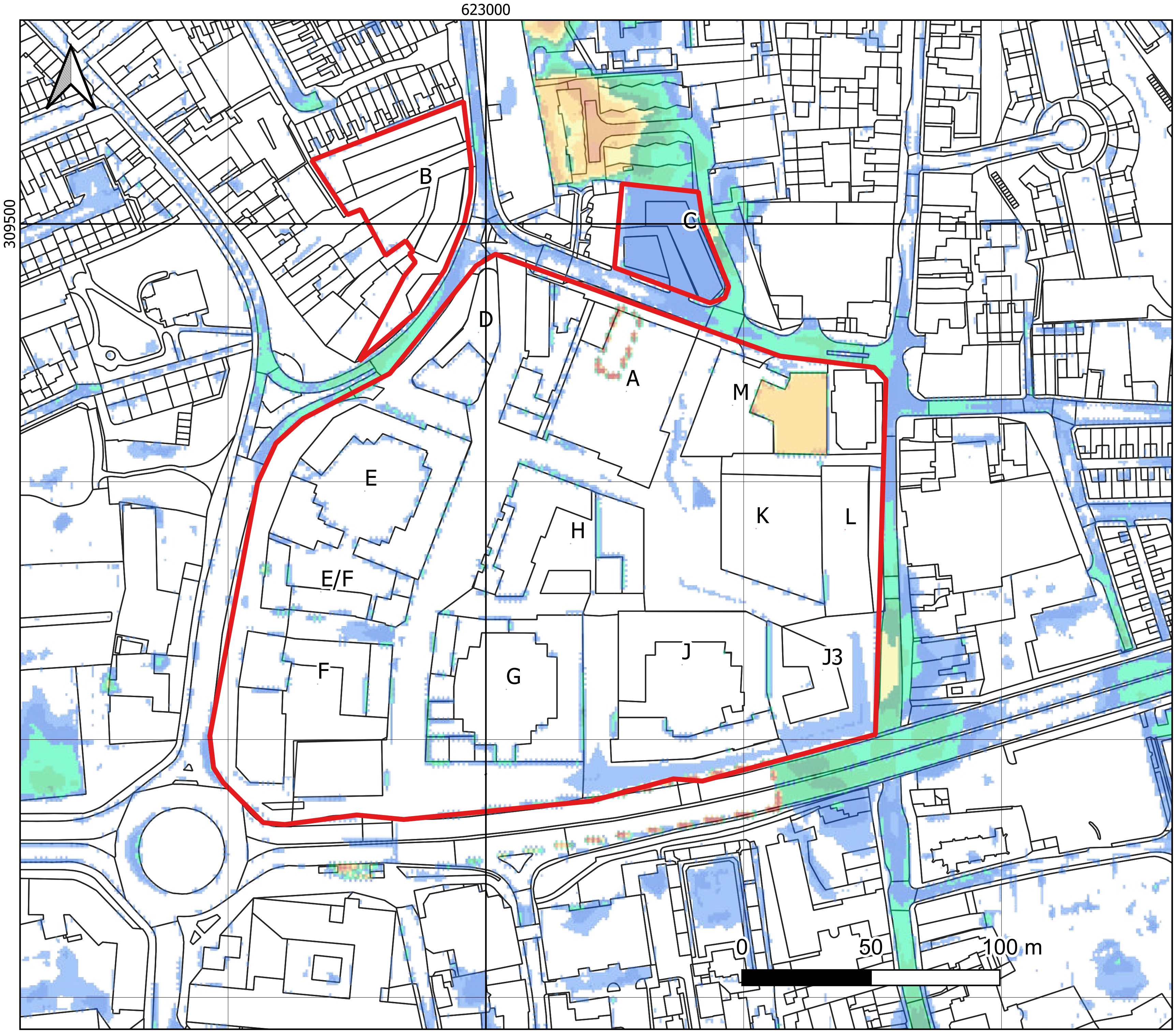
	<= 0.05
	0.05 - 0.1
	0.1 - 0.2
	0.2 - 0.3
	0.3 - 0.4
	0.4 - 0.5
	0.5 - 0.6
	0.6 - 0.7
	0.7 - 0.8
	0.8 - 0.9
	0.9 - 1.0
	> 1

ANGLIA SQUARE SURFACE WATER MODEL

PROPOSED

1:100 Year Flood Event

Royal HaskoningDHV
Enhancing Society Together



Key

Site Boundary

Depth (m)

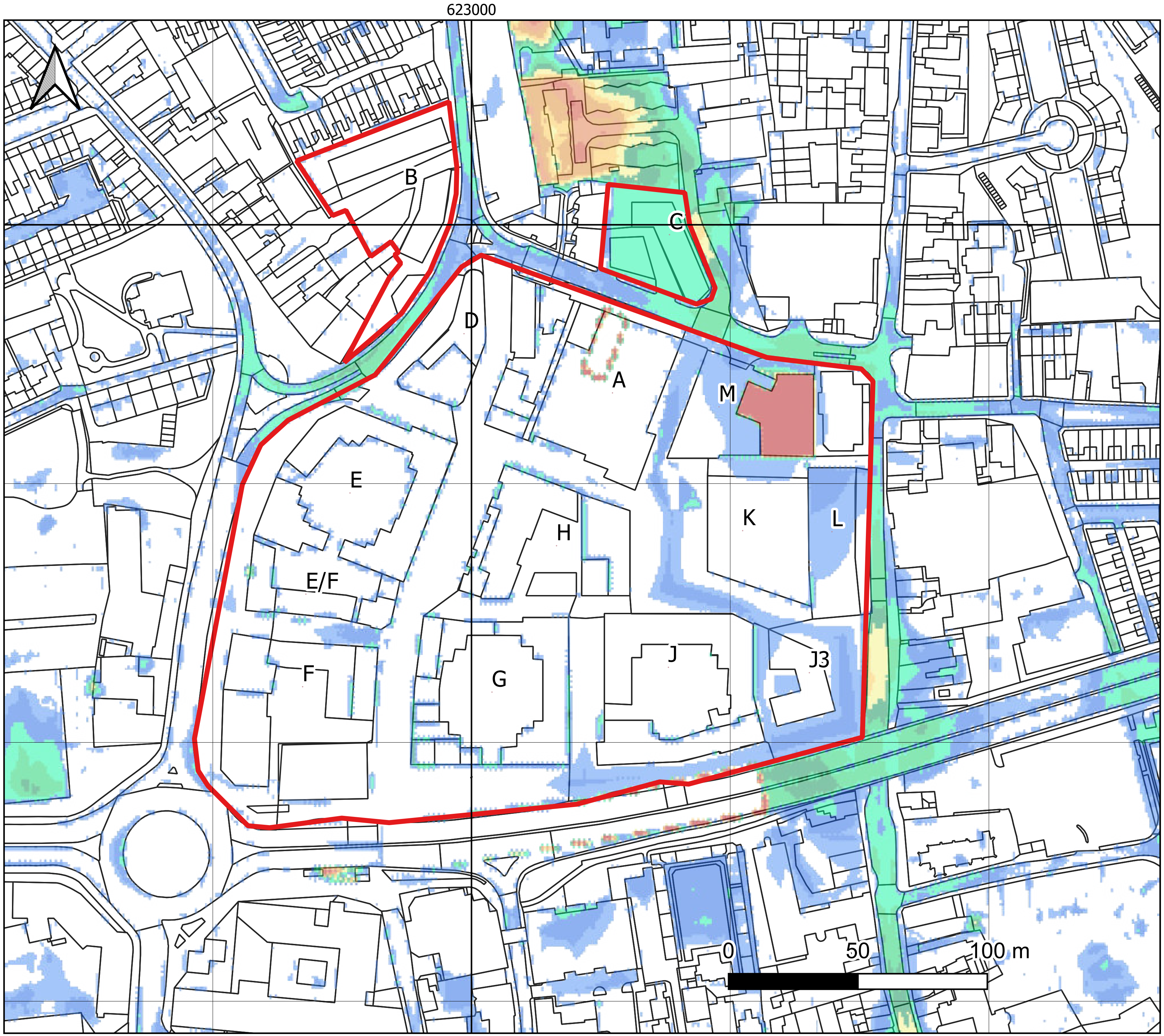
<= 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
0.5 - 0.6
0.6 - 0.7
0.7 - 0.8
0.8 - 0.9
0.9 - 1.0
> 1

