

Carrow Works, Norwich

Drainage & SuDS Strategy

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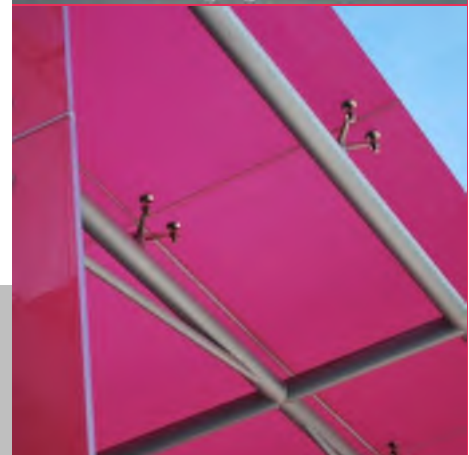
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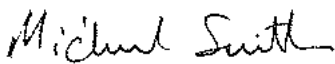
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1.0 Introduction

1.1 Project Overview

Curtins have prepared this Drainage Strategy on behalf of Fuel Properties Ltd in support of a hybrid planning application for the redevelopment of the Carrow Works site, Norwich. The Carrow Works site, forms part of the wider East Norwich Masterplan and aims to provide 4,000 new homes.

Proposals contained or forming part of this report represent the design intent and may be subject to alteration or adjustment in completing the detailed design for this project. Where such adjustments are undertaken as part of the detailed design and are deemed a material derivation from the intent contained in this document, prior approval shall be obtained from the relevant authority in advance of commencing such works.

1.2 Site Location

The Site is located approximately 1.8km southeast of Norwich City Centre on the existing Carrow Works site. The site is bound by the River Wensum to the north, the Great Eastern Main Line to the east and the A147 so south and west. The national grid reference for the site is TG 24260 07387.



Figure 1-1 - Site Location

1.3 Site Description

The existing Carrow Works site currently houses the Grade I listed Carrow Abbey and Cottages located within the centre of the site. The areas surrounding the Abbey and Cottages parcel are existing industrial buildings previously occupied by the Colemans family and more recently Unilever UK Ltd. The hybrid planning boundary has an approximate area of 16.9 ha.

A topographical survey has been carried out by CD Surveys Ltd and is included in **Appendix A**. The survey shows that the Site generally falls from the southwest to the northeast. An existing underpass beneath the Great Eastern Railway Line between the Site and the adjacent Deal Ground site is located in the northeast corner. The lowest point on site is 1.16mAOD which is the level of one of the gullies by the underpass entrance towards the northeast of the site. The level of the underpass itself reaches a level of 0.94mAOD between Carrow Works and the Deal Ground site. The site has a topographical high point of 16.20mAOD in the south-eastern corner of the site.

The northern boundary of the site adjacent to the River Wensum varies in levels from 4.14mAOD in the west to 1.39mAOD in the east. Generally, the northern areas of the site that are occupied by the historic Colemans buildings have a level of between 3.0 – 4.0mAOD. The Carrow Abbey area's levels range from 11.5-13.5mAOD.

1.4 Project Proposal

The hybrid planning application (part full, part outline), alongside Listed Building Consent and Demolition within a Conservation Area seeks to obtain approval for the following:

- **Detailed (Full) Component:**

"Full application comprising the construction of the principal means of access, the primary internal road and associated public spaces and public realm, including restoration and change of use of Carrow Abbey to former use as residential (Use Class C3), alteration and extension and conversion to residential use (Use Class C3) of the Lodge, Garage and Gardener's Cottage and the Stable Cottages, development of the former Abbey Dining Room for residential use (Use Class C3), adaptation and conversion for flexible uses (Class E and/or and/or C2 and/or and/C1 and/or C3 and/or F1 and/or F2 and/or B2 and/or B8 and/or Sui Generis) for buildings 207, 92, 206, 7 (7a, 8 and 8a), 209, 35, the Chimney and Class E and/or B2 and/or B8 for the retained Workshop (Block 258), enhanced access to Carrow Abbey and Scheduled Ancient Monument and associated ancillary works".

The full component of the application covers a site area of 5.02 ha.

- **Outline Component:**

“Demolition of existing buildings and replacement with phased residential-led (Use Class C3 and/or Class E and/or F1 and/or F2 and/or C1 and/or C2 and/or B2 and/or B8 and/or Sui Generis), landscaping, open space, new and modified access, car parking and ancillary works.”

The outline component of the application covers a site area of 11.9 ha.

The existing Abbey grounds, Mustard Seed Driers listed building, and gateway areas are proposed to be retained, with the proposed development constructed around these retained features. Due to the industrial nature of the site, the majority of the sites is impermeable. The Abbey’s Grounds make up the majority of the permeable area on site (around 2.5ha). existing Impermeable areas make up the remainder of the site area (approximately 14.4 ha). The hybrid application boundary split can be found in **Appendix B** and the proposed Landscape Masterplan in **Appendix C**.

2.0 Planning and Policy Considerations

2.1 National Planning Policy Requirements

2.1.1 National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG)

In recent years, the Government and local Councils have placed increased priority on the need for developers to take full account for the risks of their development at all stages of the planning process. The National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG) identifies how the issue of flooding is dealt with through the planning process and with the creation of a site-specific Flood Risk Assessment (FRA) for sites over 1ha in area or in Flood Zones 2 & 3.

2.1.2 DEFRA – Sustainable Drainage Systems

The Department for Environment, Food and Rural Affairs (DEFRA) national standards for sustainable drainage systems provides technical guidance on the design, construction and maintenance of Sustainable Drainage Systems (SuDS).

2.2 Local Planning Policy Requirements

2.2.1 North-Norfolk District Council Local Plan

The North Norfolk District Council Local Plan was formally adopted in Autumn 2008 and was updated in 2012 following the publication of the NPPF. The current Local Plan is due to be replaced shortly. The Local Plan sets out a vision for the area and, from this, a number of aims and objectives have been identified. Aims include:

- *To provide for sustainable development and mitigate and adapt to climate change*
- *To mitigate and adapt to impacts of coastal erosion and flooding*

Strategic and development control policies have been designed in order to achieve the objectives.

Notable policies regarding flood risk are the following:

- Policy SS 1 – Spatial Strategy for North Norfolk
Development in these Coastal Service Villages will support local coastal communities in the face of coastal erosion and flood risk. Land may be identified in or adjacent to these settlements to provide for new development or relocation from areas at risk.
- Policy SS 2 – Development in the Countryside
In areas designated as Countryside development will be limited to that which requires a rural location and is for one or more of the following:

- *coastal and flood protection.*
- *the preservation of Listed Buildings*

Proposals which do not accord with the above will not be permitted.

- Policy SS 4 – Environment

All development proposals will contribute to the delivery of sustainable development, ensure protection and enhancement of natural and built environmental assets and geodiversity and be located and designed so as to reduce carbon emissions and mitigate and adapt to future climate change.

The Council will minimise exposure of people and property to the risks of coastal erosion and flooding and will plan for a sustainable shoreline in the long-term, that balances the natural coastal processes with the environmental, social and economic needs of the area. Sustainable Drainage Systems will be encouraged, to reduce flood risk, promote groundwater recharge and improve water quality, enhance biodiversity and provide amenity benefit.)

- Policy EN 10 – Development and Flood Risk

The sequential test will be applied rigorously across North Norfolk and most new development should be located in Flood Risk Zone 1. New development in Flood Risk Zones 2 and 3a will be restricted to the following categories:

- *water compatible uses*
- *minor development*
- *changes of use (to an equal or lower risk category in the flood risk vulnerability classification) where there is no operational development (x); and*
- *'Less vulnerable' uses where the sequential test has been passed.*

New development in Flood Zone 3b will be restricted to water compatible uses only.

The Strategic Flood Risk Assessment defines zones 2, 3a and 3b in parts of North Norfolk and this will be used to inform the application of the sequential test. Where this information is not available, the Environment Agency Flood Risk Zones and a site specific Flood Risk Assessment will be used to apply the sequential test.

A site-specific Flood Risk Assessment which takes account of future climate change must be submitted with appropriate planning applications (xli) in Flood Zones 2, 3a and 3b and for development proposals of 1 hectare or greater in Flood Zone 1.

Land in Flood Zone 1 that is surrounded by areas of Flood Zones 2 or 3 will be treated as if it is in the higher risk zone and a Flood Risk Assessment will be required to prove that safe access / egress exists for the development or that the land will be sustainable for the duration of the flood period.

Appropriate surface water drainage arrangements for dealing with surface water run off from new development will be required. The use of Sustainable Drainage Systems will be the preference unless, following an adequate assessment, soil conditions and / or engineering feasibility dictate otherwise.

2.2.2 Norwich City Council Local Plan

The Norwich City Council Local Plan was formally adopted in December 2014. The Local Plan is comprised of three documents which together set out the strategic priorities for the greater Norwich area that allow the Council to manage development. The **Joint Core Strategy** sets out the strategy for regeneration and growth in the greater Norwich area up to 2026. The **Site Allocations Plan and Development Management Plan** provide detailed policies to guide and implement this strategy. The Development Management Plan has a number of spatial planning objectives, including Objective 1 – To minimise the contributors to climate change and address its impact. The objective states “*Where new development in such areas is desirable for reasons of sustainability (e.g. in the city centre), flood mitigation will be required and flood protection will be maintained and enhanced.*”

Notable policies regarding flood risk are the following:

- Policy DM3 – Design Principles
- *Significant weight will be given to the following design principles in assessing development proposals [including]:*
 - *Energy Efficiency and Climate Change*
 - *d) promote and facilitate sustainable drainage and mitigate against flood risk from surface water runoff as required by policy DM5.*
- Policy DM5 – Planning effectively for flood resilience

Flooding

All development proposals will be assessed and determined having regard to the need to manage and mitigate against flood risk from all sources. Development proposals must be supported by the relevant flood risk assessments and show that (where necessary) alternative sites of lower flood risk have been assessed, adopting a sequential approach to site selection according to the requirements of national policy and standing technical advice which supports it.

