Oaklands Meadows

Drainage Strategy

Countryside Properties & Essex County Council Property Services

Project number: L00005
L00005-AEC-NA-NA-RP-C-0002

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Quality information

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Revision History

Revision	Revision date	Details	Authorized	Name	Position
P041	18/12/19	Preliminary Issue		Anne Farmer	Associate Director
P02	23/03/20	Issued to LLFA		Anne Farmer	Associate Director
P03	28/05/21	Issued for comments		Anne Farmer	Associate Director
P04	16/06/21	Issued to support planning application		Anne Farmer	Associate Director
P05	28/07/21	Foul Water Strategy Updated		Anne Farmer	Associate Director
P06	23/09/21	Issued to support planning application		Anne Farmer	Associate Director

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Table of Contents

Figures

Tables

1. Executive Summary

SITE DETAILS	
Grid Reference & Postcode	E 580582, N 198497 approximate, site centred, closest postcode is CM3 5QN.
Approximate Site Area	The existing site covers an area of approximately 112 ha. Of this 112 Ha, approximately 41 Ha will be developable area including areas of residential, education, mixed use and local centre uses. A further minimum area of 8.59Ha will be formal recreation land.
Current Use	Predominantly agricultural land use.
Proposed Use	Residential

SURFACE WATER DRAINAGE STRATEGY	
Design Criteria	No surcharge for 1 in 1 year or 1 in 2 year return period (depending on site average slope) in accordance with Sewers for Adoption 7th Edition; No surface flooding for 1 in 30 year return period in accordance with Sewers for Adoption 7th Edition; No surface flooding overflowing from the site onto adjacent roads or properties for 1 in 100 year event including 40% increase of rainfall intensity for climate change in accordance with climate change allowances; Any flooding within the 1 in 100 yr. event plus 40% is retained on site with overland flood routes directing flows to the watercourse.
Water Quantity	The Lead Local Flood Authority (LLFA) preference is that runoff should be first restricted to the greenfield 1 in 1 year runoff rate during all events up to and including the 1 in 100 year rainfall event with climate change (CC). Runoff rate on the site is 2.984 l/s/ha.
Water Quality	Drainage hierarchy from ECC design guide has been applied. Infiltration test to be completed to confirm or discard the option of infiltration in the Site. The risk-based approach is facilitated via a SuDS Management Train of a number of components in a series that provides a range of treatment processes delivering gradual improvement in water quality and providing an environmental buffer for accidental spills or unexpected high pollutant loadings from the site.
Proposed catchment areas	Residential areas assumed to be 60% impermeable. Hard standing areas assumed to be 100% impermeable. Greenfield assumed to be 20% impermeable. Detention basins assumed to be 100% impermeable.
Required storage capacity	The total storage required for the site is approximately 22,000 m^3 (to be confirmed through detailed design). This includes an allowance of 10% for urban creep.
The strategy	The pipe diameters and storage volumes have been reduced as much as possible to show surcharge for the 1 in 30 year event but not allowing excessive uncontrolled flooding in the 1 in 100 year event plus 40% CC. The drainage strategy aims to manage rainfall at source and mimic the natural drainage regime. In order to provide a sustainable drainage strategy and not alter the current drainage regime, a network of swales around the boundary of the site are provided to not only protect the site from overland flow but also to preserve the existing drainage regime.

	The robust SuDS strategy has applied good management practices and design principles to control and manage surface water run-off to reduce the existing risk of flooding from surface water and not pose an additional flood risk to the site.
SUDS design	The SuDS techniques suitable for this development have been identified in accordance to CIRIA C753 The SuDS Manual Part D – Technical Detail. The maintenance scheme of all SuDS will be provided at either full application stage or discharge of conditions stage.

FOUL WATER DRAINAGE STRATEGY

Design Criteria	The design flows for gravity sewers for residential developments should be 4000 litres/unit dwelling/per 24 hours. The following design flows for industrial development should be used where the actual details of flows are unknown: ▪ Domestic flow element – calculated in accordance with BS EN 752-4 or in the absence of appropriate information, 0.6 l/s per hectare of developable land. ▪ No trade effluents are expected To provide a self-cleansing regime within foul gravity sewers, the minimum flow velocity should be 0.75 m/s at one-third design flow. Where this requirement cannot be met, then this criterion would be satisfied by a 150 mm nominal internal diameter gravity sewer having a gradient not flatter than 1:150 where there are at least 10 dwelling units connected.
The strategy	The proposed development has been divided into different catchments with the site discharging into the public foul water sewer via two existing manholes. The split of the development into separate networks (one on the east and one on the west of the proposed development) has been undertaken to reduce the impact of the incoming flows into the existing Anglian Water (AW) network as much as possible. The west catchment is discharging into the existing foul water pipe that runs under Burnham Road (B1012), in vicinity of the roundabout between B1012 and B1418. The central and east catchments are discharging into a manhole located in Ferrers Road. The foul system for the east and west catchments will drain via gravity into the existing foul water network. To minimize depth of sewers and due to the existing topography, a pumping station will be provided to drain the central catchment. The proposed drainage strategy has been discussed and agreed in principle with AW. The eastern network has sufficient capacity for the proposed discharge. Anglian Water are reviewing the capacity of the western network. To aid the potential capacity issues within the western network, it is proposed that an existing development of c.140 homes, located to the south of the proposed pumping station, will be redirected through the proposed pumping station into the eastern network. This will enable to partially offset the impact of the new development on the western network.

OWNERSHIP AND MAINTENANCE

It will be necessary to discuss with AW whether they will adopt any surface and foul water network. If they are unable to adopt the network, it will be maintained by a management company appointed by the developer.

The adopted highway drainage is expected to be the responsibility of the Highway Authority and the private drains and channels will be responsibility of the individual property owners.

In the absence of any public bodies to adopt the proposed retention basin and other SuDS within the proposed development, a management company will be employed to undertake the required maintenance of these features. Details of these arrangements are subject to confirmation during the detailed design process.

2. Introduction

This Drainage Strategy has been prepared to support the outline Planning Permission, with all matters reserved (but with full details provided for the principal means of vehicular access to the site, the initial phase of on-site highway works, strategic ground reprofiling, strategic surface water attenuation and strategic foul drainage) for the Oaklands Meadows site. This report specifies the Drainage Strategy for the areas of development in accordance with the relevant guidelines. This report should be read in conjunction with the Flood Risk Assessment (FRA)[1] report of the site.

The development area consists of 112 ha. and is located to the north of the town of South Woodham Ferrers. The existing site is categorised as "greenfield".

2.1 Background

This Drainage Strategy has been prepared in accordance with the National Planning Policy Framework (NPPF)[2] and the Planning Practice Guidance[3] set out on GOV.UK. The scope of this assessment has been established through consultations with the Environment Agency (EA) and Anglian Water (AW).

The Drainage Strategy is based upon available and up to date flood risk information, drainage design guidance and SuDS design guidance, available online from the Environment Agency, British Geological Survey (BGS), MAGIC website, CIRIA and Essex County Council. This includes:

- Geology Maps from BGS.
- Aquifer designations, groundwater vulnerability and Soilscape Maps from MAGIC.
- Essex Sustainable Drainage Systems Design Guide 2019.
- CIRIA C753 SuDS Manual 2015.
- Sewers for Adoption 7th Edition.
- Approved Document H of the Building Regulations Planning Practice Guidance.

2.2 Scope of assessment

In accordance with the NPPF and given the size of the proposed development, an FRA and associated Drainage Strategy should be undertaken for this site. The assessment should demonstrate to the decision-maker how flood risk will be managed now and over the development's lifetime, taking climate change into account, and with regard to the vulnerability of its users.