ANGLIA SQUARE SURFACE WATER MODEL

PROPOSED

1:100 Year plus 20% Climate Change Flood Event

Royal HaskoningDHV
Enhancing Society Together



Key

Site Boundary

Depth (m)

	<= 0.05
	0.05 - 0.1
	0.1 - 0.2
	0.2 - 0.3
	0.3 - 0.4
	0.4 - 0.5
	0.5 - 0.6
	0.6 - 0.7
	0.7 - 0.8
	0.8 - 0.9
	0.9 - 1.0
	> 1

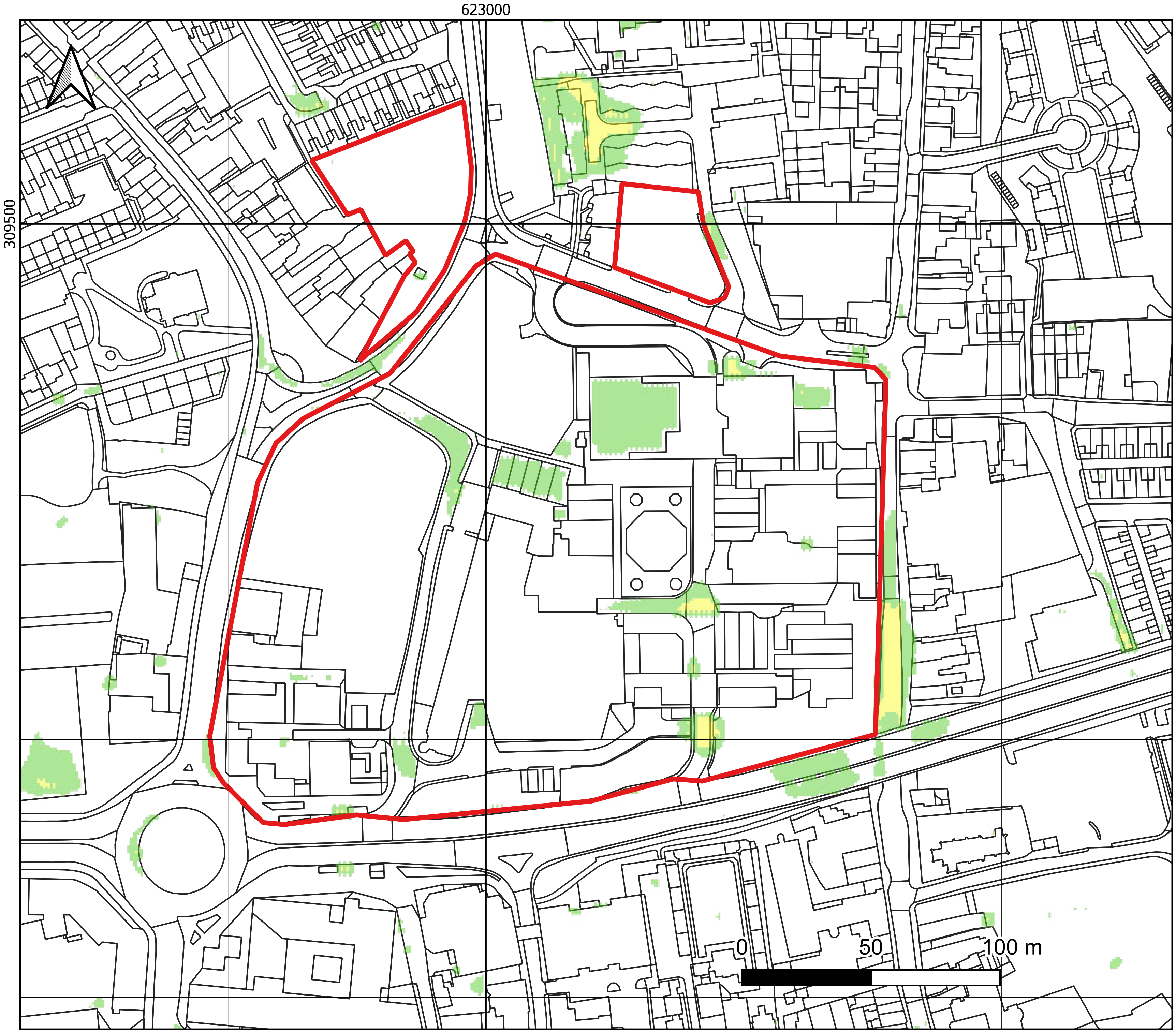
ANGLIA SQUARE SURFACE WATER MODEL

PROPOSED

1:100 Year plus 40% Climate Change Flood Event

Royal HaskoningDHV
Enhancing Society Together

Appendix I Modelled Surface Water Hazard Mapping



Key

Site Boundary

Hazard Rating

<= 0.05

0.05 - 0.75 (Low)

0.75 - 1.25 (Moderate)

1.25 - 2 (Sigificant)