The sequential site assessment as set out in the NPPF will be expected to consider reasonable alternatives for locating the development in a zone of lower flood risk on any site elsewhere in Norwich, except in the case of:

- *Proposals within the city centre regeneration areas identified on the Policies map, in which case the assessment need only take account of reasonable alternative sites within the boundary of the relevant regeneration area concerned or (where no such alternative sites exist) alternative regeneration areas elsewhere in the city centre;*
- *Any other proposal which is consistent with and forms part of a specific allocation for development within the Site allocations plan and other adopted development plan documents, in which case the requirement for the sequential test will not apply.*

In the case of proposals in areas of higher flood risk which are within the city centre but which fall outside the regeneration areas identified on the Policies map, the search area for reasonable alternative sites should take account of:

- *a) the scale and function of the proposal;*
 - *b) the potential contribution of the use or uses proposed to overall regeneration of the city centre, including through the provision of new housing;*
 - *c) where the proposal is for retail, leisure or other main town centre uses, the suitability of any alternative locations in relation to policy DM18 of this plan;*
 - *d) any objectively identified need for the use proposed which justifies a location in the city centre in order to support the objectives and policies of the development plan.*
- *For the purposes of this policy “city centre” means the area defined on the city centre Policies map insets, including both the City Centre inset and Northern City Centre Area Action Plan inset.*

Sustainable drainage and surface water flooding

Mitigation measures to deal with surface water arising from development proposals should be incorporated to minimise the risk of flooding on the development site and where possible reduce the risk, otherwise at least minimise the risk, within the surrounding area.

Sustainable drainage measures appropriate to the scale and nature of the development shall be incorporated in all development proposals involving the erection of new buildings or the extension of existing buildings until such time as thresholds are established by nationally applicable standards for sustainable drainage. Such measures will be required except where this is not technically feasible or where it can be demonstrated that other factors preclude their use.

Within the critical drainage catchments as identified on the Policies map and in other areas where the best available evidence indicates that a serious and exceptional risk of surface water flooding exists, all development proposals involving new buildings, extensions and additional areas of hard surfacing should ensure that adequate and appropriate consideration has been given to

mitigating surface water flood risk. Developers will be required to show that the proposed development:

- o a) 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*
- o b) 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.

Surface Treatment

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:

- o a) in areas of impermeable soils as identified in Appendix 1;*
- o b) 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*
- o c) 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.

2.2.3 Greater Norwich Area Strategic Flood Risk Assessment (SFRA) (2017 & 2021)

The Level 1 SFRA (2017) aims to provide up to date information and guidance on all sources of flood risk throughout the Greater Norwich area, taking into account the latest flood risk information and

national planning policy. The SFRA aims to ensure all sources of flood risk are understood so they can be managed effectively throughout the planning process, taking into account the potential impacts of climate change. The SFRA provides a broad yet detailed assessment of flood risk, providing the evidence base for policies, recommendations, and guidance to help ensure the effective management of flood risk.

The Level 1 SFRA also provides guidance regarding the application of the Exception Test, aiding Norwich City Council in identifying when the Exception Test is required. It provides information on when a more detailed Level 2 SFRA will be required with regards to strategic site allocations.

The Level 2 SFRA (2021) provides a detailed assessment of all sources of flooding for sites identified by the Greater Norwich Planning Policy team as being potential allocation sites. It builds upon the Level 1 SFRA, providing site-specific assessments to provide the necessary information required to support the application of the Exception Test. All 26 sites proposed by the Greater Norwich Planning Policy team required a Level 2 assessment of flood risk.

2.2.4 Local Flood Risk Management Strategy (2015)

The aim of the Local Flood Risk Management Strategy (LFRMS) is to serve as a tool to better understand and manage flood risk within the area. For the city of Norwich, Norfolk County Council are the Lead Local Flood Authority, covering planning applications with regards to surface water drainage for the entire county of Norfolk. The aim of the document is:

“To work with organisations, businesses and communities to manage flood risk and, where it is practicable, affordable and sustainable to do so, to reduce risk to life, property and livelihoods that may arise from local surface runoff, ordinary watercourse and groundwater flooding.”

The document outlines the challenges and the objectives Norfolk have identified to coordinate flood risk management on a day-to-day basis. Additional information is provided regarding flood risk sources and the Risk Management Authorities who are responsible different flood risk management activities.

Norfolk conducted a Local Flood Risk Management Strategy Policy Review in 2021. Since the adoption of the 2015 LFRMS, Norfolk has experienced wide spread flooding, experienced significant growth and development, and has seen a change in the legislative landscape. As a result, the 2015 Strategy’s policies were reviewed against new and emerging national strategies and policies. This resulted in 3 new policies and minor updates to the existing policies.

2.2.5 Surface Water Management Plan (2011)

The Surface Water Management Plan (SWMP) provides an assessment of surface water flood risk and outlines a long-term action plan for managing surface water. Norfolk produced five SWMPs, including a Plan for the Norwich Urban Area. Both historic and predicted flooding from different flood risk sources are assessed, including sources which have been identified as surface water, sewer and groundwater

flooding. This assessment has been used to identify 3 Critical Drainage Areas (CDA) across the Norwich Urban Area. The proposed development does not fall within a CDA.

2.2.6 Preliminary Flood Risk Assessment (2011)

The Preliminary Flood Risk Assessment (PFRA) serves as high level screening exercise to help Norfolk County Council identify areas of flood risk across the borough. Historic and predicted flood risk data has been assessed to identify areas at risk of flooding from surface water runoff, groundwater, and ordinary watercourse. The PFRA was used to inform the LFRMS by identifying areas potentially at flood risk that may require more detailed studies. Norwich ranked first on the PFRA Settlement Priority Ranking in Norfolk, with a number of people, critical infrastructure, and non-residential properties above the flood risk threshold.

3.0 Flood Risk Summary

A detailed site-specific Flood Risk Assessment (FRA) has been written for this site (081440-CUR-XX-XX-T-C-92031). The FRA outlines the existing flood risk posed to the site, as well as evaluating how the proposed development will affect these risks

4.0 Existing Drainage

4.1 Public Sewerage

Anglian Water are responsible for the public sewerage in Norwich. Anglian Water mapping for the site has been obtained, this mapping indicates the site is bisected by an existing 600mm diameter foul water sewer. The sewer is located west of the retained Carrow Abbey building and flows from north to south. Mapping indicates that sewers outfalls to the 1050mm Diameter public sewer in A147. An extract of the mapping can be found below in Figure 4-1 and the mapping can be found in **Appendix D**.