The Drainage Strategy needs to consider surface water and provide:

- An estimate of how much surface water run-off the development will generate.
- Details of existing methods for managing surface water runoff, e.g. drainage to a sewer.
- Plans for managing surface water and for making sure there's no increase in the volume of surface water and rate of surface water runoff.

2.3 Aims & Objectives

The main purpose of the report is to provide sufficient drainage information to ensure the development can be suitably drained, is safe from flooding and will not pose risk to third parties, with a focus on the management of surface water runoff.

The main objectives of this drainage strategy are:

[1] AECOM (September 2021), Oaklands Meadows – Flood Risk Assessment. Ref: L00005-AEC-NA-NA-RP-C-0001
[2] National Planning Policy Framework Planning Practice Guidance available at www.gov.uk/government/collections/planning-practice-guidance
[3] EA Guidance 'Flood Risk and Coastal Change' available at www.gov.uk/guidance/flood-risk-and-coastal-change

- Identify the existing drainage situation for the site and surroundings.
- Demonstrate that the development can be safely drained and will not increase flood risk elsewhere.
- Outline the drainage strategy for the site and discuss potential methods to utilise Sustainable Drainage Systems (SuDS).

SuDS drainage solutions will be designed in accordance with Essex Sustainable Drainage Systems Design Guide and CIRIA C753 SuDS Manual 2015, in order to achieve source control, attenuation and pollution control within the catchments of individual parcels. National and local design principles and drainage requirements criteria have been applied to each of the catchments to reduce the hydraulic stress on the downstream watercourse and to ensure water quality improvements.

2.4 Limitations

The information, views and conclusions drawn concerning the site are based, in part, on information supplied to AECOM by other parties. AECOM has proceeded in good faith on the assumption that this information is accurate. AECOM accepts no liability for any inaccurate conclusions, assumptions or actions taken resulting from any inaccurate information supplied to AECOM from others.

3. Site Description

3.1 Existing Site

The site is located immediately to the north of the town of South Woodham Ferrers. It is located to the north of Burnham Road (B1012) and to the east of Willow Grove. The B1418 runs up through the site and northwards towards the settlement of Woodham Ferrers. Ordnance Survey National Grid reference to the centre of the site is E 580582, N 198497 and the closest postcode is CM3 5QN.

The existing site covers an area of approximately 112 Ha. Of this 112 Ha, approximately 41 Ha. will be developable area including areas of residential, education, mixed use and local centre uses. A further minimum area of 8.59Ha will be formal recreation land. The majority of the site is currently undeveloped and is predominantly agricultural land.

A parcel of land (approximately 4.22 ha.) owned by Sainsbury's is situated on the boundary with the proposed development land, facing the B1012. This includes a new Sainsbury's store, external car park and a health facility centre.

A site location plan is included in Appendix A (Drawing L00005-AEC-NA-NA-DR-C-1001). The plan shows the overall site boundary and individual boundaries for Countryside and ECC land.

3.2 Topography

The topographical survey carried out in March 2021 shows that the western part of the site fall from the northeast to the southwest with steep falls from approximately 30.0mAOD on the north eastern boundary to 8.0 mAOD at the roundabout between B1012 and B1418. The parcel on the west of B1418 fall from 20.0 mAOD to 8.5 mAOD.

The eastern part of the proposed development falls from north to south with levels dropping from 40.0mAOD to 9.5mAOD. The parcel in the centre of the site is not proposed for development due to the steep nature of the existing topography. A small parcel in the south of B1012 at the east of the whole site is included in this submission, with existing levels falling from 9.5 mAOD to 6.0 mAOD. The topographical survey is included in Appendix A.

3.3 Hydrology

The Fenn Brook flows north to south through the western portion of the site. It was classed as Main River by the Chelmsford City Council Strategic Flood Risk Assessment (SFRA)[4]. The Environment Agency carries out maintenance, improvement or construction work on main rivers to manage flood risk.

A branch of the Fenn Brook flows north east to south west through the site. This branch crosses the B1418 to the north of its roundabout junction with the B1012 in a culvert; to the west of the B1418. It was classed as Ordinary Watercourse by the SFRA along much of its length, becoming a Main River downstream of the B1418. Lead local flood authorities, district councils and internal drainage boards carry out flood risk management work on ordinary watercourses.

The contours on the western part of the site fall directly towards the Fenn Brook branch and to existing ditches that convey the runoff into the Fenn Brook branch. Therefore, the runoff from the existing site discharges into the Fenn Brook.

The Fenn Brook Branch crossing the site joins the Fenn Brook to the north of the B1012 between its roundabout junction with the B1418 and the roundabout junction with the A132. The Fenn Brook flows south under the B1012 on the north-western edge of South Woodham Ferrers and under an unclassified road and then under a railway line, where it connects to Fenn Creek. The Fenn Brook connects to the Fenn Creek at a point approximately 650m south of the Site. The Fenn Creek flows in a southerly direction towards the River Crouch, which is located approximately 2.5km south.

[4] JBA Consulting (October 2017), Chelmsford City Council – Level 1 and Level 2 Strategic Flood Risk Assessment

The topographical survey shows no watercourses in the eastern land. The contours in the centre and east of the site are falling towards the B1012. There is a small pond close to the Fenn Brook branch, although it is not clear whether the pond is associated with the Fenn Brook Branch.

There is an existing ditch in the south of B1012, between the Memorial Gardens and the southern parcel. This ditch flows in a north to south direction, crossing below the railway lines.

An existing hydrology plan is included in Appendix A (Drawing L00005-AEC-NA-NA-DR-C-0002).

3.4 Site Geology & Hydrogeology

The geological mapping for the site from British Geological Survey (BGS)[5] shows the drift geology is absent in much of the site, predominantly in the north, south and east, meaning that the solid bedrock geology will likely be present immediately beneath topsoil and subsoil in those areas. Head Deposits, comprising Clay, Silt, Sand and Gravel are present on the west of the site.

The superficial deposits overlying the bedrock geology are the London Clay Formation in the majority of the site and Claygate Member on the east. Both comprise Clay, Silt and Sand. The site geology has been assessed in more detail in the Geotechnical and Geoenvironmental Desktop Study[6].

The superficial deposits underlying the site (Head Deposits) are classified as a Secondary Undifferentiated aquifer. This designation is assigned in cases where it has not been possible to attribute either aquifer category A or B due to the variable characteristics of the rock type.

The Claygate Member is classified as a Secondary A Aquifer. Secondary A aquifers are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. The London Clay Formation is classified as Unproductive Strata. This designation applies to materials with low permeability that have negligible significance for water supply or river base flow.

The Head Deposits and the Claygate Beds both imply a low permeability stratum which may locally be suitable for soakaway drainage subject to detailed assessment. Further investigation should be undertaken to determine the depth of the Head Deposits and the feasibility of soakaway or other infiltration system. It is recommended to undertake percolation tests in the strategic locations to determine the infiltration rate of the Head Deposits. The percolation tests should be undertaken in accordance with BRE Digest 365 Soakaway Design.

MAGIC groundwater vulnerability map classifies the site as minor aquifer intermediate vulnerability in the western area and minor aquifer low vulnerability in the eastern area. The soil class for the site is 6 – Freely draining lime-rich loamy soils and 17 – Slowly permeable seasonally wet acid loamy and clayey soils.

A review of available BGS borehole records within the vicinity of the site was undertaken in the Geotechnical and Geoenvironmental Desktop Study. It identified groundwater strikes and seepages within the Claygate Member at depths of between 2.0m and 2.5m. No groundwater strikes were recorded in the Head deposits or the London Clay Formation in the boreholes reviewed. Groundwater flow, where present, is likely to be in a southerly direction towards the Fenn Creek (c. 270m south-east) which converges with the River Crouch approximately 2.5km south.