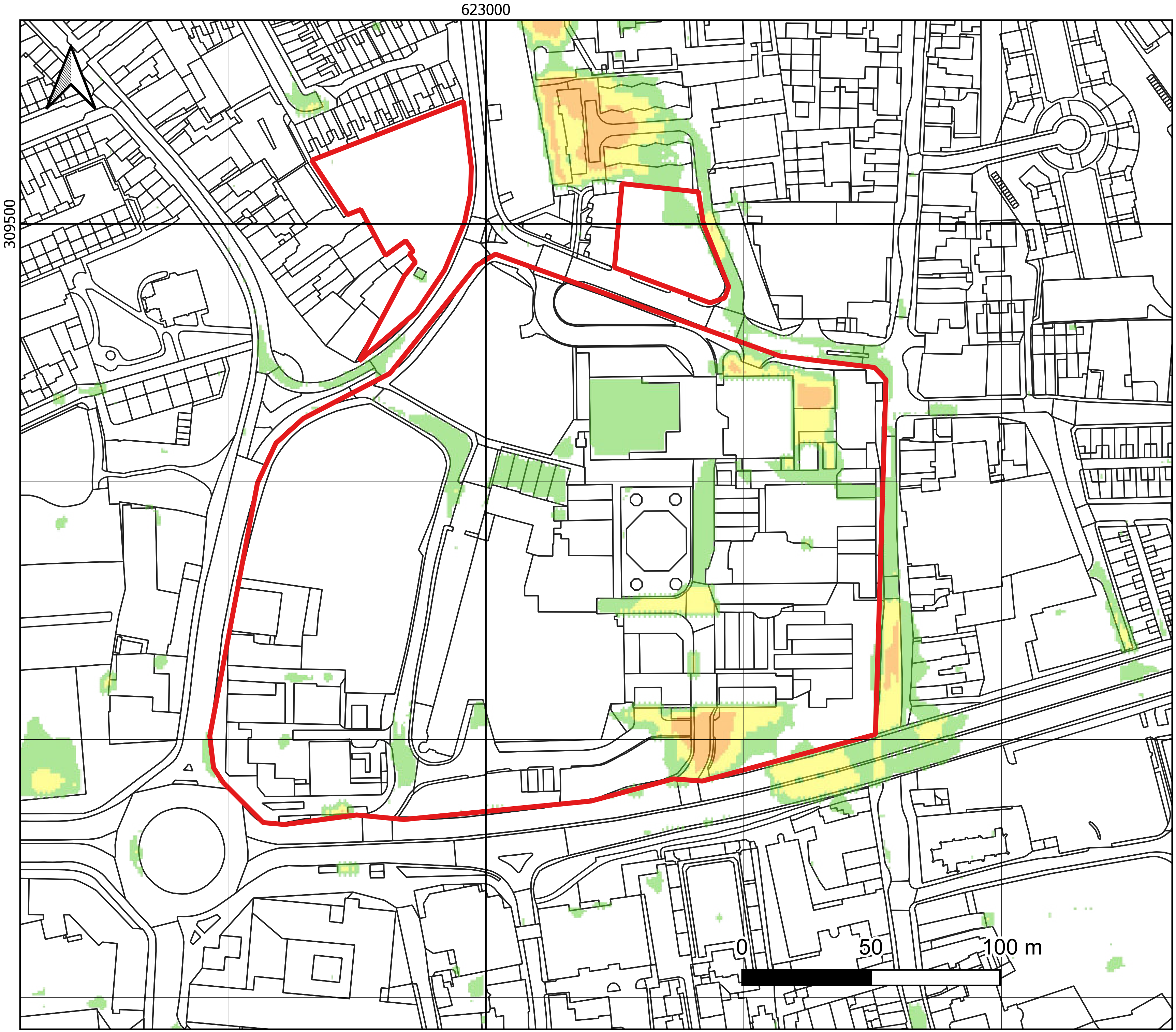
> 2 (Extreme)

ANGLIA SQUARE SURFACE WATER MODEL

EXISTING

1:30 Year Flood Event

Royal HaskoningDHV
Enhancing Society Together



Key

Site Boundary

Hazard Rating

<= 0.05

0.05 - 0.75 (Low)

0.75 - 1.25 (Moderate)

1.25 - 2 (Sigificant)

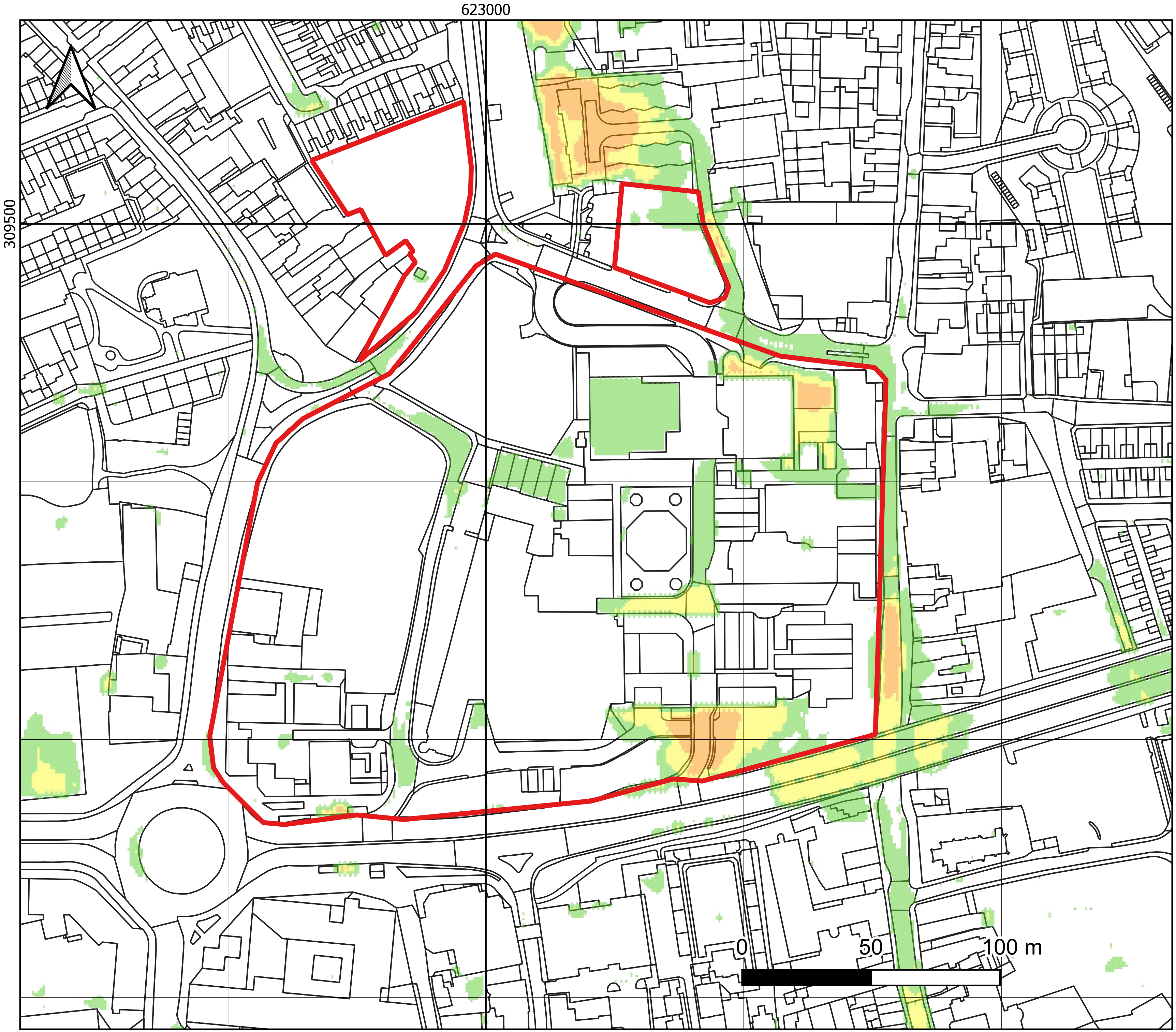
> 2 (Extreme)