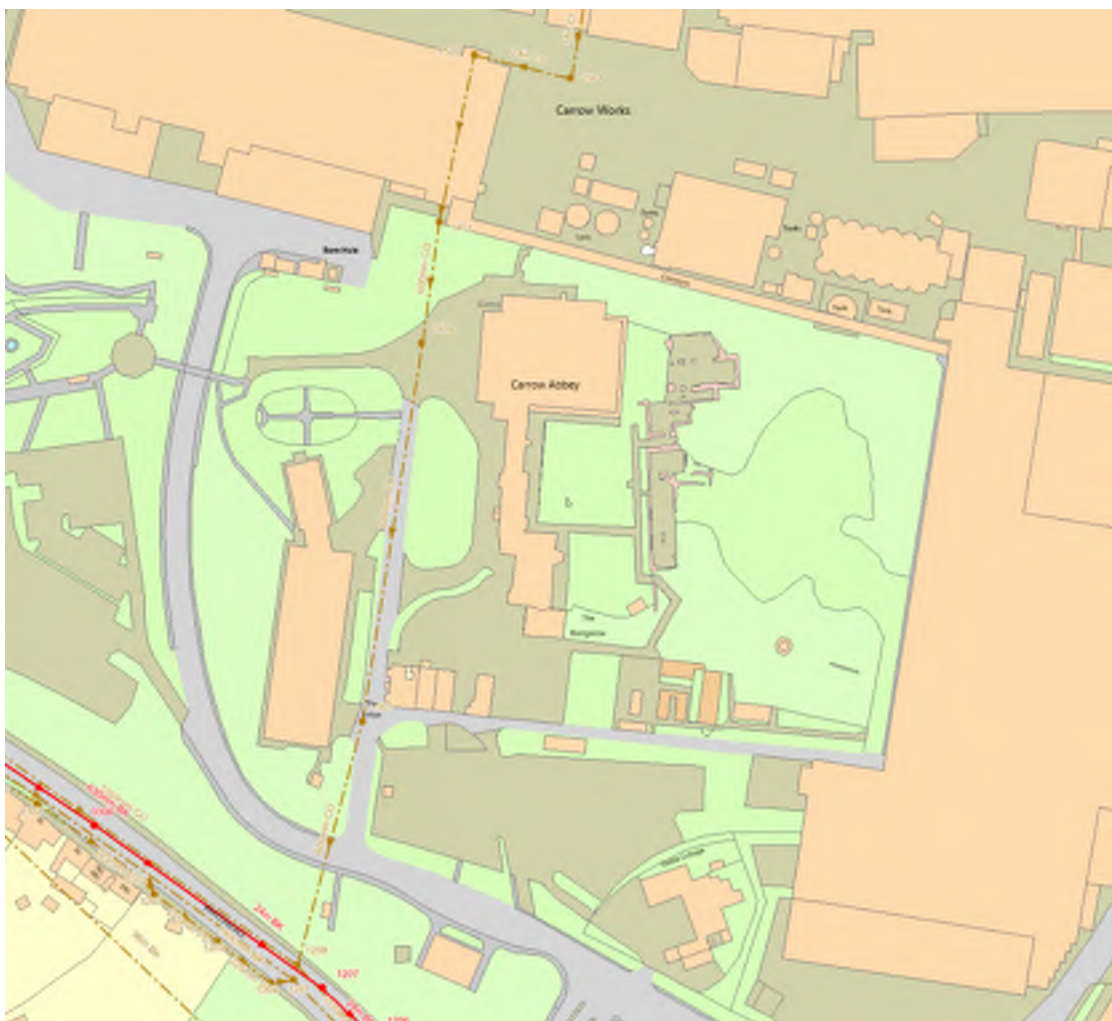


Figure 4-1 - Anglian Water Mapping Extract

A ground penetrating radar (GPR) survey of the site was carried out in November 2018 by WYG, this survey identified manholes and pipework that appears to align with the above mapping; however due to covers being unable to be lifted the route and diameter was unable to be confirmed. GPR survey can be found in **Appendix E**.

As this existing foul water sewer serves the Carrow Works site exclusively, it is anticipated to be removed as part of the development. A new foul water drainage network is proposed to be developed following development of the outline portion of the scheme.

4.2 Private Drainage

As discussed in the Section 4.1, a GPR survey was carried out in November 2018, this survey indicated that the site is served by both private surface and foul water systems.

4.2.1 Surface Water

The existing private drainage system contains two outfall methods: disposing of surface water via infiltration through soakaways and discharging surface water into the River Wensum. It can be seen that the northern area of the site discharges to the River Wensum, whereas the southern area (including the Abbey) discharges to the ground via infiltration.

The drainage system to the north has multiple outfalls to the River Wensum. It is proposed to retain and reuse three outfalls to the river in the northwest corner of the site. The retained outfalls have been identified in Figure 4-2 below.

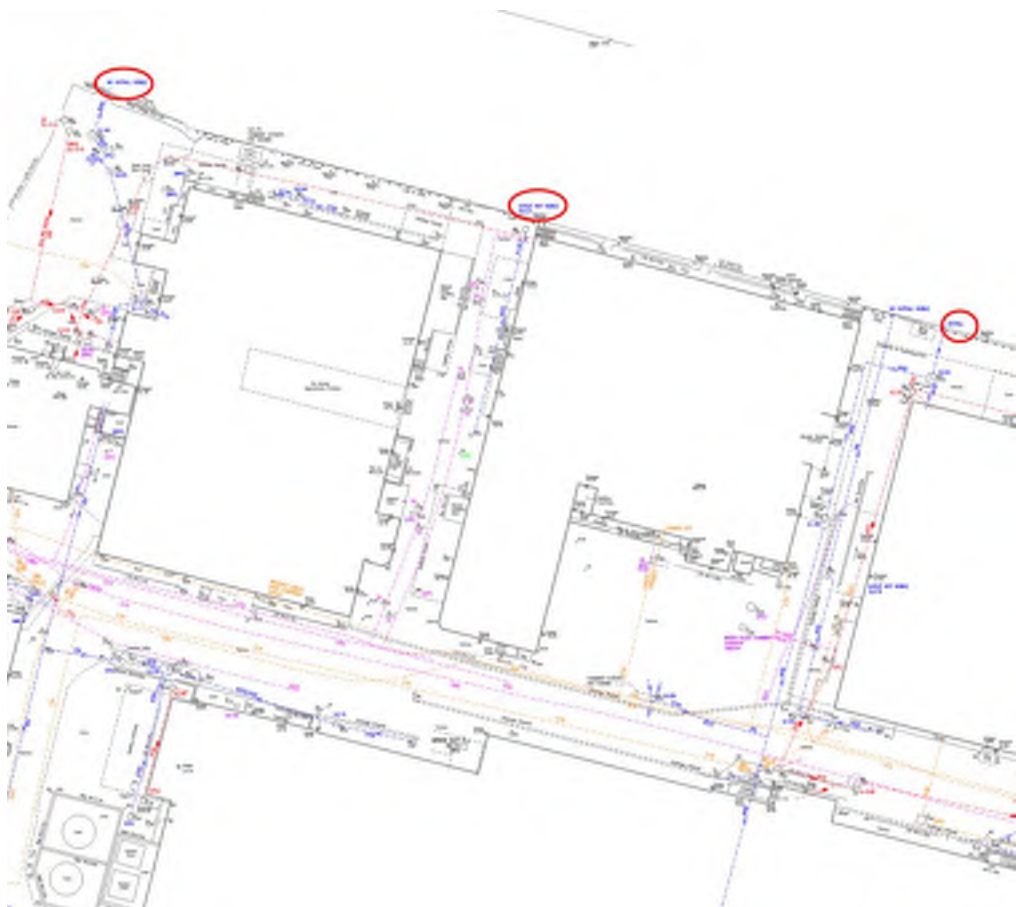


Figure 4-2 - GPR Extract Retained Outfalls

Carrow Abbey and the surrounding vegetated landscape is indicated to outfall via multiple soakaways, these soakaways have been identified in Figure 4-3. The vegetated area and highway south of the Abbey is also indicated to outfall via soakaways, see Figure 4-4. It is proposed that these existing systems are to be retained and left in situ as part of the scheme. At the time of writing no infiltration testing had been carried out, the reuse of the existing soakaways is subject to receipt of acceptable infiltration results. The proposals to maintain these soakaways is due to the sensitive nature of the Abbey Site and the Carrow Priory ruins.



Figure 4-3 - GRP Extract Carrow Abbey



Figure 4-4 - GPR Extract South of Abbey

4.2.2 Foul Water

The GPR survey did not include a definitive outfall for foul water on site, at the time of writing a CCTV survey had not been carried out therefore the existing foul water on site requires further investigation.

However, it is envisioned that the proposed development will be designed with a new below ground foul water system to serve each of the housing development. The foul water network is proposed to be developed following planning and following receipt of detailed above ground information. The exception is where existing buildings are proposed to be retained, these areas will look to reuse the existing below ground infrastructure.

An existing pump can be seen to be located in the underpass in the northeast corner of the site, it is proposed to remove the existing foul water pump and install a surface water pump to convey run off in the underpass to the proposed surface water system.

Where sewers are proposed to be abandoned or removed, works are to be carried out in accordance with building regulations Part H.

5.0 Proposed Drainage Strategy

5.1 General

The drainage strategy proposes to follow the existing site arrangement by disposing of surface water via infiltration and via outfalls to the River Wensum. Where surface water runoff is proposed to outfall to the River Wensum, it is intended to do so at a controlled 1 in 100 greenfield run-off rate (Q100) for all new build areas and for all storms (these areas are identified in Figure 5-1 below by red hatches). Where existing outfalls are proposed to be reused the existing catchment entering system is proposed to remain uncontrolled (shown in blue below); this is to avoid deep excavations adjacent to listed buildings that may affect their foundations. The River Wensum is tidal in this area and the overall site discharge is proposed to be heavily reduced.

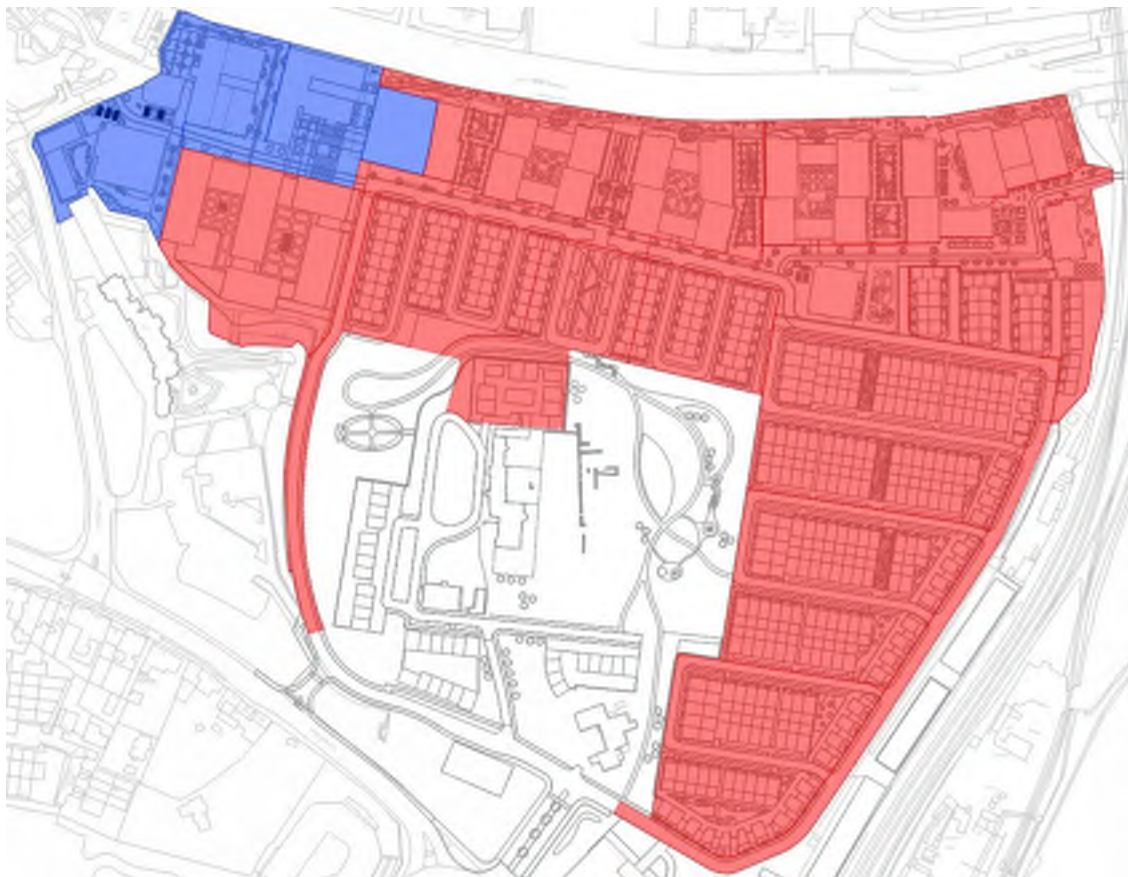


Figure 5-1 - Controlled & Uncontrolled Catchments

The hybrid planning application submitted is as such that the majority of the proposed plots are located within the outline planning areas of the site. Only with highways, the Abbey and a small area of existing commercial buildings fall within the full planning area.