The low permeability of the London Clay Formation is likely to prove unsuitable for infiltration and may act as a barrier to infiltration if required.

In conclusion, depending on the proposed depth of water attenuation features, trial pit investigation comprising between one and three holes including permeability testing, at each of the preliminary attenuation feature locations should be undertaken to understand the nature of the strata for each attenuation feature.

According to drainage hierarchy contained in the Essex Sustainable Drainage Systems Design Guide, the viability of an adequate soakaway or other infiltration system or a hybrid solution of infiltration and discharging

[5] British Geology Maps from British Geology Survey available at www.bgs.ac.uk
[6] AECOM (February 2019), South Woodham Ferrers – Geotechnical and Geoenvironmental Desktop Study

into a surface water body should always be considered before discharging all run off into a surface water body only. A copy of the British Geological Survey maps for this area are included in Appendix B, Figures 5-10.

3.5 Historical Land Use

Historical mapping shows that land use on-Site has comprised predominantly agricultural fields since the earliest mapping edition of the 1880s with no significant changes evident. Hamberts Farm is shown adjacent to the Site, facing B1012, on the earliest mapping, with additions to the buildings in the farmyard over subsequent years.

The construction of the railway to South Woodham Ferrers is mapped for the first time in 1898 and this initially included a branch line that passed in a cutting through the western part of the site (c. 400m long). This branch was dismantled by the 1920s and the cutting is gradually abandoned and ultimately backfilled over the subsequent years, no longer shown on mapping from 1979.

Since the site has historically remained as greenfield, it is likely no contamination is present on the site.

3.6 Public Sewers

The available sewer records dating from February 2017 have been reviewed.

3.6.1 Surface Water Sewers

There is only one surface water sewer present on the site and it does not fall within any proposed development area. There is an outfall which drains existing residential properties on Kingsway, Edwin Hall View and The Tabrums to the south of the Site and the B1012. The surface water sewer flows north into the B1418, where the B1418 is crossed by the ordinary watercourse, the surface water sewer discharges into the watercourse. There is no diameter stated for this sewer.

There is a surface water sewer present in the B1012 Burnham Road, flowing east to west, shown as a 375 mm, then a 525 mm diameter pipe. Where Hullbridge Road has its junction with Burnham Road the surface water sewer turns south and becomes a 675 mm diameter pipe. Thereafter, at the junction of Hullbridge Road and King Edwards Road, it is joined by a 300 mm diameter surface water sewer; the main surface water sewer turns east and flows beneath King Edwards Road in 900 mm diameter pipework. Towards the end of King Edwards Road, the surface water sewer turns south down East Bridge Road. It is likely, although not confirmed, that the surface water sewer eventually flows into Clementsgreen Creek.

There is another surface water sewer present in the B1012 Burnham Road, commencing at a 'high point' near where the other sewer commences but flowing west to east, shown as a 450 mm and then a 600 mm diameter pipe. The surface water sewer turns south down Ferrers Road; again, it is likely, although not confirmed, that the surface water sewer eventually flows into Clementsgreen Creek.

3.6.2 Foul Water Sewers

There are no foul water sewers present on the site. AW asset records show a foul water sewer which serves Woodham Ferrers to the west of the site, this flows south as a 175 mm diameter pipe and flows south-south-east parallel to Fenn Brook, before turning south-south-west and then south again to run at the rear of existing residential properties on Willow Grove road from which it receives flows from a 150 mm foul sewer serving those properties. The main 175 mm diameter foul sewer continues south-south-east beneath the roundabout junction with the A132, B1012 and Willow Grove road.

There is a foul water sewer present in the B1012 Burnham Road, running parallel to the surface water sewer. Diameter of the pipe is not present on Anglian Water records. The sewer comes from the south in front of Hamberts Farm and runs through B1012, flowing east to west, until the roundabout between B1012 and B1418. Towards the roundabout the foul water sewer turns down through Wickford Road.

4. Planning Policy and consultation responses

The Site's drainage scheme will be designed in accordance with UK Building Regulations, NPPF and in line with the Local Plan Policy document 'Essex Sustainable Drainage Systems Design Guide[7]' and CIRIA SuDS Manual C753 Document[8].

4.1 National Planning Policy Framework

Section 14 of the National Planning Policy Framework 2019 (NPPF) and the associated Planning Practice Guidance (PPG) details current policy with respect to flood risk. Paragraph 163 of the NPPF outlines that When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Therefore, a drainage strategy is required to support the Flood Risk Assessment and demonstrate that the development can be safely drained and will not increase flood risk in elsewhere.

Paragraph 165 on the NPPF states that major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:

a) take account of advice from the lead local flood authority;

b) have appropriate proposed minimum operational standards;

c) have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and

d) where possible, provide multifunctional benefits.

4.2 CIRIA C573 SuDS Manual

The CIRIA C573 SuDS Manual covers the planning, design, construction and maintenance of sustainable systems (SuDS), to assist with their effective implementation within both new and existing developments. The guidance looks at how to maximise amenity and biodiversity benefits and deliver the key objectives of managing flood risk and water quality.

The overarching benefit of SuDS is therefore to achieve maximum beneficial gains in terms of water quantity, water quality, amenity and biodiversity. The storm water for the Proposed Development has been be designed on a SuDS basis in line with the guidance provided by the CIRIA C753 SuDS manual.

4.3 Local Planning Policy

The proposed development area Oaklands Meadows is within Chelmsford City Council's Local Plan and classified as Strategic Growth Site 10. The stage 3 masterplan framework document[9] was submitted for formal consideration by Chelmsford City Council in January 2021. The masterplan was updated following extensive engagement ('Stage 0') and technical stakeholder workshops ('Stage 1') and it also incorporates further updates following public consultation ('Stage 2'). The Chelmsford City Council Cabinet approved the masterplan in March 2021.

Essex County Council LLFA has provided a draft copy of the Essex Sustainable Drainage Systems Design Guide, 2019, which is intended for use by developers who are seeking guidance on the Lead Local Flood Authority (LLFA) standards for the design of sustainable surface water drainage in Essex. It provides guidance on the planning, design and deliver of attractive and high-quality SuDS schemes which should offer multiple benefits for the environment and community alike.

[7] Essex County Council (2019), Essex Sustainable Drainage System Design Guide
[8] CIRIA (2015), CIRIA C753 The SuDS Manual
[9] Broadway Maylan and David Lock Associates (2021), Land North of South Woodham Ferrers – Stage Three Masterplan Framework Submission

This guide is understood to complement The CIRIA SuDS Manual, hence both have been taken into consideration to determine the SuDS proposals for the development.

The guide specifies the level of information expected at each stage of the planning application process. At outline stage it is expected that the drainage strategy includes enough information to demonstrate that the principles of ECC standards are met and the drainage system itself is viable. This should include:

- The LLFA required Pro Forma;
- Flood Risk Assessment (as in the NPPF);
- Drainage Strategy;
- Preliminary layout drawings showing potential features, and location of discharge points;
- Preliminary storage calculations and greenfield runoff rate calculations;
- Preliminary landscape proposals;
- Preliminary ground investigation report, to show potential viability of infiltration; and
- Evidence of third-party agreement for discharge to their system.

Reference has also been made to Chelmsford Local Plan Policy S2 – Addressing Climate Change and Flood Risk and Policy DM18- Flooding/SuDS to ensure that the requirements of the local plan are addressed within this drainage strategy.