ANGLIA SQUARE SURFACE WATER MODEL

EXISTING

1:75 Year Flood Event

Royal HaskoningDHV
Enhancing Society Together



Key

Site Boundary

Hazard Rating

<= 0.05

0.05 - 0.75 (Low)

0.75 - 1.25 (Moderate)

1.25 - 2 (Sigificant)

> 2 (Extreme)

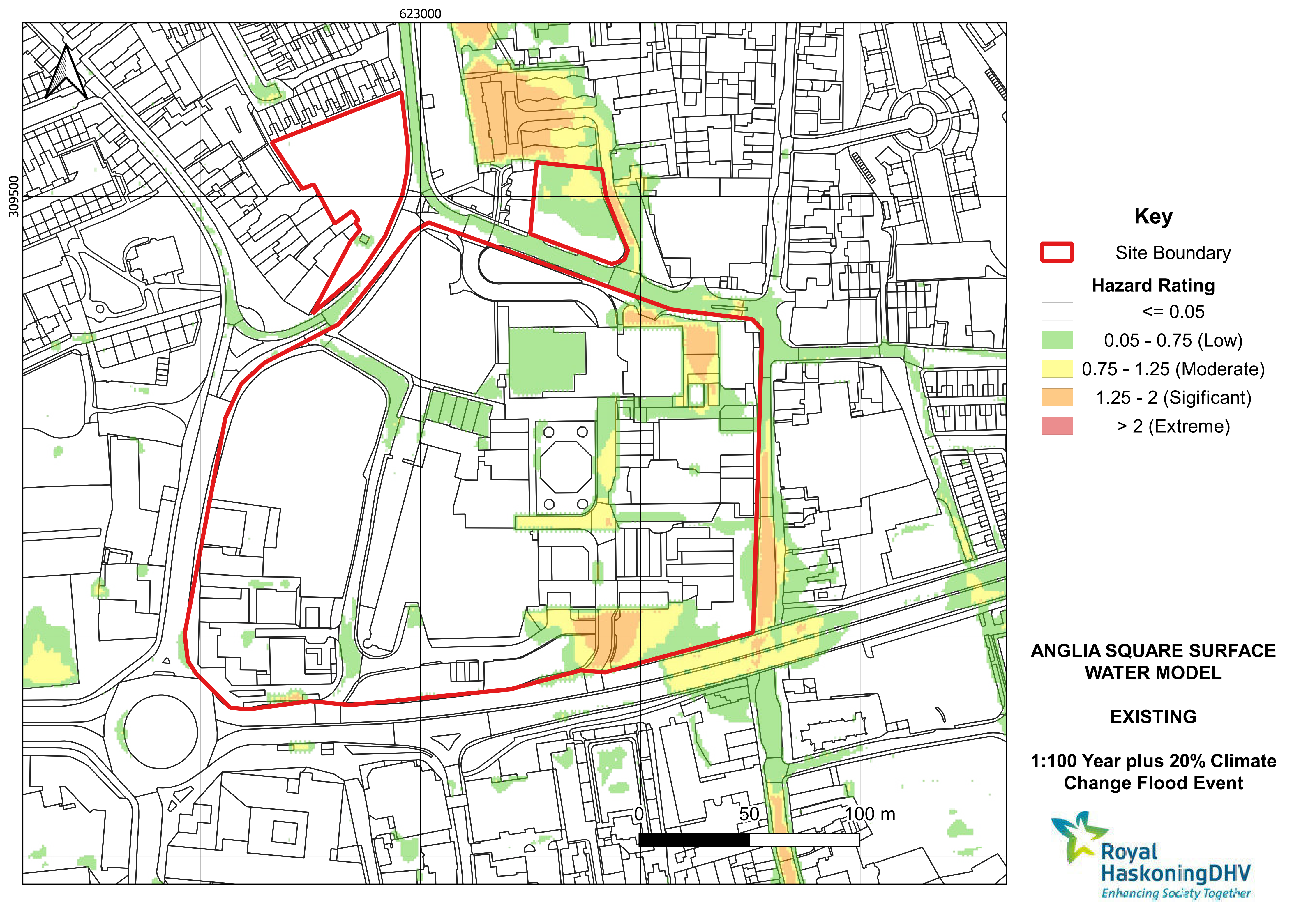
ANGLIA SQUARE SURFACE WATER MODEL

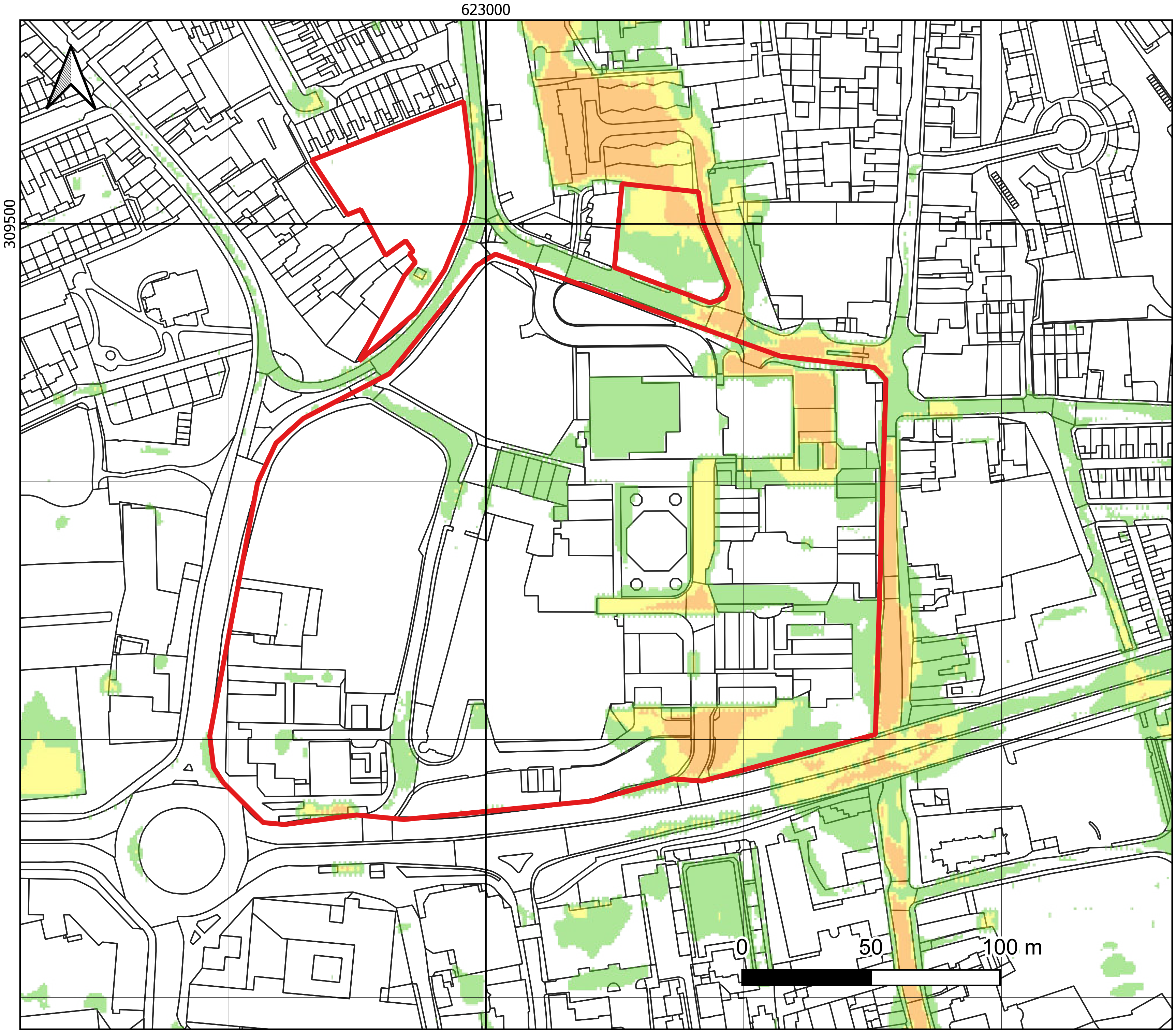
EXISTING

1:100 Year Flood Event

Royal HaskoningDHV

Enhancing Society Together