To allow pipes and attenuation to be sized in the full planning network, plots have been assigned a controlled flow rate before discharging into highway system. Areas highlighted in the red in Figure 5-1

are proposed to be controlled at the Q100 rate, this approach was discussed and agreed with the LLFA during a pre planning meeting. Catchments and their classification can be found in **Appendix F**.

In line with the updated government guidance for the area, the surface water drainage has been designed to cater for up to the 1 in 100 year return period + 45% climate change. A general arrangement drawing of proposed drainage system can be found in **Appendix G**.

As discussed in Section 4.2.2, it is envisioned that the existing foul water serving the Abbey will be left in situ and foul water for the proposed development and remaining retained buildings is envisioned to also outfall to this existing public sewer

5.2 Surface Water

In line with the Drainage Hierarchy, surface water run off from a site should endeavour to be controlled as close to the source as possible. Discharge from site should be via one of the methods detailed in **Table 1**, in descending priority;

Table 1 - Discharge Opportunities

Sustainable Drainage Hierarchy	Site Specific Application
Store rainwater for later use	Proposed residential plots fall within the outline planning application, as plots are progressed in detail rainwater harvesting techniques are to be reviewed by M&E engineer.
Use infiltration techniques, such as porous surfaces in non-clay areas	Where existing catchments drain via infiltration it is proposed to either reuse the infiltration system or provide a new system (subject to infiltration testing results). Due to the previous site usage, the majority of the site is at an elevated contamination risk therefore not appropriate for infiltration. Infiltration has only be used in areas where existing infiltrating devices are used and contamination risk is known to be low.
Attenuate rainwater in ponds or open water features for gradual release	Spatial constrains on site limit opportunities to include ponds or open water on site.
Attenuate rainwater by storing in tanks or sealed water features for gradual release	The proposed drainage strategy proposes to attenuate surface water within below ground cellular storage.
Discharge rainwater direct to a water course	Where infiltration is not a viable outfall method due to previous commercial land use or proximity to proposed/existing listed building, it is proposed to discharge surface water to the River Wensum via a proposed outfall and an existing retained outfall.
Discharge rainwater to a surface water sewer/drain	The drainage strategy proposes to outfall runoff using infiltration and to the River Wensum.
Discharge rainwater to a combined sewer	The proposed drainage strategy proposes to outfall runoff using infiltration and to the River Wensum.

5.2.1 Proposed Site Discharge

Overview

The aggregation of the majority of the positively drained areas across the site is equal to the 1 in 100 year greenfield run-off rate. However, as described throughout this section, two catchments are proposed to freely discharge. A summary of the total site discharge is provided below. The below tables should be read in conjunction with the Catchment Plan contained in **Appendix F**.

Table 2 - Site Discharge Summary

Catchment Name	Total Area (ha)	Method of Discharge	Discharge Rate (l/s)
A,B,C,D,E,F,G,H, I, J	9.48	Controlled (Q100)	96.73
K, L, M, N, Q, R,	6.17	Infiltration	N/A
O, P, S	1.25	Uncontrolled	914.92

As per Table 1 the site proposed to outfall via two methods of discharge: infiltration and discharging directly into the River Wensum. Table 3 indicates each catchment area, the size of the catchment, planning classification of the catchment and the discharge method of the catchment. The table is an extract for the Catchment plan in **Appendix F**.

Table 3 - Catchment Classification

Catchment Name	Catchment (ha)	Discharge Method/Location	Planning Classification
A1	0.85	Proposed East Outfall	Outline
A2	0.99	Proposed East Outfall	Outline
A3	1.18	Proposed East Outfall	Outline
B	0.56	Proposed East Outfall	Outline
C1	0.63	West Outfall	Outline
C2	0.58	West Outfall	Outline

Catchment Name	Catchment (ha)	Discharge Method/Location	Planning Classification
C3	0.39	West Outfall	Outline
D	0.79	West Outfall	Outline
E	1.08	West Outfall	Outline
F	0.98	Proposed East Outfall	Outline
G	0.20	West Outfall	Full
H	0.21	West Outfall	Full
I	0.31	Proposed East Outfall	Full
J	0.73	Proposed East Outfall	Full
K	2.38	Existing Infiltration	Full
L	1.08	Existing Infiltration	Outline
M	0.53	Existing Infiltration	Outline
N	0.61	Existing Infiltration	Outline
O	0.73	Existing Outfall	Full
P	0.39	West Outfall	Full
Q	1.28	Proposed Infiltration	Outline
R	0.29	Existing Infiltration	Full
S	0.13	Existing Outfall	Outline

Table 3 indicates that an area of 6.17ha is proposed to be disposed of via infiltration utilising either existing infiltration systems or where this is not possible reinstated systems.

This leaves a remaining 10.73 ha that outfalls to the River Wensum, of which 9.48 ha is proposed to be controlled to the Q100 rate. The Q100 rate has been calculated using MicroDrainage as 10.2 l/s/ha see Figure 5-2 below. The Q100 rate has been selected as this will provide a significant betterment when compared with the existing uncontrolled discharge from the site. This approach is seen as acceptable

as the River Wensum in this location is tidal and less susceptible to fluvial flood events. However, following consultation with the LLFA it was agreed that although the river is tidal a significant betterment would be provided.

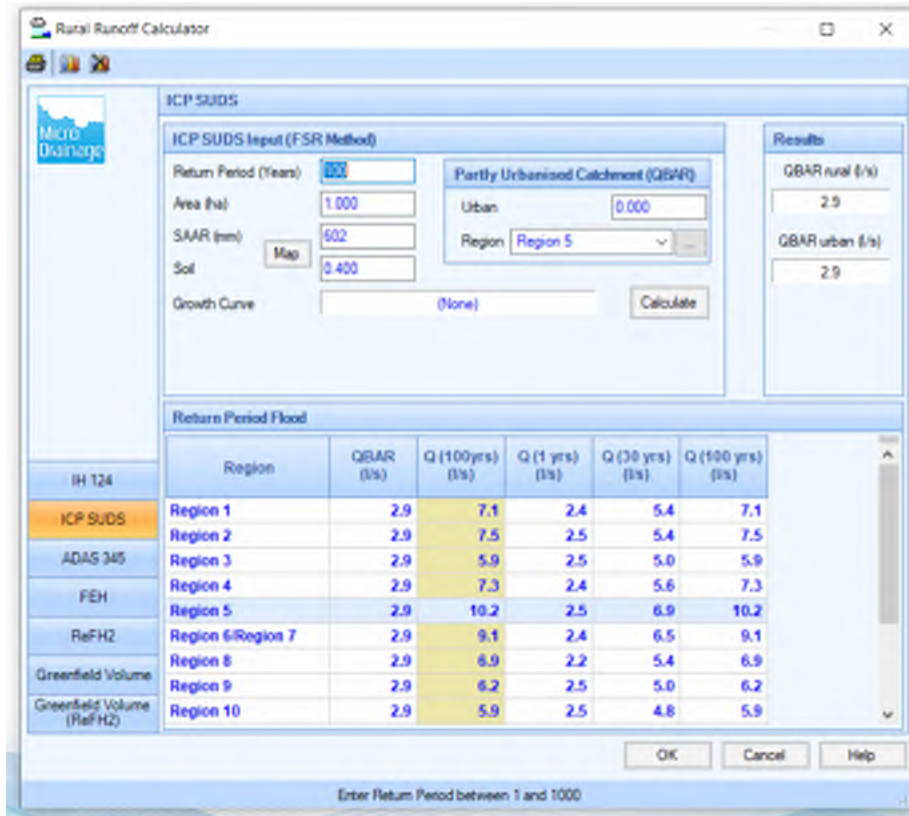


Figure 5-2 - Q100 Controlled Rate

The Q100 rate is the proposed final outfall rate from the proposed drainage system for the east outfall. The west outfall has a combined outfall rate of 378.8 l/s of which the proposed plots contribute a total controlled rate of 39.58 l/s. Plots have been assigned controlled outfall rates on a plot by plot bases, taking into account spatial constraints of the plot, location of outfall and spatial constraints of the road.