4.4 Consultation responses

4.4.1 Anglian Water

A pre-planning enquiry was submitted to AW on behalf of Countryside Properties and Essex County Council Property Services and the Pre-Planning Assessment report was received on 20th May 2019 and the Pre-Planning Addendum Report was received on 12th November 2019. Both documents are included in Appendix C and summarized below:

- The foul drainage from the development is in the catchment of South Woodham Ferrers Water Recycling Centre, which currently does not have capacity to treat the flows from your development site. AW are obligated to accept the foul flows from the development with the benefit of planning consent and would therefore take the necessary steps to ensure that there is sufficient treatment capacity should the planning authority grant planning permission.
- The Pre-Planning Addendum Report identified the point of connection (POC) as a manhole located 550m south from the development site boundary. The report considered that the whole catchment will discharge into a single connection, hence a minimum 300mm dia. sewer will be required to convey new flows from the proposed development.
- The capacity assessment of the existing AW network highlights the POC receives surface water flows, therefore some enhancement to the FW sewerage system would be required in order to accommodate the whole development.

Ongoing liaison with AW has been undertaken to agree a suitable foul water drainage strategy for the development. Following this it has been agreed that the development will drain to two different networks, one to the east of the site and one to the west. A pumping station will be provided to drain the central catchment, including the existing development to the south (c.140 homes), which will connect to the network draining to the east of the site. The existing catchment currently drains to the network to the west of the site and therefore offsets a proportion of the proposed flows to the western network. This approach was discussed with AW in a meeting on the 26th April 2021 and liaison is ongoing to finalise this solution. Please refer to Section 7 for the foul drainage strategy.

4.4.2 Lead Local Flood Authority

The Lead Local Flood Authority (LLFA) for the area, Essex County Council were consulted by email, dated 2nd October 2019, in order to provide a copy of the Surface Water Management Plan and the Preliminary Flood Risk Assessment Report of the area.

The FRA and Drainage Strategy were submitted to the LLFA in April 2020 through the SuDS Planning Advice Written Response Service in order to obtain preliminary comments from the LLFA. A response from the LLFA to the pre-application advice was received on the 14th May 2020. The LLFA confirmed they were happy with the drainage strategy in principle. The flood mitigation proposal sufficiently addresses the SUDS principles to manage surface water flows from the site and also mitigates the overland flows by incorporating open SUDS features. A copy of the ECC pre-application response is included in Appendix C.

A Development Flood Risk Management Pre-Application Advice Meeting with representatives from the LLFA and Local Planning Authority was held on the 25th February 2021. The surface water drainage strategy was discussed in the meeting and the current strategy agreed in principle. The drainage strategy is detailed in Section 6 of this report.

5. Proposed development

The proposed development comprises:

1. Residential development of up to 1020 homes (Class C3);
2. Up to 88 bedroom units of residential care use (Class C2 use);
3. Up to 1,100 sq m GEA Neighbourhood centre (including retail uses) within class E and including a multi-purpose community centre;
4. Up to 1,200 sqm GEA of other commercial uses falling within Class E (of which not less than 1000 sq m to be business floorspace within Use Class Eg);
5. 2fe Primary School and 2 no. 56 place Early Years facilities
6. 5 serviced plots for Travelling Showpeople (GEA 10,000sqm);
7. Open spaces and other landscaped areas, including parks, play areas wildlife habitat areas, allotments, community orchards, formal/informal open space, playing fields and associated ancillary maintenance buildings, structures and pavilion;
8. All associated highway infrastructure, including means of vehicular access to the site and all internal roads and service areas;
9. Pedestrian, cycle and bridleway routes (including partial extinguishment of Bridleway 25);
10. Vehicular and cycle parking to serve the proposed development;
11. All drainage works including foul drainage infrastructure, Sustainable Urban Drainage Systems including ground and surface water attenuation features;
12. Ground Reprofiling Works;
13. Demolition of existing buildings;
14. All associated ancillary works including services and utilities.

Phase 1 of the development is in accordance with Design and Access Statement. The drainage strategy has informed the site layout to ensure that adequate planning for attenuation and surface water drainage features have been taken into consideration within the proposed layout. The site layout is included within Appendix D and shown in Figure 1 below.

Figure 1 Proposed site layout

The site has been divided into eighteen development parcels. Table 5-1 summarizes all the parcels grouped by development areas, road areas and green areas within the site.

The use of the majority of the development areas (DA) is residential only, however DA105 is expected to be a school and local centre and DA108 will be a mixed-use area for travelling show people and commercial uses. The drainage strategy has been developed to mimic the natural surface water drainage of the area utilising the existing watercourses.

The green areas (GA) are included in Table 5-1 to ensure the runoff from all areas that are expected to drain into the proposed development are considered. The runoff from all areas will be attenuated before being discharged into the existing watercourses. The runoff from the rest of the non-developed greenfield areas is draining via existing routes or proposed swales mimicking the existing drainage regime. Therefore, these areas are expected to drain directly to the existing watercourse with no increase in flows, hence no attenuation is required. The hardstanding areas (RA101 to RA108) represent for the areas reserved for the main roads crossing the site. Drawing L00005-AEC-NA-NA-DR-C-5005, included within Appendix D, illustrates the proposed catchments including development areas, roads and green areas.

The drainage strategy will propose a separate foul and surface water sewer network to service the whole of the development site. The following sections provide details on the drainage strategy of both networks.

Table 5-1 Parcel allocation within the site

	Development Areas		Hardstanding	Green area
Parcel Number	DA001	DA101	RA101	GA101
	DA002	DA102	RA102	GA102
	DA003	DA103	RA103	GA103
	DA004	DA104	RA104	GA104
	DA005	DA105	RA105	GA105
	DA006	DA106	RA106	GA106
	DA007	DA107	RA107	GA107
	DA008	DA108	RA108	GA108
	DA009			GA109
	DA010			

Figure 2 Western developable areas

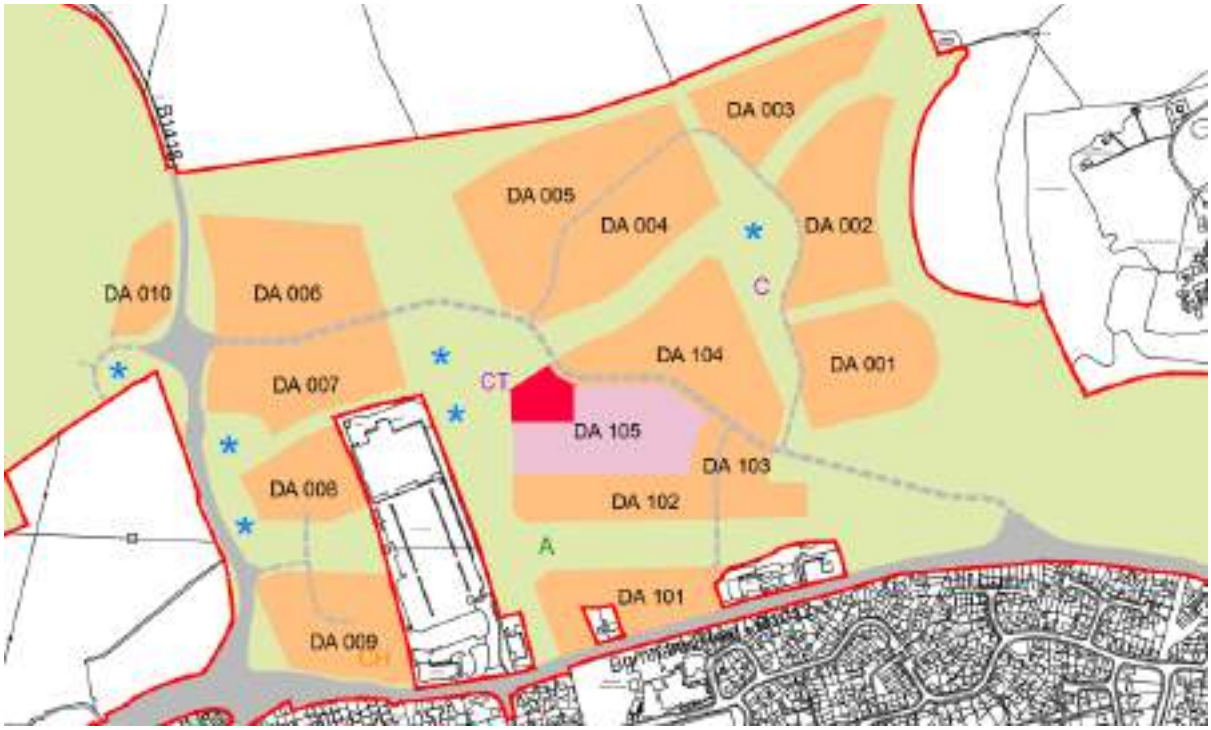


Figure 3 Eastern developable areas

6. Surface Water Drainage Strategy

6.1 Design Criteria

The following constitutes a drainage strategy to support the hybrid Planning Permission.