623000
309500
Key
Site Boundary
Hazard Rating
<= 0.05
0.05 - 0.75 (Low)
0.75 - 1.25 (Moderate)
1.25 - 2 (Sigificant)
> 2 (Extreme)
0
50
100 m
ANGLIA SQUARE SURFACE WATER MODEL
EXISTING
1:100 Year plus 20% Climate Change Flood Event
Royal HaskoningDHV
Enhancing Society Together



Key

Site Boundary

Hazard Rating

<= 0.05

0.05 - 0.75 (Low)

0.75 - 1.25 (Moderate)

1.25 - 2 (Sigificant)

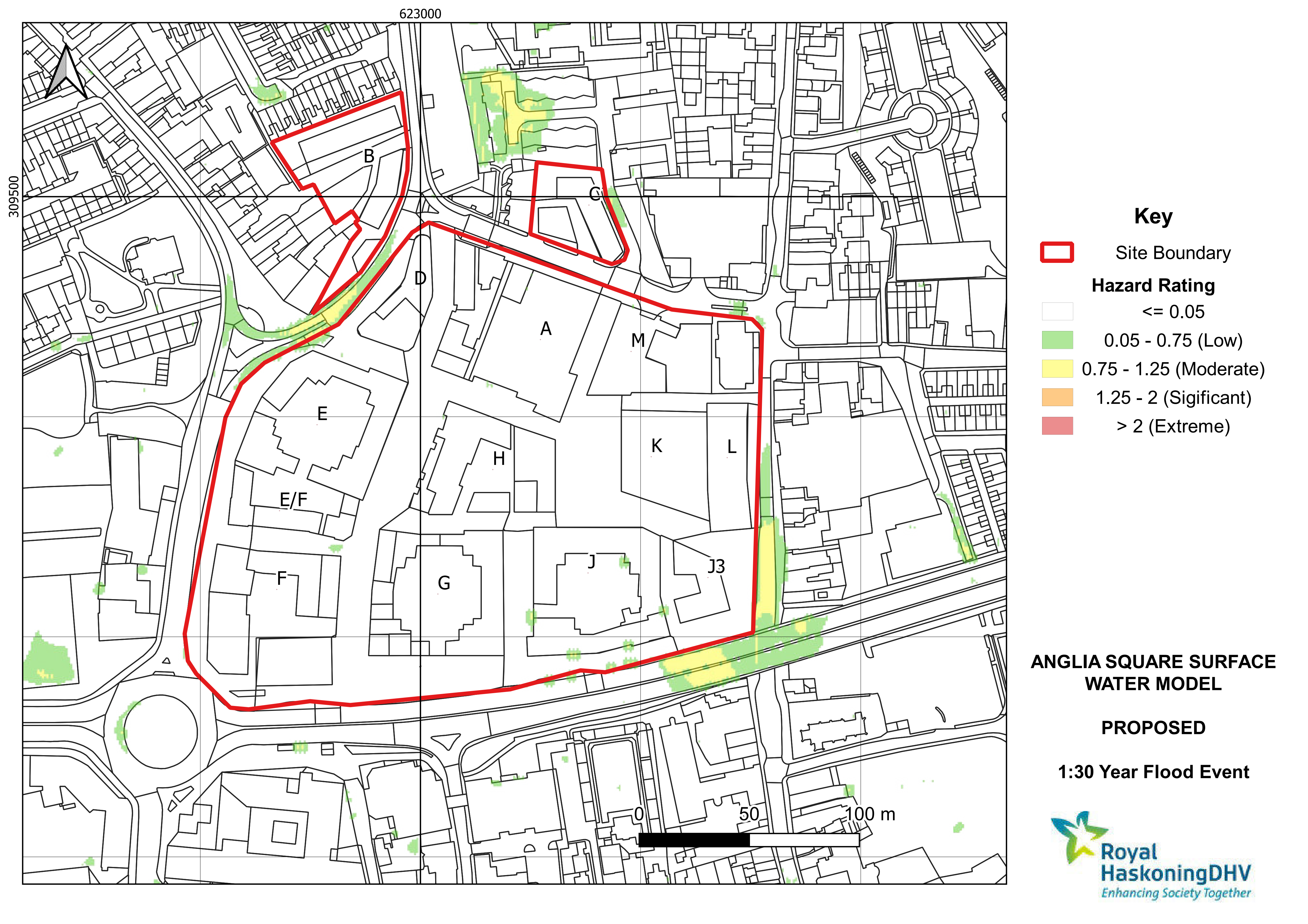
> 2 (Extreme)