A hydraulic model has been designed for the site with the catchment areas associated with the outline planning plots assigned to a single point of outfall per catchment. A control has been modelled limiting the catchment to its assigned discharged rate, this approach allows the strategic system to be assessed and sized sufficiently whilst also provided an indication of the attenuation required for each plot.

Due to the outline status of the plots, it has been assumed that the entire plot is impermeable, therefore no allowance for landscaping has been included. This is seen as conservative.

The hydraulic modelled has been assed line with government guidance for the area, the surface water drainage has been designed to cater for up to the 1 in 100 year return period + 45% climate change. A general arrangement drawing of proposed drainage system can be found in **Appendix G** and hydraulic calculations can be found in **Appendix H**.

East Outfall

The east outfall is a proposed outfall is controlled to a discharge rate of 57.15 l/s before outfalling directly into the River Wensum. The table below outlines the plots that are proposed to outfall to the east network, the catchment area, the flow rate and attenuation required on plot. Due to the size of Catchment A three outfalls have been provided.

Table 4 - East Outfall Catchments

Catchment Name	Catchment (ha)	Controlled Discharge Rate (l/s)	Attenuation Required (m ³)
A1	0.85	15.00	472
A2	0.99	12.00	618
A3	1.18	15.00	720
B	0.56	15.00	276
F	0.98	7.33	694

West Outfall

The west outfall is proposed to reuse an existing outfall to the River Wensum and as such the final outfall rate to the River Wensum is made up of both controlled and uncontrolled rates. Catchment areas G, H and C are proposed to discharge upstream of the existing pipework and therefore the controlled rate from these areas has been prorated based on catchment area and a vortex control chamber provided. Catchment areas D & E are proposed to discharge downstream of the vortex control and will be controlled separately on each plot.

The maximum flow rate from the west outfall is 378.8 l/s, of which 39.58 l/s is controlled from the proposed drainage network. See Figure 5-3 for diagram.

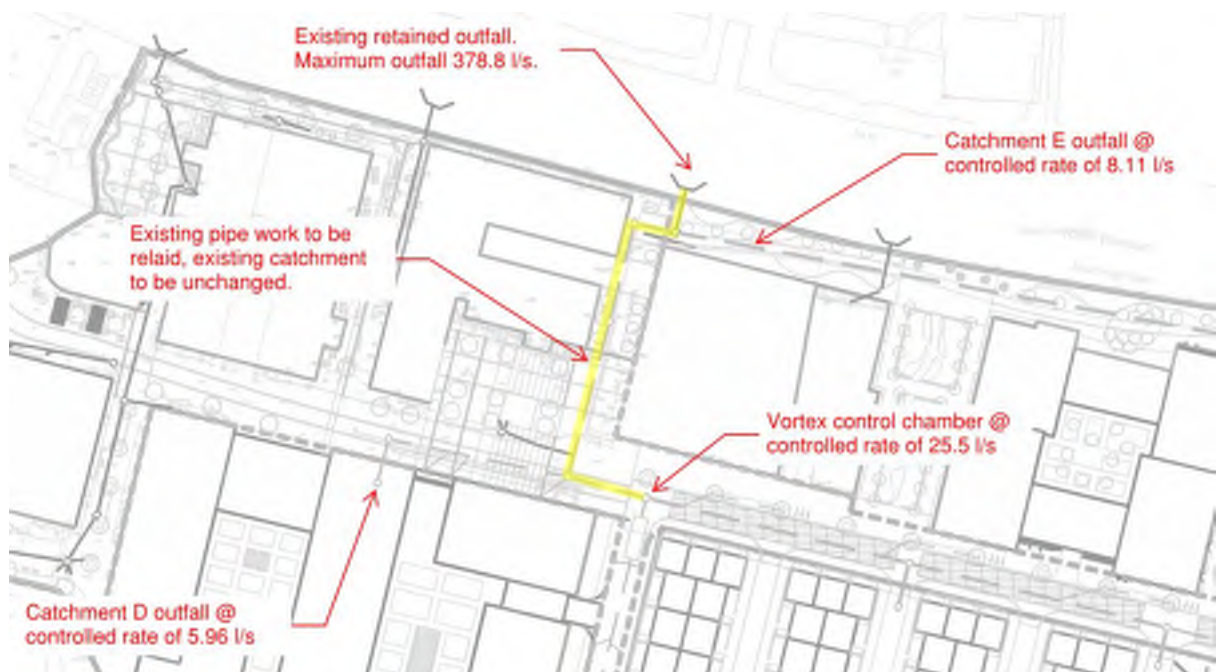


Figure 5-3 - West Outfall Diagram

Catchment C is the only plot proposed to discharge upstream of the retained network and outfall (highlighted in Figure 5-3), due to the size of Catchment C three outfalls have been provided. The table below outlines the outfall from Catchment C identifying the catchment area, the flow rate and attenuation required on plot.

Table 5 - West Outfall Catchments Upstream of Existing Network

Catchment Name	Catchment (ha)	Controlled Discharge Rate (l/s)	Attenuation Required (m ³)
C1	0.39	10.00	193
C2	0.73	11.00	319
C3	0.48	20.00	286

The remaining controlled catchment areas D and E are detailed in the table below –

Table 6 - D & E Catchments

Catchment Name	Catchment (ha)	Controlled Discharge Rate (l/s)	Attenuation Required (m ³)
D	0.79	5.96	561
E	1.08	8.11	763

As identified in Figure 5-3 the existing retained buildings are proposed to utilise the existing arrangement and outfall uncontrolled (Catchment Area O & P) as per the existing regime on site. Due to spatial constraints in this area and the historic nature of the buildings, any attenuation associated with it would be required to be below ground and deep. The construction of these features may pose a risk to be structural integrity of the building and therefore have not been included. As the River Wensum is tidal and the existing system discharges freely, the risk of instability due to the installation of attenuation has been assessed to outweigh the risk of flooding. The catchment areas associated with these buildings are identified below.

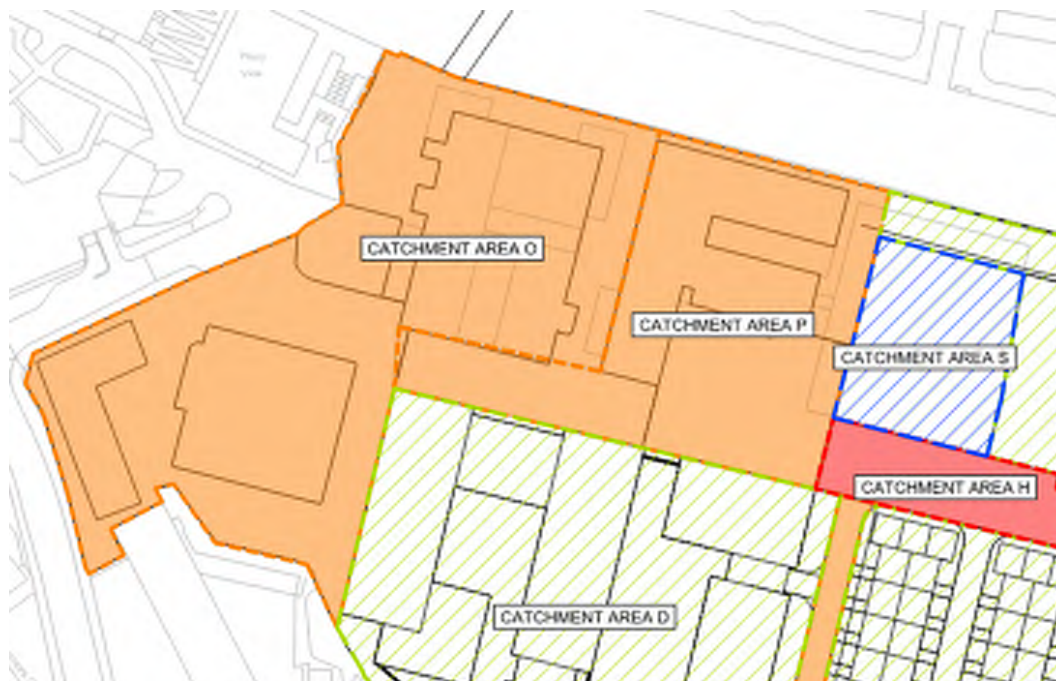


Figure 5-4 - Retained Building Catchments

5.2.2 Attenuation

As discussed in Section 5.2.1 separate attenuation is to be provided within the highways and on plot. Where attenuation is provided in the highways this is proposed to be in the form of below ground cellular storage crates.

The plots fall within the outline planning classification of the application and therefore the details of attenuation in these areas will be confirmed at a later design stage. However, it is envisioned that it will be provided via permeable paving, bioretention, blue/green roofs or below ground cellular storage.

The required attenuation has been calculated using Causeway Flow for the 100 year return period + 45% climate change, calculations can be found in **Appendix H**.

The west outfall requires a total of 2,919m³ of storage, 797m³ of which is proposed to be provided using below ground cellular storage and the remaining 2,122m³ on plot as part of the outline planning extents, the form of which is to be confirmed at a later design stage.

The east outfall requires a total of 4,024m³ of storage, 1,315m³ of which is proposed to be provided within the detailed planning boundary using below ground cellular storage and the remaining 2,709m³ on plot as part of the outline planning extents, the form of which is to be confirmed at a later design stage.

5.2.3 Sustainable Drainage Systems

Developments should utilise sustainable drainage systems (SuDS) unless there are practical reasons for not doing so. As mentioned previously, the design should aim to reduce run-off rates and ensure that run-off is managed as close to its source as possible as per the drainage hierarchy (see Table 1).