The objectives of the drainage strategy are to:

- Manage surface water runoff on-site to minimise flood risk
- Manage surface water discharge from the site so that it does not adversely affect third parties
- To ensure ongoing operation and maintenance through appropriate management / adoption.

A sustainable drainage system (SuDS) will be used to reduce the potential impact of development on the surrounding area and drainage systems with respect to surface water drainage discharge. A sustainable approach to drainage mitigates the impact of new development on flood risk and builds resilience to flooding. It also provides opportunities to remove pollutants from urban runoff at source and combines water management with green space, with benefits for amenity, recreation and wildlife.

6.1.1 Climate change impact

Based on the PPG it is recommended that potential effects of Climate Change should be considered realistically for the lifetime of a proposed development and that "…developers, the local planning authority and Environment Agency should discuss and agree what allowances are acceptable".

Table 2 on the PPG (reproduced in Table 6-1). specifies anticipated changes in extreme rainfall intensity in small and urban catchments. For flood risk assessments and strategic flood risk assessments, both the central and upper end allowances should be assessed to understand the range of impact.

Table 6-1 PGG Table 2 peak rainfall intensity allowance in small and urban catchments

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

The surface water drainage calculations have assessed a worst case 40% allowance for climate change for the 1 in 100 year storm event.

6.1.2 Drainage network design

The surface water drainage system will be designed in accordance with Sewer for Adoption 7th Edition. Therefore, the following criteria will be used:

- No surcharge for 1 in 1 year or 1 in 2 year return period (depending on site average slope) in accordance with Sewers for Adoption 7th Edition;
- No surface flooding for 1 in 30 year return period in accordance with Sewers for Adoption 7th Edition;
- No surface flooding overflowing from the site onto adjacent roads or properties for 1 in 100 year event including 40% increase of rainfall intensity for climate change in accordance with climate change allowances.
- Any flooding within the 1 in 100 yr. event plus 40% is retained on site with overland flood routes directing flows to the watercourse.

6.2 Water Quantity

The Site's drainage scheme will be designed in accordance with UK Building Regulations, NPPF and good practice. In line with the Local Plan Policy document 'Essex Sustainable Drainage System Design Guide' Document, a new development is required to attenuate surface water run-off so that the run-off rate is no greater than the run-of prior to development taking place.

The Site is currently greenfield, hence no existing surface water sewers are present on it. As stated in Section 3.6.1, there is only one surface water sewer present on the site and it does not fall within any proposed development area.

The current greenfield run-off rates from the Site have been calculated using IH124 *Flood Estimation for Small Catchments*[10]. MicroDrainage Source Control was used to undertake the calculations using the following parameters:

- Area 50ha
- SAAR (Standard Annual Average Rainfall) 578mm
- SOIL 0.450
- Urban 0.0
- Region 6

The calculation results are shown in Table 6-2 and Micro Drainage outputs are included in Appendix E.

Table 6-2 Existing surface water runoff rates

Annual Exceedance Probability (AEP)	Flow rate (l/s)	Runoff rate (l/s/ha)
100% (Q1)	**149.2**	**2.984**
50% (Q2)	154.7	3.094
42.9% (QBAR)	175.6	3.512
3.3% (Q30)	460.0	9.200
1.0% (Q100)	560.0	11.200

Essex Sustainable Drainage Systems Design Guide states that for all applications where infiltration is not viable, the LLFA expect to see that the discharge rates are being restricted to 1 in 1-year greenfield runoff rate when discharging into a watercourse. Also, SuDS networks should be designed to mimic natural discharge routes.

The LLFA preference is that runoff must not increase due to the development and all runoff should be first restricted to the greenfield 1 in 1-year runoff rate during all events up to and including the 1 in 100 year rainfall event with climate change. On this basis, the maximum allowable discharge rate from the site is 2.984 l/s/ha. Suitable attenuation will be incorporated into the design to provide the required storage.

6.3 Water Quality

6.3.1 Drainage hierarchy

The Essex Sustainable Drainage Systems Design Guide specifies a Drainage Hierarchy in accordance with the Approved Document H of the Building Regulations Planning Practice Guidance[11], hence all surface water run off must aim to be discharged as high up the following hierarchy as possible:

1) Rainwater re-use (rainwater harvesting/greywater recycling).

[10] IH Report 124 Flood Estimation for Small Catchments, D C W Marshall & A C Bayliss, Institute of Hydrology, 1994.
[11] HM Government (2015), The Building Regulations 2010 Approved Document H – Drainage and waste disposal

2) An adequate soakaway or other infiltration system.

3) Hybrid solution of infiltration and discharging to a surface water body.

4) To a surface water body.

5) To a surface water sewer.

6) To a combined sewer.

According to the drainage hierarchy, interception measurers should always be considered before discharging all run off into a surface water body only. CIRIA C753 SuDS Manual defines interception as the capture and retention on site of the first 5mm of the majority of all rainfall events. Interception processes include rainwater harvesting, infiltration and evapotranspiration using temporary shallow ponding or storage within the soil or upper aggregate layers.

Interception would contribute to the runoff characteristic from the site to more closely reflect greenfield runoff behaviour as well as it provides more time for the pollution load to biodegrade and/or be acted on by natural treatment processes.

Although the London Clay Formation covers the majority of the site, superficial Head Deposits are present in some areas. Both imply a low permeability stratum which may locally be suitable for soakaway drainage subject to detailed assessment. Further investigation should be undertaken to determine the depth of the Head Deposits and the feasibility of soakaway or other infiltration systems. It is recommended to undertake percolation tests in the potential soakaway locations to determine the infiltration rate of the Head Deposits. The percolation tests should be undertaken in accordance with BRE Digest 365 Soakaway Design.

AECOM was commissioned by Countryside to undertake a ground investigation at the site to acquire ground and groundwater data. AECOM issued a technical note in the 12th April 2021 to summarise the findings and provide an interim geotechnical assessment of the data acquired from that ground investigation.

The ground investigation was completed between 12th and 21st October 2020 and comprised the installation of three 50mm diameter groundwater monitoring standpipes in the three boreholes, two falling head tests in two boreholes and one infiltration test in a trial pit. In both of the falling head tests completed, the drop in water level over the elapsed time was insufficient to meet the criteria for calculation of a permeability value. The infiltration test in the trial pit recorded a minor reduction and so the required reduction to between 75% and 25% of the trial pit capacity over which the infiltration rate is calculated was not achieved. Taking this into consideration, the options of an infiltration system or a hybrid solution of infiltration and discharging into a surface body have been discarded.