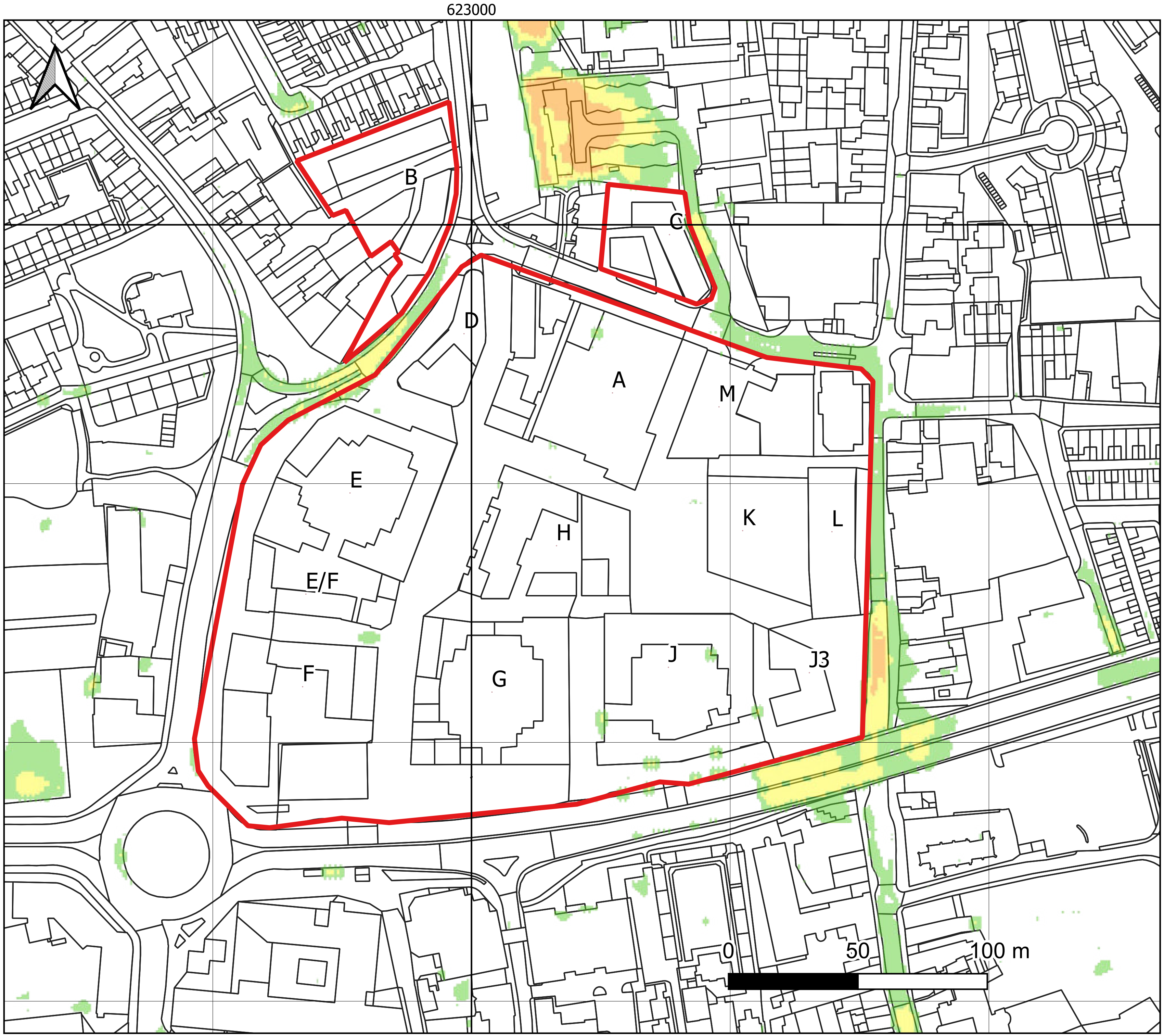
ANGLIA SQUARE SURFACE WATER MODEL

EXISTING

1:100 Year plus 40% Climate Change Flood Event

Royal HaskoningDHV
Enhancing Society Together


623000
309500
B
C
D
A
M
E
H
K
L
E/F
J
J3
F
G
0
50
100 m
Key
Site Boundary
Hazard Rating
<= 0.05
0.05 - 0.75 (Low)
0.75 - 1.25 (Moderate)
1.25 - 2 (Sigificant)
> 2 (Extreme)
ANGLIA SQUARE SURFACE WATER MODEL
PROPOSED
1:30 Year Flood Event
Royal HaskoningDHV
Enhancing Society Together



Key

Site Boundary

Hazard Rating

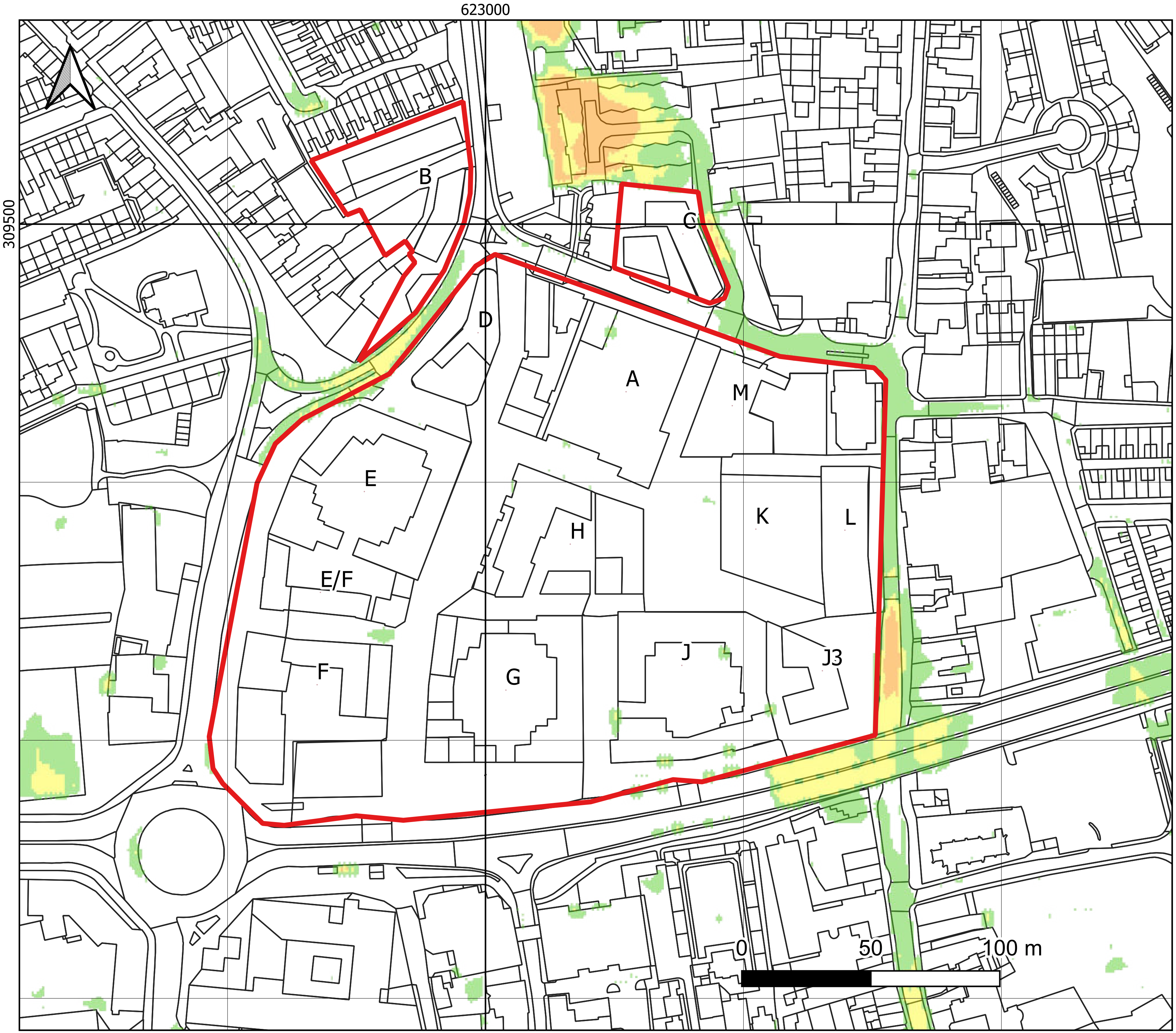
<= 0.05
0.05 - 0.75 (Low)
0.75 - 1.25 (Moderate)
1.25 - 2 (Sigificant)
> 2 (Extreme)