The SuDS Hierarchy sets out the preferred method of discharging and managing water from a development site and aims to highlight why each item has been utilised or discounted.

Table 7 analyses the SuDS hierarchy and the appropriate techniques with specific focus on this project.

Table 7 - SuDS Opportunities

SuDS Technique	Site Specific Analysis
Rainwater Harvesting	Proposed residential plots fall within the outline planning application, as plots are progressed in detail rainwater harvesting techniques are to be reviewed by M&E engineer at a later design stage.
Living or Roofs/Areas	<p>It is envisioned that blue/green roofs will be included within in the on plot drainage designs, as these areas fall within the outlining planning area this will be confirmed at a later design stage.</p> <p>The buildings within the full planning area are retained listed building and as such blue/green roofs are not proposed.</p>

SuDS Technique	Site Specific Analysis
Basins and Ponds	<p>Due to spatial constraints basins or ponds are not proposed within the full planning area.</p> <p>It is envisioned that the potential of including basins and ponds will also be limited due to spatial constraints, however as the plot designs progress the options will be reviewed.</p>
Bio-retention and Swales	<p>Bio-retention areas are proposed within the full planning application boundary, it is proposed that parts of the highways will runoff directly into the bio-retention areas. The bio-retention areas are to be used for treatment only and not proposed to be used as storage.</p>
Infiltration Devices	<p>It is proposed to reuse existing infiltration structures on site where suitable. These are shown on the Drainage General Arrangement in Appendix G.</p>
Permeable Surfaces	<p>Permeable paving is envisioned to be included within the on-plot outline drainage strategy.</p> <p>Porous sub-base with impermeable surfacing is proposed In the surround areas of the existing buildings to the northwest corner of the site around the listed building in the northwest corner of the site (Catchments O&P), it is proposed to outfall runoff via linear channels to a granular sub base where this will enter the below ground drainage system. This is intended to slow the flow of run-off in the uncontrolled portion of the scheme, provide some additional attenuation and reduce flood risk, without installing large attenuation tanks adjacent to the foundations of listed buildings.</p>
Tanked Systems	<p>Tanked systems are proposed within both the full and outline planning areas on the site. Within the full planning area tanked systems are proposed to provide a total of 2,112m³ of storage.</p>

5.2.1 Water Quality – Full Planning Area

The proposed drainage strategy manages pollution risk for the site based on a simple qualitative method as defined in the CIRIA SuDS Manual C753, consisting of an assessment of likely pollution hazard levels for the site and SuDS performance capacities:

Step 1. Allocate suitable pollution hazard indices for the proposed land use

TABLE 26.2 Pollution hazard indices for different land use classifications				
Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways ¹	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways ¹	High	0.8 ²	0.8 ²	0.9 ²

Figure 5-5 - Extract of CIRIA SuDS Manual C753. Pollution Hazard Indices for Land Use Classification

For the development that falls within the full planning application this has been identified as ‘Commercial Yards/All Other Roads’, the existing retained buildings are classified as ‘Commercial Yard’ and the highway as ‘All Other Roads’.

Step 2. Select SuDS with a total pollution mitigation index that is equal or exceeds the pollution hazard index.

TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters			
Type of SuDS component	Mitigation indices ¹		
	TSS	Metals	Hydrocarbons
Filter strip	0.4	0.4	0.5
Filter drain	0.4 ²	0.4	0.4
Swale	0.5	0.5	0.5
Bioretention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.5
Pond ³	0.7 ³	0.7	0.5
Wetland	0.6 ³	0.8	0.8
Proprietary treatment systems ^{1,4}	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

Figure 5-6: Extract of CIRIA SuDS Manual C753. Pollution Mitigation Indices

The ‘Commercial Yards’ are proposed to drain via linear channels that outfall to a granular subbase before entering the wider strategic network, for the purpose of the indices matrix this can be viewed as ‘Permeable Paving’.

‘All Other Roads’ (Highways) are proposed to drain via roadside bioretention that outfall to a granular subbase before entering the wider strategic network.

Both permeable paving and bioretention areas provide sufficient treatment for their respective land use and pollution hazard level.

Due to spatial and arboriculture constraints the retained highways are proposed to drainage via road gully’s, it is proposed that before entering the downstream system where SuDS components are present these catchments is proposed to pass through a full retention petrol interceptor. Mitigation indices for a AquaTreat Water Treatment Separator can be found –

Table 8 - AquaTreat Water Treatment Separator Treatment Indices

TSS	Metals	Hydrocarbons
0.85	0.64	0.99

5.2.1 Water Quality – Outline Planning Area

The proposed drainage strategy manages pollution risk for the site based on a simple qualitative method as defined in the CIRIA SuDS Manual C753, consisting of an assessment of likely pollution hazard levels for the outlining planning area and SuDS performance capacities:

Step 1. Allocate suitable pollution hazard indices for the proposed land use

TABLE 26.2 Pollution hazard indices for different land use classifications

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways ¹	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways ¹	High	0.8 ²	0.8 ²	0.9 ²

Figure 5-7 - Extract of CIRIA SuDS Manual C753. Pollution Hazard Indices for Land Use Classification

The development that falls within the outline planning application has been identified as ‘Residential Roofs’, ‘Individual Property Driveways’ or ‘Commercial Yards,’.

Step 2. Select SuDS with a total pollution mitigation index that is equal or exceeds the pollution hazard index.

TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters			
Type of SuDS component	Mitigation indices ¹		
	TSS	Metals	Hydrocarbons
Filter strip	0.4	0.4	0.5
Filter drain	0.4 ²	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond ¹	0.7 ²	0.7	0.5
Wetland	0.8 ¹	0.8	0.8
Proprietary treatment systems ^{1,3}	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

Figure 5-8: Extract of CIRIA SuDS Manual C753. Pollution Mitigation Indices

The above figure provides an indication of how treatment may be provided within the outlining planning area, however the exact details of the SuDS components used within these areas will be confirmed at a later design stage.

Permeable paving, bioretention areas (blue/green roofs) and filter strips provide sufficient treatment for their respective land use and pollution hazard level. Where areas are identified at the later design stages that are not covered by these, bypass or full retention separators will be used to ensure the hazard indices are met for all areas of the development.

5.2.2 Flood Exceedance

Information taken from the Carrow Bridge TS Norwich Monitoring Station (TG2390007700) indicates that the typical high tide level for the River Wensum at this location is 0.99mAOD. The proposed eastern outfall from the site is proposed at a level of 1.00mAOD, this sits above the typical high tide level.

The western outfall from the site proposes to reuse an existing outfall. The outfall level is unknown however the next upstream invert level is 0.64mAOD, therefore it has been assumed that the pipe is laid at a grade of 1 in 100.

Both the known upstream level and assumed downstream outfall level sits below the typical high tide level, to allow for this within the design a surcharged outfall has been modelled for all return periods and durations. Calculations can be found in **Appendix H**.

Using the climate change allowances provided by the Environment Agency for the fluvial and pluvial flood risk to the site, a further assessment has been undertaken into the impact of the design rainfall event (1 in 100 year +45%CC) occurring simultaneously with the design river flooding event (1 in 100 year +11%CC). Surcharged outfall for both the west and east outfalls have been modelled to simulate river levels in the Wensum during a 1 in 100 year fluvial event occurring in the 2080s. Calculations can be found in **Appendix I**.

This model indicated that a total of 677m³ of flooding would occur at the east outfall (MH 29), however levels indicate that should flooding occur at this manhole the exceedance flows would flow towards and enter the River Wensum.

The west outfall indicates the system would flood (511m³) at its lowest point (MH SW36), where flood water would be located within the highway and surrounding areas.

5.3 Foul Water

As discussed in Section 4.2.2 it is envisioned that the existing foul water serving the Abbey building is to be retained. A new foul water network is proposed to serve the new developments across the site with existing sewerage being retained where feasible. An assessment into the foul water loading is to be undertaken following planning and during the detailed developments of the plot drainage. The existing Anglian Water sewer that bisects the site will be retained from the Abbey to its outfall in the south and abandoned or diverted to the north.

Foul water on site proposed to be designed in accordance with Building Regulations Part H and is believed to remain private.

5.3.1 Nutrient Neutrality

Guidance has also been provided by Natural England with regards to the potential to affect water quality by treated foul effluent resulting in adverse nutrient impacts on habitat sites. The proposed development will result in a net increase in population served by the Anglian Water wastewater system. At this stage it is known that there are various options available for the mitigation of this impact, however, currently no specific mitigation measure has been opted for.

The detailed aspect of this application does not include any new buildings, therefore it is proposed that nutrient neutrality is considered and conditioned at the reserved matters application stage, where the new housing developments will be brought forward for assessment.

6.0 General Maintenance

It is assumed that all drainage within the site will be maintained as a private network. A suitable maintenance strategy will be included within handover documentation by the contractor once final details and suppliers have been chosen for the individual drainage elements. This strategy should be adopted to ensure the drainage network is cleaned regularly and the routine maintenance and cleansing regime should be documented.