Regarding groundwater monitoring, no groundwater strikes were recorded during the formation of the exploratory holes. The water levels in the standpipes installed during the fieldwork were subject to an ongoing programme of monitoring, intended to comprise six visits at approximately monthly intervals from the end of fieldwork. At the time of this report, four rounds of monitoring have been completed. The results of the first four rounds of monitoring are showing presence of shallow groundwater.

Table 24.6 on CIRIA C753 SuDS Manual 2015 identities other interception methods that can be assumed to be compliant for zero runoff from the first 5mm for 80% of events during the summer and 50% in winter. These include green roof, permeable pavements, filter strips and detention basins. These additional SuDS will be considered in the drainage strategy of the Site in order to reduce the runoff of the majority of all rainfall events and reduce pollution on the existing watercourses. Online storage will be included in the drainage strategy in order to combine attenuation storage with treatment facility on both critical and frequent events.

6.3.2 Water quality management

All surface water should go through stringent treatment in order to protect water source and biodiversity. According to The Essex Sustainable Drainage Systems Design Guide, at the full application stage and at discharge of conditions it is expected that the simple index approach is used to ensure that there is sufficient treatment for the site. This should be shown by the hazard pollution level indices and the mitigation indices that the features used provide.

SuDS provide natural variability in their ability to removal contamination which drains across a site, therefore the management of water quality is founded on a risk-based approach. The risk-based approach is usually facilitated via a SuDS Management Train where several components are used in a series to a range of treatment

processes delivering gradual improvement in water quality and providing an environmental buffer for accidental spills or unexpected high pollutant loadings from the site.

The range of treatment process that can be exploited within a design of a sustainable drainage system include; sedimentation, filtration and biofiltration, separation, absorption, biodegradation, volatilisation, precipitation, hydrolysis, oxidation, reduction and substitution plant uptake and photolysis. The level of treatment is strongly related to the velocity control and the retention time.

At this stage a simple index approach to water quality risk management has been adopted and is deemed acceptable as the pollution hazard level of the Site land uses is considered to be low to medium based on Section 6 Water Quality Management of the CIRIA SuDS Manual. Each pollution hazard level has individual pollution hazard indices as shown in Table 6-3 below.

Table 6-3 CIRIA (2015) Pollution Hazard Indices for Different Land Use Classifications

Land use	Pollution Hazard Level	Total Suspended Solids (TTS)	Metals	Hydro-carbons
Residential Roofs	Very low	0.2	0.2	0.05
Commercial/Industrial Roofs	Low	0.3	0.2	0.05
Individual property driveways, residential car parks, low traffic roads, car parks with infrequent change	Low	0.5	0.4	0.4
Commercial yard and delivery areas, car parking with frequent change, all roads except low traffic roads and trunk roads/motorways	Medium	0.7	0.6	0.7
Sites with heavy pollution, industrial sites, trunk roads and motorways	High	0.8	0.8	0.9

Each individual SuDS component has a corresponding pollution mitigation index as outlined in Table 6-4 below.

Table 6-4 CIRIA (2015) Indicative SuDS mitigations indices for discharges to surface water

Mitigation Indices			
Type of SuDS Component	Total Suspended Solids (TSS)	Metals	Hydro-carbons
Filter Strip	0.4	0.4	0.5
Filter Drain	0.4	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	0.7	0.7	0.5
Wetland	0.8	0.8	0.8

In order to successfully deliver adequate treatment, the chosen SuDS components have a total pollution mitigation index that equals or exceeds the pollution hazard index.

Total SuDS mitigation index ≥ Pollution hazard index

In accordance with Table 6-3, the land use on the site with highest pollution hazard is 'individual property driveways, residential car parks, low traffic roads, car parks with infrequent change'. Therefore, it is expected that the location of a detention basin prior to discharge to the receiving waterbody, the Fenn Brook Branch, will be sufficient to comply with the simple index approach for water quality risk management.

The suitability of different SuDS components within the Management Train is indicated in Table 6-5.

Table 6-5 Indicative suitability of SuDS components within the Management Train

SuDS component	Interception	Close to source/ primary treatment	Secondary treatment	Tertiary treatment
Rainwater harvesting	Y			
Filter strip	Y	Y		
Swale	Y	Y	Y	
Filter drain	Y		Y	
Pervious pavements	Y	Y		
Bioretention	Y	Y	Y	
Green roof	Y	Y		
Pond	[3]	Y	Y	Y
Wetland	[3]	Y[2]	Y	Y
Infiltration systems	Y	Y[2]	Y	Y
Attenuation storage tanks	Y[4]		Y	
Proprietary treatment systems		Y[5]	Y[5]	Y[5]

Notes:

(1) Interception components are also normally also a treatment component (excluding rainwater harvesting which only removes runoff from the system.
(2) For roof runoff only
(3) Interception design might be possible in certain scenarios, but would require detailed justification
(4) If unlined and design performance can be demonstrated (noting the need to protect groundwater)
(5) Where design performance can be demonstrated

The simple index approach is considered to be satisfied in the strategic drainage strategy. The use of detention basins will be sufficient to comply with the simple index approach for water quality risk management for run off from low traffic roads. Swales and filter drains, along the highway, have also been proposed where feasible, to improve the water quality of the site further.

Furthermore, there will be a combination of trapped gullies and channels with sumps in highways and associated car parks that will catch silt from any road runoff leading to an improvement of water quality and drain into the detention basins. All upstream chambers from detention basins will be provided with sumps to allow for settlement of silt.

Any car parks considered to be of sufficient size to require further pollutant protection will be provided with a suitably sized interceptor.

At the subsequent planning stages, each individual development parcel will be required to prepare and submit information to demonstrate the drainage strategy is in compliance with this document and any additional SuDs components.

6.4 Proposed catchment areas

Due to the topography of the site, the parcels will drain via several surface water networks and be attenuated via detention basins before discharging into the existing watercourses. Therefore, the site has been divided into seven catchments, with at least one detention basin per catchment. A catchment plan of the site is included in Appendix D.

The total area and contributing area for each catchment has been determined. An assumed impermeable area for the development parcels has been used for the purposes of assessing runoff, this has been based on an allowance of 20% for all green areas, 60% impermeable for developable land and 100% impermeable for strategic roads and detention basins. Greenfield areas, where runoff is expected to discharge into the detention basins or across developable areas, have been included in the catchments, whereas greenfield areas downstream developable areas and SuDS have not been included in the catchments and are considered to drain as the existing regime. Since the detention basins fall within the greenfield areas, 20% of their catchment have already been included in the greenfield area table, so an additional 80% impermeability has been included for the detention basins only to achieve the 100% impermeability.

The development impermeable areas have been used to size the attenuation basins and can be found below in Table 6-6 to Table 6-9.