ANGLIA SQUARE SURFACE WATER MODEL

PROPOSED

1:75 Year Flood Event

Royal HaskoningDHV
Enhancing Society Together



Key

Site Boundary

Hazard Rating

<= 0.05

0.05 - 0.75 (Low)

0.75 - 1.25 (Moderate)

1.25 - 2 (Sigificant)

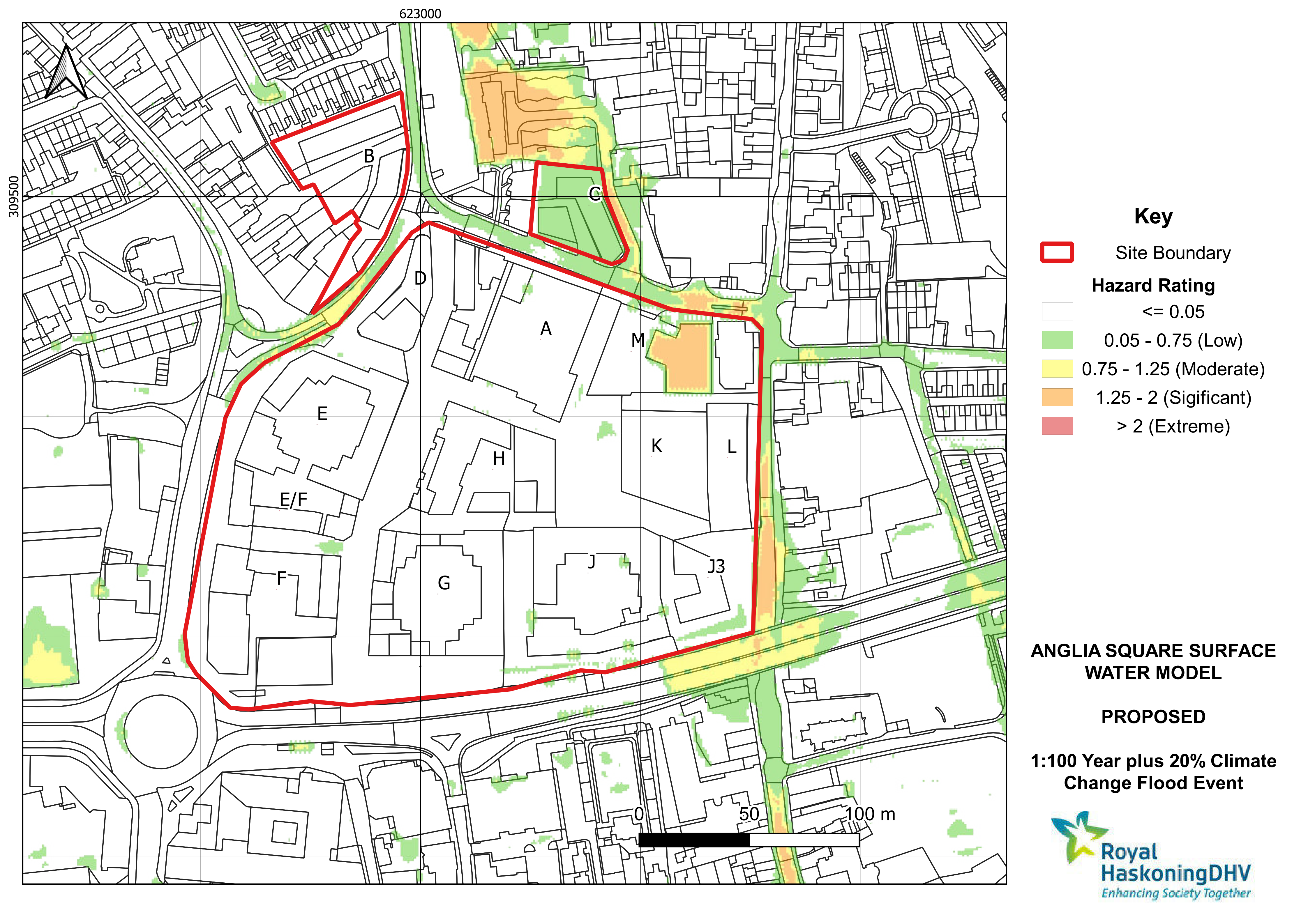
> 2 (Extreme)