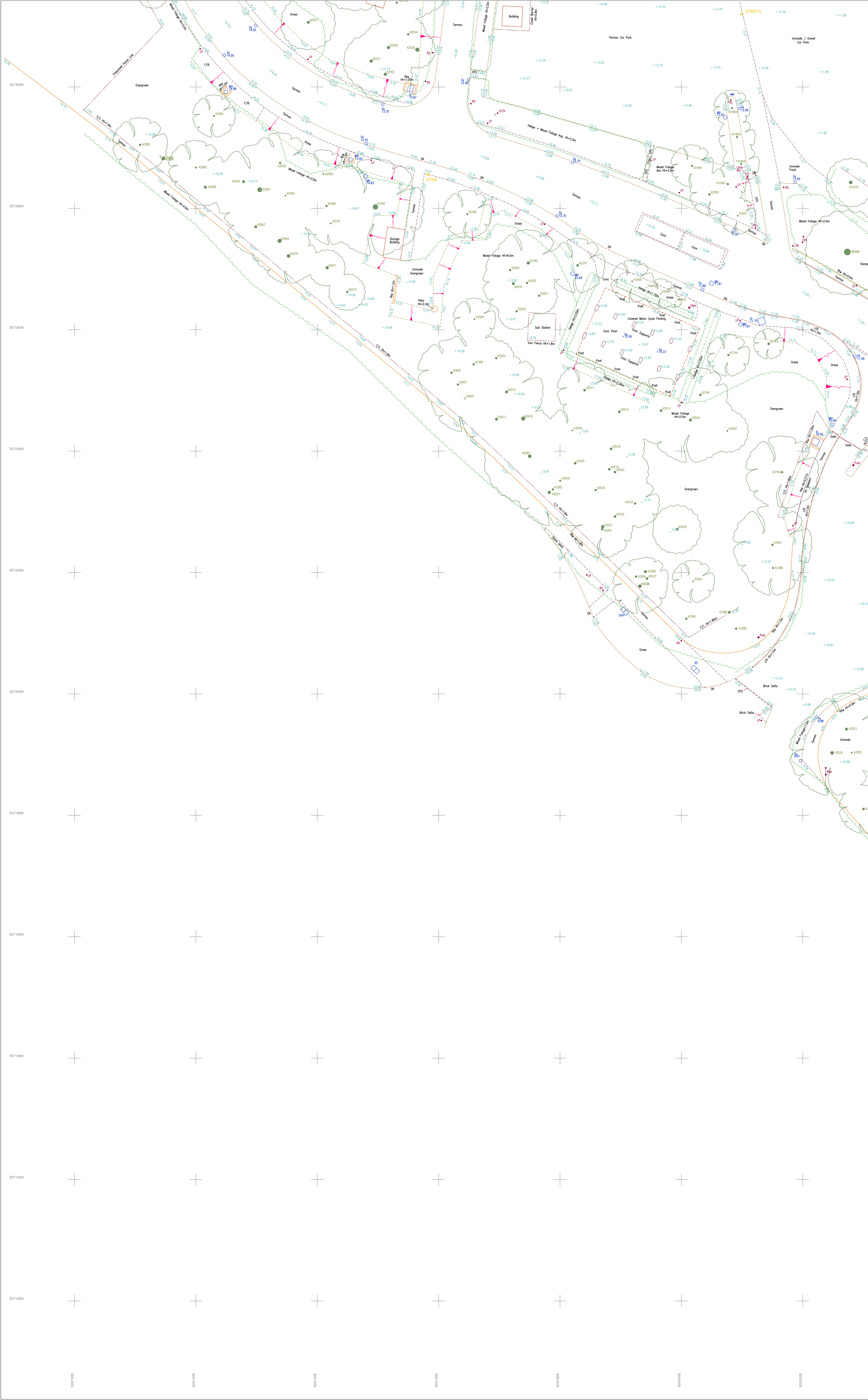
An Operation and Maintenance Manual has been written by Curtins and should be referenced for general maintenance, this can be found in **Appendix J**.

7.0 Conclusions and Recommendations

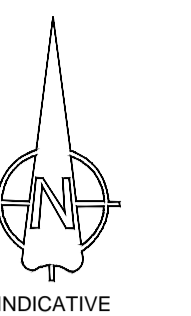
This report is intended to provide further details on the design of the drainage systems for the proposed redevelopment of the Carrow Works site and to act as additional information in support of the planning application. The conclusions to be drawn from this report are as follows:

- The southern area of the site proposes to outfall via infiltration through either existing soakaway structure, where existing structures cannot be retained existing soakaways are to be reinstalled or cleaned.
- The northern area proposes to outfall to the River Wensum at a Controlled rate of Q100.
- The northwest of the site (Catchments O&P) that are proposed refurbishments of existing listed buildings are proposed to discharge as per the existing regime.
- Where attenuation is required, it is provided via below ground cellular storage in the full planning application area.
- Further details of the drainage strategy for the outline planning areas will be provided at the reserved matters application stage. The discharge rates and attenuation volumes required have been outlined in this report.
- To combat flooding due to high tides, outfalls are proposed to be installed above the typical high tide level or a surcharged outfall has been modelled using the typical high tide level.
- Permeable paving, bioretention and Petrol interceptors are proposed to treat run off within the full planning application area before it is discharged into the River Wensum.
- It is envisioned that Foul Water will utilise the existing connections to the public sewer located on site.

Appendix A – Site wide topographical survey



Notes:
 Whilst every effort has been made to correctly identify species of trees on the site, we advise that an arborologist be consulted before any final decisions are made.
 All information contained in this drawing (including digital data) should be checked and verified prior to any fabrication or construction.
 Grid coordinates are based on an OS GNSS system on a plane grid with a scale factor of 1.0000.

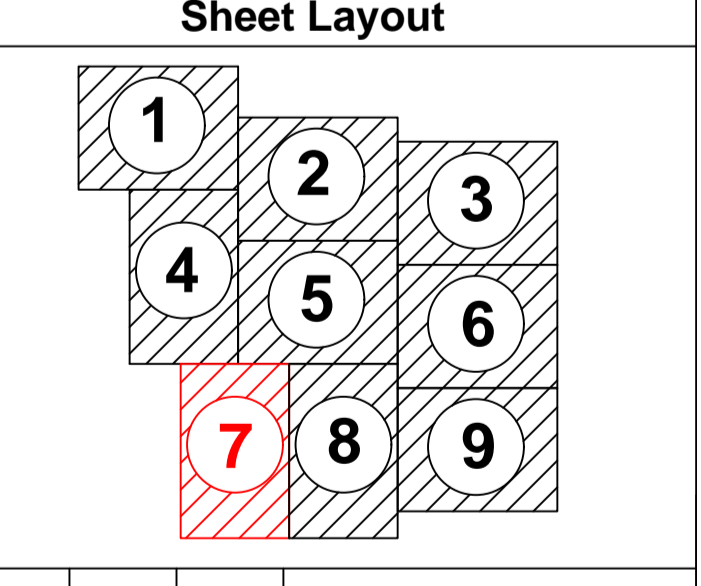


Legend:

Fences	Buildings	Fences
Sub	Overhead Electric	Overhead Electric
Hedges	Overhead Fibre	Overhead Fibre
Trees	Gate	Gate

Abbreviations:

BLK	BLK	BLK
CONC	CONC	CONC
GRASS	GRASS	GRASS
OVERGROWN	OVERGROWN	OVERGROWN
ROAD	ROAD	ROAD
UTILITY	UTILITY	UTILITY
WATER	WATER	WATER
WELL	WELL	WELL
WIND	WIND	WIND



Rev. Suffix	Date	Initial	Revision Details

Levelling GNSS Datum OSGB36
 To an OS GNSS Datum

Client
Cushman & Wakefield LLP

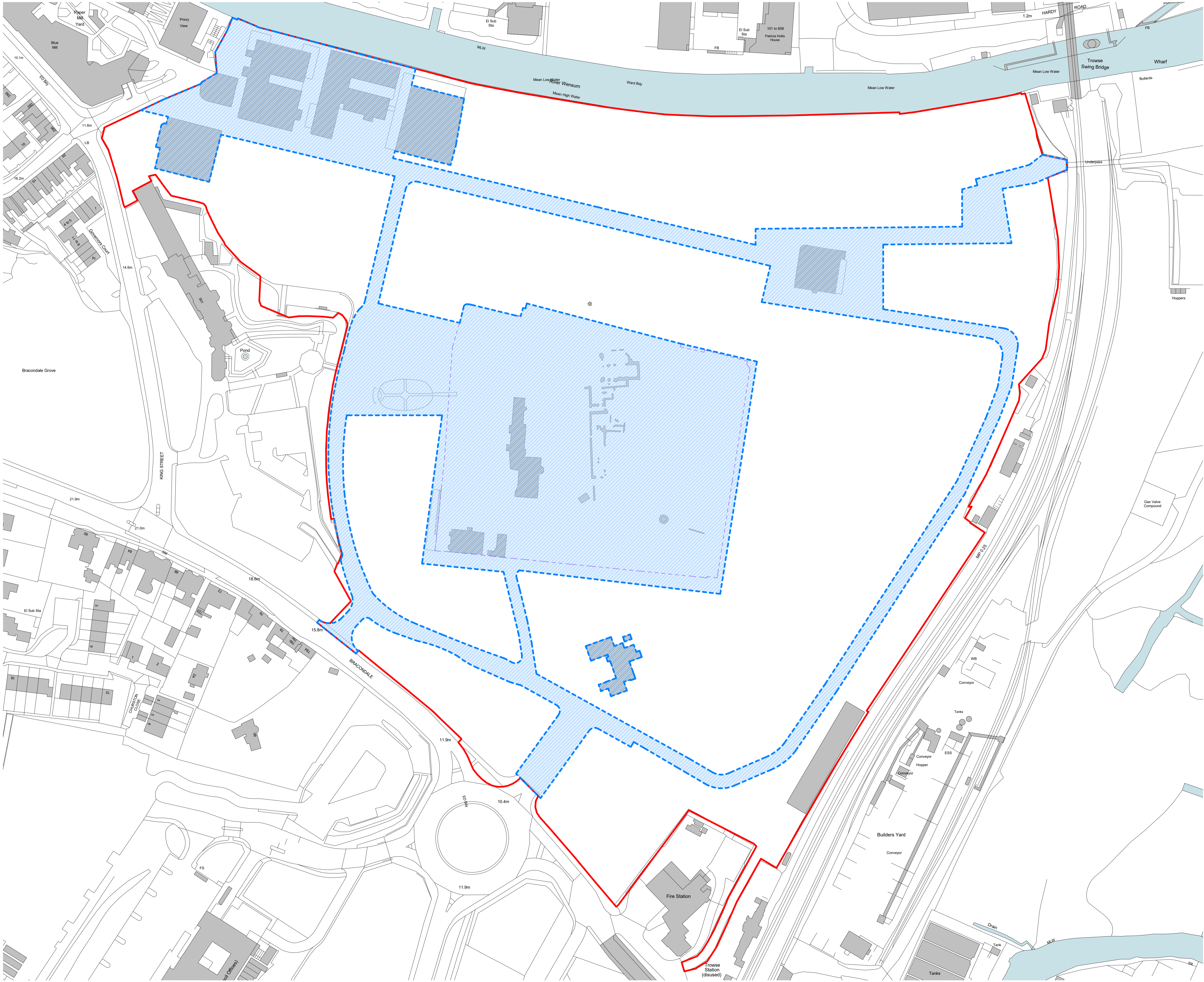
Location
 Carrow Works
 Norwich, NR1 2DD