Table 6-6 Development areas

Parcel	Dev. Area (Ha.)	Impermeability (%)	Imp. Area (Ha.)	Network
DA001	2.00	60%	1.20	A
DA002	2.31	60%	1.39	A
DA003	1.69	60%	1.01	B
DA004	1.94	60%	1.16	B
DA005	2.74	60%	1.64	B
DA006	2.53	60%	1.52	D
DA007	1.94	60%	1.16	D
DA008	1.17	60%	0.70	E
DA009	1.90	60%	1.14	E
DA010	0.75	60%	0.45	F
DA101	1.50	60%	0.90	H
DA102	1.79	60%	1.07	H
DA103	0.34	60%	0.20	H
DA104	2.41	60%	1.45	H
DA105	2.50	60%	1.50	H
DA106	6.64	60%	3.98	I
DA107	2.50	60%	1.50	I
DA108	1.78	60%	1.07	I
Total	**38.43**		**23.06**	

Table 6-7 Strategic road areas

Parcel	Dev. Area (Ha.)	Impermeability (%)	Imp. Area (Ha.)	Network
RA101	0.54	100%	0.54	A
RA102	1.11	100%	1.11	B
RA103	0.82	100%	0.82	D
RA104	0.40	100%	0.40	E
RA105	0.26	100%	0.26	F
RA106	1.52	100%	1.52	H
RA108	0.30	100%	0.30	I
Total	**4.97**		**4.97**	

Table 6-8 Landscape and open space areas

Parcel	Dev Area (Ha.)	Impermeability (%)	Imp Area (Ha.)	Network
GA101	4.14	20%	0.83	I
GA103	0.52	20%	0.10	A
GA104	0.16	20%	0.03	F
GA106	0.28	20%	0.06	E
GA107	0.46	20%	0.09	D
GA108	0.72	20%	0.14	B
GA109	1.28	20%	0.26	H
Total	**7.56**		**1.51**	

Table 6-9 Detention basins areas

Parcel	Dev Area (Ha.)	Impermeability (%)	Imp Area (Ha.)	Network
Detention Basin A	0.28	80%	0.22	A
Detention Basin B	0.43	80%	0.34	B
Detention Basin D	0.29	80%	0.23	D
Detention Basin E	0.22	80%	0.18	E
Detention Basin F	0.09	80%	0.07	F
Detention Basin H	0.55	80%	0.44	H
Detention Basin I	0.56	80%	0.45	I
Detention Basin J	0.10	80%	0.08	I
Total	**2.52**		**2.02**	

6.5 Maximum permitted discharge rate

Section 6.2 identifies a runoff rate of 2.984 l/s/ha. as the proposed discharge rate based on a 1 in 1 year greenfield runoff for the Site. The strategy proposes that all flows leaving the Site will be restricted using a vortex flow control device. Detention basins have been designed upstream of the flow control device to provide enough storage volume and avoid flooding in the developable land. The discharge rate of each catchment has been calculated multiplying the runoff rate per the total area of the catchment.

The site has been divided into seven catchments. All of them discharge into a single detention basin located in vicinity of the watercourses except Network J, where two online detention basins have been designed to provide the required storage volumes. The reasons to separate the volume in different basins are the steep topography of the site and the lack of available space to include a single but bigger detention basin downstream of all developable areas.

Table 6-10 illustrates a summary of the catchment areas, discharge rate and required storage volumes. Storage volumes have been calculated using Micro Drainage models. The total storage volume required for the site is approximately 22,000 m^3. This includes an allowance of 10% of roof areas for urban creep in compliance with ECC SuDS design guide.

The attenuation basins have been designed in accordance to Essex Sustainable Drainage Systems Design Guide, assuming a maximum depth of water of 1.2m and a minimum freeboard allowance of 300mm above the 1 in 100yr. plus 40% CC water level.

As per the ECC design guide, preliminary checks have been carried out to ensure the attenuation features can either have 50% capacity available 24 hours after a 1 in 30-year storm event or have the capacity to store a subsequent 1 in 10 year storm event after a 1 in 30-year storm event. Results from the checks are included in Section 6.7.

Table 6-10 Attenuation storage volume and discharge rate per catchment

Network	Total area (ha.)	Imp Area (ha.)	Discharge rate (l/s)	Attenuation basin	Attenuation Storage (m^3)
Network A	5.37	3.45	16.0	Detention basin A	2465
Network B	8.20	5.42	24.5	Detention basin B	3820
Network D	5.75	3.82	17.2	Detention basin D	2525
Network E	3.75	2.47	11.2	Detention basin E	1680
Network F	1.17	0.81	3.5	Detention basin F	585
Network H	11.36	7.36	33.9	Detention basin H	5175
Network I	15.09	8.21	45.0	Detention basin I Detention basin J Total network J	5120 720 5840
TOTAL	**50.69**	**31.55**	**151.2**		**22,000**

Historically, minimum discharge rates have been limited to 5 l/s due to the risk of blockage of outlets with an orifice size of smaller than 50mm. However, the use of appropriate protection elements such as trash screens and sufficient upstream treatment orifice sizes can be made larger with discharge rates being limited far below 5 l/s without causing an unacceptable risk of blockage. The opening of the smallest flow control device in the site, which is located in Network F, is 85mm dia. Therefore, it is not considered to be at high risk of being blocked. Nevertheless, a trash screen upstream of the device is still recommended.

Storage structures and flow control device details can be found in the hydraulic model outputs included in Appendix E.

6.6 The drainage strategy

The drainage strategy has been designed in accordance with the Essex County Council SuDS Design Guide. The topographical survey confirms the majority of the site falls towards the Fenn Brook Branch, hence the rainfall is

captured in each network, being attenuated in its correspondent detention basin, and finally discharging into the watercourses. Networks A, B, D, E & H discharge into the Fenn Brook Branch whereas Networks F discharge into the Fenn Brook directly. Network J, which drains the east of ECC land, discharges into a different watercourse on the south of the site.

All networks have been modelled with MicroDrainage based on the inflows from the development parcels, greenfield areas and highways stated in Section 6.4. Following the Essex Sustainable Drainage Systems Design Guide, 2019, the networks have been modelled using the FSR model in accordance to the criteria from Sewers for Adoption 7th Edition stated in section 6.1. Additional 10% flow has been added to the overall area to take into consideration the urban creep allowance at this stage. However, it might be applied only on roof areas in future models created at full planning application in order to reduce slightly the required storage volume on the Site. The CV value and rest of input parameters have been included as stated in Essex County Council SuDS Design Guide.

The networks have been sized for not experiencing surcharge on 1 in 1 year return period and no flooding on 1 in 30 year return period. For the 1 in 100 year event plus 40% climate change, the system shows limited flooding, and the flooding will be retained on site with overland flood routes directing flows to the watercourses. The Micro Drainage calculations are included in Appendix E.

In accordance to Essex County Council SuDS Design Guide, the drainage strategy is managing rainfall at source and it mimics the natural drainage regime. In order to provide a sustainable drainage strategy and not alter the current drainage regime, a network of swales around the boundary of the site is provided to not only protect the site from overland flow but also to preserve the existing drainage regime. The proposed swales in conjunction with existing ditches will convey the overland flows to the existing watercourses, protecting the proposed developable areas but replicating the existing flow paths as much as possible. The swales will be of adequate capacity to convey the 1in100years Greenfield Runoff including a 40% allowance for climate change. The swale sizes are to be confirmed at full planning application stage.

All the developable areas fall within Flood Zone 1, so there is low risk of flooding from fluvial. Flood Zone 1 comprises land assessed as having a less than 0.1% (1 in 1000) annual probability of river flooding. Besides this, the risk of pluvial flooding is high in some of the developable areas on the south of the Fenn Brook Branch. This is due to the presence of a valley corridor in parallel to the river. The existing runoff crosses the site through the valley discharging finally on the Fenn Brook Branch, in vicinity of the culvert below the B1418.

The pluvial flood risk map is included in Appendix D (Drawing L00005-AEC-NA-NA-DR-C-5004). Figure 4 shows the pluvial flood risk in the centre of the site. The green area represents the 1 in 30 yr. flood risk extent.

Figure 4 Pluvial flood risk and overland flow routes

The SuDS strategy has utilised good management practices and design principles to control and manage surface water run-off to reduce the existing risk of flooding from surface water and not pose an additional flood risk to the site. The inclusion of swales upstream these areas will protect the site, conveying flows into the existing watercourses. The overland flows will be captured within the swales upstream the developable areas, running through the swales at low velocities before discharging into the watercourse, and therefore mitigating the pluvial flooding on the site.