ANGLIA SQUARE SURFACE WATER MODEL

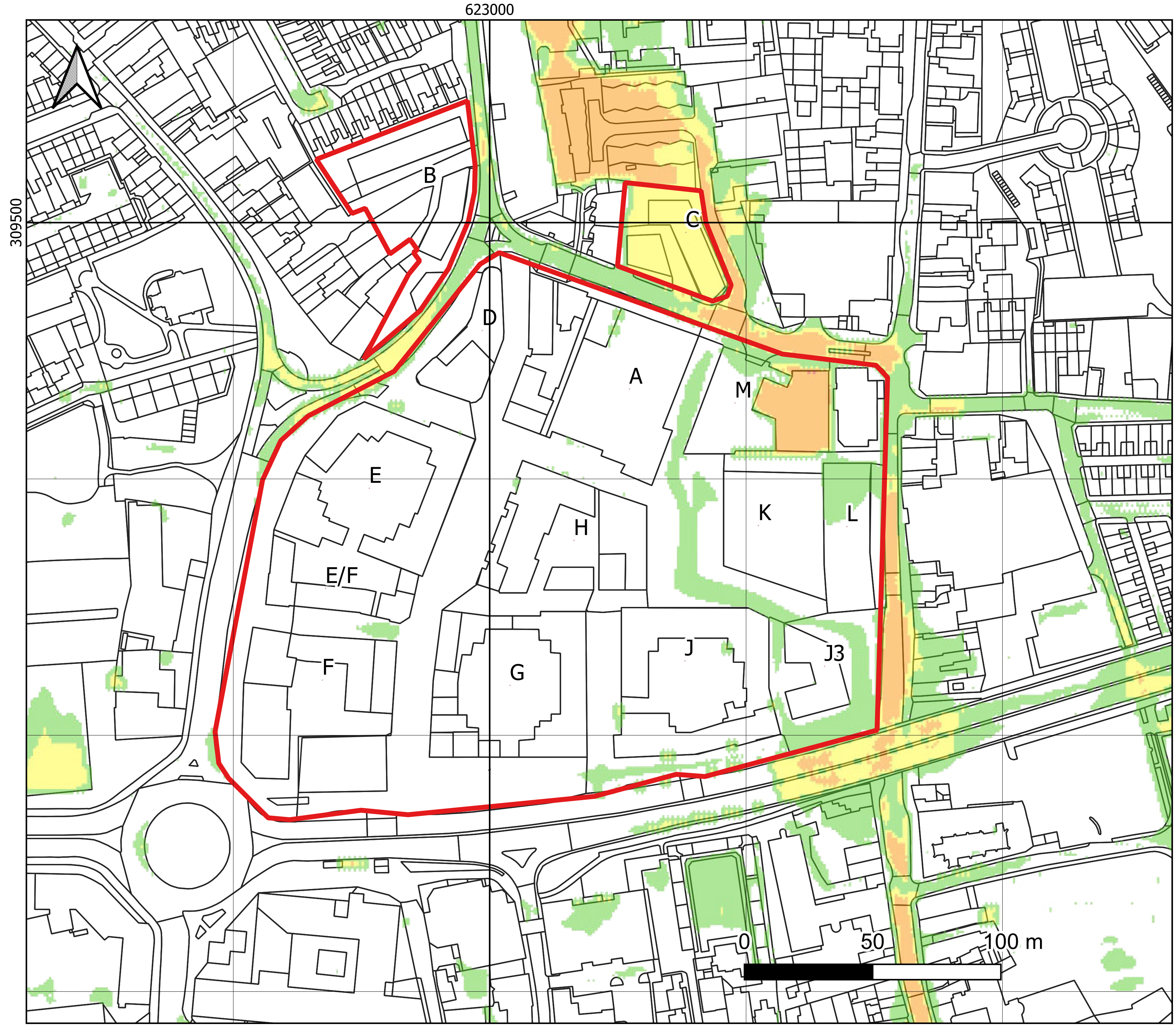
PROPOSED

1:100 Year Flood Event

Royal HaskoningDHV
Enhancing Society Together



623000
309500
B
C
D
A
M
E
K
L
H
E/F
F
G
J
J3
0
50
100 m
Key
Site Boundary
Hazard Rating
<= 0.05
0.05 - 0.75 (Low)
0.75 - 1.25 (Moderate)
1.25 - 2 (Sigificant)
> 2 (Extreme)
ANGLIA SQUARE SURFACE WATER MODEL
PROPOSED
1:100 Year plus 20% Climate Change Flood Event
Royal HaskoningDHV
Enhancing Society Together



Key

Site Boundary

Hazard Rating

<= 0.05

0.05 - 0.75 (Low)

0.75 - 1.25 (Moderate)

1.25 - 2 (Sigificant)

> 2 (Extreme)

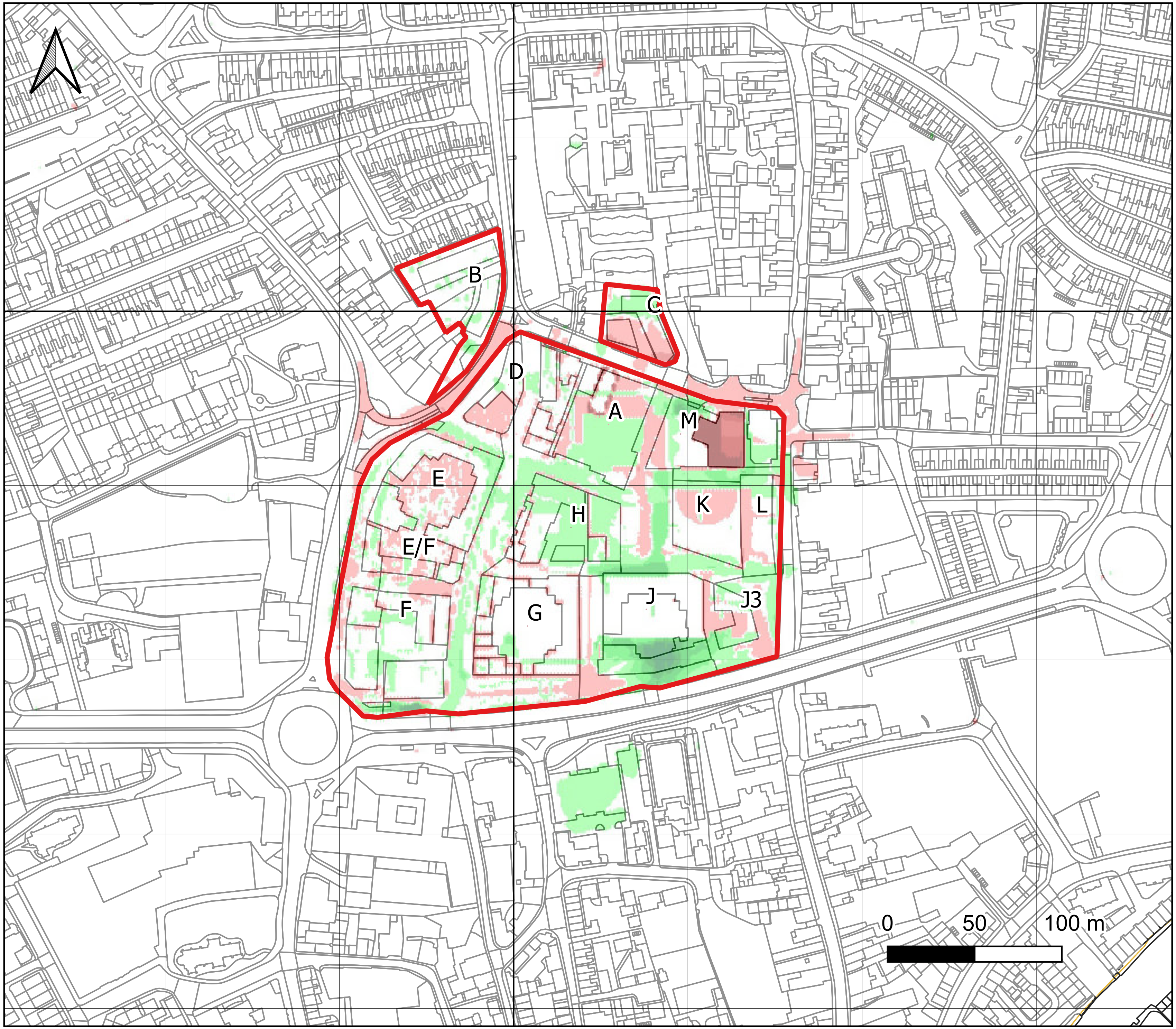
ANGLIA SQUARE SURFACE WATER MODEL

PROPOSED

1:100 Year plus 40% Climate Change Flood Event

Royal HaskoningDHV
Enhancing Society Together

Appendix J Offsite Impact Map



Key

Site Boundary

Change from Existing (m)

<=0.8
-0.8 - -0.6
-0.6 - -0.4
-0.4 - -0.2
-0.2 - -0.02
-0.02 - 0.02
0.02 - 0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
> 0.8

ANGLIA SQUARE SURFACE WATER MODEL

IMPACTS

1:100 Year Plus 40% Climate Change Flood Event

Royal HaskoningDHV
Enhancing Society Together