Drawing Title
**Topographical Survey
 Sheet 7 of 9**

Job No. 1805022 Old Job No.
 Drawing Number Revision Suffix
CW/1805022/7

Scale 1:200m (A0) Date August 2018

Appendix B – Planning Parameter Plan



Notes

Do not scale from this drawing.
 All contractors must visit the site and be responsible for taking and checking dimensions.
 All construction information should be taken from figured dimensions only.
 Any discrepancies between drawings, specifications and site conditions must be brought to the attention of the supervising officer.
 This drawing & the works depicted are the copyright of JTP.

This drawing is prepared for the specific project stage in the Drawing Status section below and it is not intended to be used for any other purpose. Whilst all reasonable efforts are used to ensure drawings are accurate, JTP accept no liability for any reliance placed on, or use made of, this plan by anyone for purposes other than those stated in the Drawing Status below.

- Key**
- Hybrid Application Boundary
 - Detailed Application
 - Existing Buildings To Be Retained
 - Scheduled Monument

Notes

Rev	Date	Description	Drawn	Chkd
Drawing Status				
Draft				



Project
Carrow Works, Norwich

Drawing Title
**Parameter Plans
 Hybrid Application Boundaries**

Scale @A1 1 : 1000 Job Ref. 02022
 Drawing No. PP-01 Revision.
 Scale Bar 0 10 20 30 40 50 m
 Sheet Code
 02022-JTP-PP-01 - Hybrid Application Boundaries

Appendix C – Landscape Masterplan

- notes
1. Read in conjunction with all relevant Architects, Engineers & design team drawings & specifications
 2. Any discrepancies must be drawn to the attention of the lead consultant in writing
 3. All dimensions are in millimeters unless otherwise noted & are subject to checking on site prior to fabrication or ordering of materials
 4. This drawing is the copyright of Bowles & Wyer (and other consultants where referenced)

key



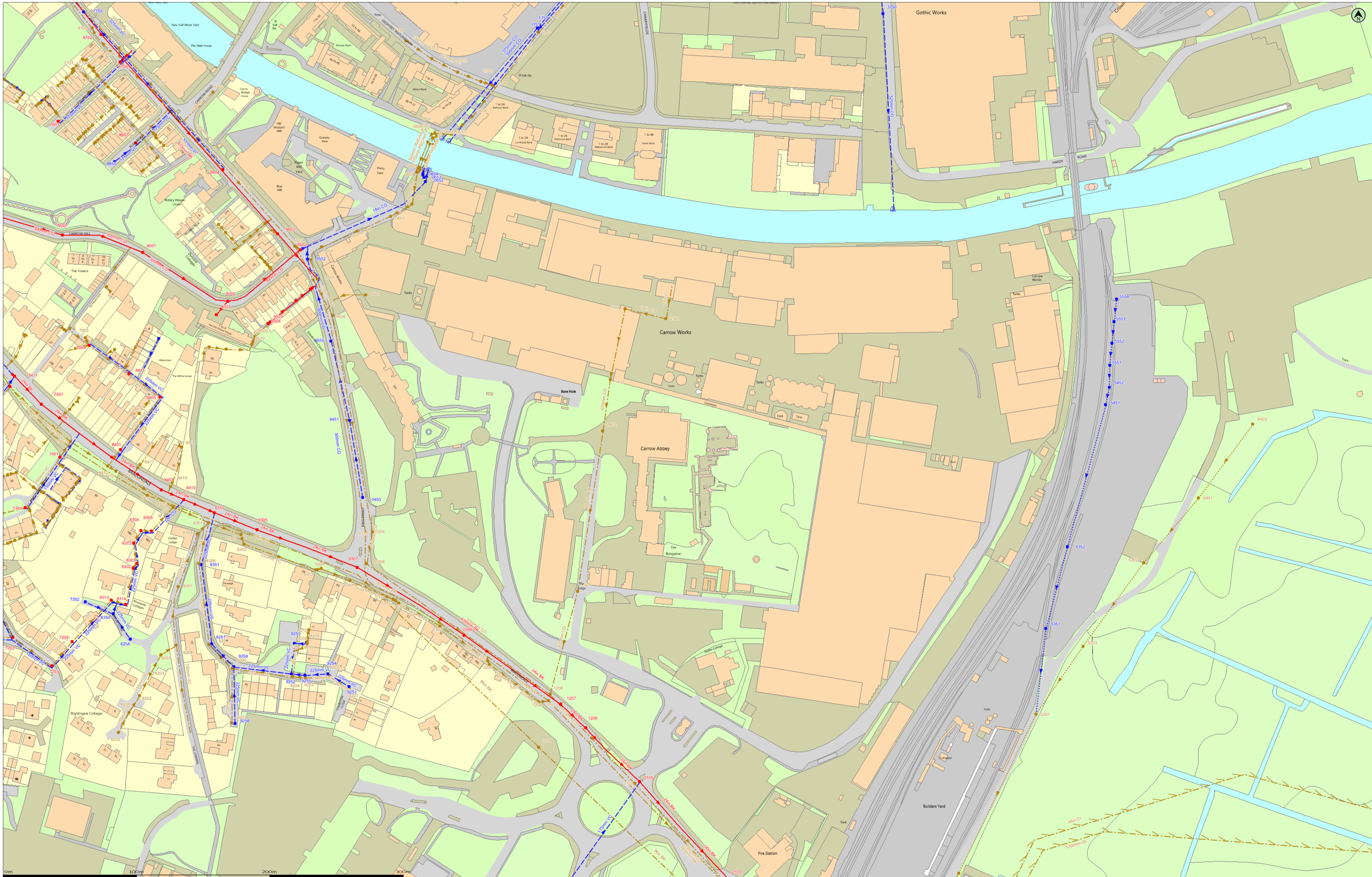
Orig 17.06.22 FL n/a
 rev date by chk notes

BOWLES & WYER
 5 Williams Court, Tunnel Way, Pitstone, Nr. Leighton Buzzard, LU7 9GJ
 Tel: 01296 662439 Fax: 01296 663959 Email: admin@bowleswyer.co.uk

project title
CARROW WORKS, NORWICH
 drawing
ILLUSTRATED LANDSCAPE MASTERPLAN
 job number drawing number
2962 2962-11-13
 status
FOR COMMENT

scale 1:1000@A1
 0 1000 2000

Appendix D – Public Sewer records



(c) Crown copyright and database rights 2022 Ordnance Survey 100022432 Date: 09/05/22 Scale: 1:1250 Map Centre: 624247,307447 Data updated: 30/04/22 Our Ref: 850333 - 1 Wastewater Plan A1

This plan is provided by Anglian Water pursuant to its obligations under the Water Industry Act 1991 sections 198 or 199. It must be used in conjunction with any search results attached. This information on this plan is based on data currently recorded but position must be regarded as approximate. Service pipes, private sewers and drains are generally not shown. Users of this map are strongly advised to commission their own survey of the area shown on the plan before carrying out any works. The actual position of all apparatus MUST be established by trial holes. No liability whatsoever, including liability for negligence, is accepted by Anglian Water for any error or inaccuracy or omission, including the failure to accurately record, or record at all, the location of any water main, discharge pipe, sewer or disposal main or any item of apparatus. This information is valid for the date printed. This plan is produced by Anglian Water Services Limited (c) Crown copyright and database rights 2022 Ordnance Survey 100022432. This map is to be used for the purposes of viewing the location of Anglian Water plant only. Any other uses of the map data or further copies is not permitted. This notice is not intended to exclude or restrict liability for death or personal injury resulting from negligence.

Foul Sewer	—	Outfall*	—
Surface Sewer	—	Sewage Treatment Works	⊕
Combined Sewer	—	Public Pumping Station	⊕
Final Effluent	—	Decommissioned Pumping Station	●
Rising Main*	—		
Private Sewer*	—		
Decommissioned Sewer*	—		
	—	Manhole*	●

*Colour denotes effluent type

mike.smith9293@gmail.com	□
Carrow Works	●
	●