Based on 37% of the total catchment, as assumed in the above drainage strategy, is developable land that will be attenuated down to 1in1 Greenfield Runoff Rate, the drainage strategy will provide a betterment to the surface water flood extends for the 1in100 and the 1in1000 and also the provision of swales will provide additional storage and delay the concentration of surface runoff at the low point close to the confluence of the ordinary watercourse and the main river, at the west of the site by the B1418, due to the longer drainage paths.

The detention basins have been placed to ensure existing land falls towards the basin and that the proposed development plots will be able to ensure exceedance flows from extreme events or blockages are conveyed to the basins. Detailed design of plots and the S278 works will need to take this into consideration.

The drainage strategy for the individual development parcels might include, where feasible, additional SuDS measures to promote attenuation and treatment at source.

6.7 SuDS design

The Environment Agency and Essex County Council requires SuDS to be considered for inclusion within the drainage strategy for proposed developments such as this. The SuDS techniques suitable for this development have been identified in accordance to CIRIA C753 The SuDS Manual Part D – Technical Detail.

Each SuDS feature has its own specific design specifications, which are expected to be followed unless agreed otherwise the LLFA. The detention basins have been designed in accordance to CIRIA C753 and Essex Sustainable Drainage Systems Design Guide.

- Side slopes to be 1 in 4;
- Low flow channels to prevent erosion at the inlet and to route last remain run-off to the outlet;
- Maximum water depth of 1.2 for safety reasons;
- Minimum 300mm freeboard above maximum water depth; and
- Features not to be set above utilities and services.

CIRIA C753 generally recommends including a forebay within the detention basins to try to contain accumulative sediments. However, the detention basins are expected to be used as part of the public space and as forebays can become unsightly they are not proposed for inclusion within the development. However, catchpit manholes will be installed upstream all the detention basins to catch sediments from the networks.

All detention basins have been designed with the landscape architect to maximise them as open space and integrate them with other recreational areas. This has enriched their aesthetic and recreational value, promoting health and well-being for the residents as well as creating attractive, pleasant and useful urban environments that will support and enhance local communities.

The results of the ground investigation are showing presence of shallow groundwater in the site. Therefore, lining of the detention basins with a geomembrane liner will be required in order to keep them empty and provide the required attenuation volume in flooding events.

As per the ECC design guide, preliminary checks have been carried out to ensure the attenuation features can either have 50% capacity available 24 hours after a 1 in 30-year storm event or have the capacity to store a subsequent 1 in 10 year storm event after a 1 in 30-year storm event.

The storage volume for the 1 in 30-year storm event was at less than half capacity of all detention basins, hence the systems successfully pass the half drain down test. Results from the checks are summarised in the table below.

Table 6-11 Half drain down test for attenuation basins

Network	Attenuation basin	Available Storage Volume (m^3)	Volume on the 1 in 30 yr. event (m3)	Half Drain down test result
Network A	Detention basin A	2465	1025	Pass
Network B	Detention basin B	3820	1680	Pass
Network D	Detention basin D	2525	1145	Pass
Network E	Detention basin E	1680	750	Pass
Network F	Detention basin F	585	245	Pass
Network H	Detention basin H	5175	2260	Pass
Network I	Detention basin I	5120	2208	Pass
	Detention basin J	720	311	Pass
TOTAL		**22,000**	**9,624**	

The swales have been designed in accordance with CIRIA C753 and Essex Sustainable Drainage Systems Design Guide. Also, low flow channels within the detention basins have been designed following the same principles.

- Side slopes to be 1 in 4;
- Longitudinal slope constraint between 0.5-6% in general. Check dams incorporated in slopes greater than 3% (which may allow slopes to increase up to 10%);
- Normal maximum swale depth to be 400-600mm;
- Swale bottom width designed to be 0.5-2.0m;
- Design of the swales should half empty within 24 hours; and
- Flow velocities should be kept lower than 1.0 m/s to prevent erosion.

The maintenance requirements and frequency shown are in line with CIRIA C753 recommendations (e.g. Table 22.1 summarizes operation and maintenance requirements for detention basins and Table 17.1 summarizes operation and maintenance requirements for swales).

Table 6-12 Attenuation and maintenance requirements for detention basins

Maintenance schedule	Require action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly
	Cut grass – for spillways and access routes	Monthly (during growing season), or as required.
	Cut grass – meadow grass in and around basin	Half year (spring – before nesting season, and autumn)
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Monthly (for first year), then annually or as required
	Check any penstocks and other mechanical devices	Annually
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from inlets, outlets, outlets and forebay	Annually (or as required)
	Manage wetland plants in outlet pool – where provided	Annually (as set out in Chapter 23 of CIRIA C573)
Occasional Maintenance	Reseed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Evert 2 years, or as required
	Remove sediment from inlets, outlets, forebay and main basin when required	Every 5 years, or as required (likely to be minimal requirements where effective upstream source control is provided)
Remedial actions	Repair erosion or other damage by reseeding or re-turfing	As required.
	Repair/rehabilitation of inlets, outlets and overflows	As required
	Relevel uneven surface and reinstate design levels	As required
	Realignment of rip-rap	As required

Table 6-13 Attenuation and maintenance requirements for swales

	Require action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – to retain grass height within specified design range	Monthly (during growing season), or as required
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
	Inspect infiltration surface for ponding, compaction, silt accumulation, record areas where water in ponding for >48 hours	Monthly, or when required
Occasional maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required of if bare soil is exposed over 10% or more of the swale treatment area
Remedial actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

7. Foul Water Drainage Strategy

The foul water drainage strategy has been based on the requirements as set out in Sewers for Adoption 7th Edition and the network has been modelled using MicroDrainage. The model outputs and foul drainage strategy drawings can be found in Appendix F.

The following principles have been taken into consideration for the foul drainage strategy

- The design flows for gravity sewers for residential developments should be 4000 litres/unit dwelling/per 24 hours.
- The following design flows for industrial development should be used where the actual details of flows are unknown:
  - Domestic flow element – calculated in accordance with BS EN 752-4 or in the absence of appropriate information, 0.6 l/s per hectare of developable land. Applicable on development areas DA105 and DA108.
  - No trade effluents are expected
- To provide a self-cleansing regime within foul gravity sewers, the minimum flow velocity should be 0.75 m/s at one-third design flow. Where this requirement cannot be met, then this criterion would be considered to be satisfied by a 150 mm nominal internal diameter gravity sewer having a gradient not flatter than 1:150 where there are at least 10 dwelling units connected.

Table 7-1 summarizes the areas, number of dwellings and associated peak flows on all development areas. The number of dwellings are approximate based on residential density's.

Table 7-1 Estimated flows in Development Areas

Parcel	Office/Resi.	Area (Ha.)	Dwellings	Flow (L/s)
DA001	Residential	2.00	56	2.6
DA002	Residential	2.31	65	3.0
DA003	Residential	1.69	48	2.2
DA004	Residential	1.94	55	2.5
DA005	Residential	2.74	77	3.6
DA006	Residential	2.53	68	3.2
DA007	Residential	1.94	63	2.9
DA008	Residential	1.17	44	2.0
DA009	Residential	1.90	57	2.6
DA010	Residential	0.75	11	0.5
DA101	Residential	1.50	53	2.5
DA102	Residential	1.79	62	2.9
DA103	Residential	0.34	11	0.5
DA104	Residential	2.41	84	3.9
DA105	School & Local Centre	2.50	0	9.0
DA106	Residential	6.64	193	8.9
DA107	Residential	2.50	73	3.4
DA108	Travelling Show people	1.78	0	6.4
EDA001	Residential	TBA	c.140	6.5

Total		**38.43**	**1020 Proposed c.140 Existing**	**62.6 Proposed 6.5 Existing**

The site has been divided into three different catchments for the foul drainage strategy, with the site discharging into two manholes located in two existing networks. AW have undertaken works to identify suitable points of connection for the site. The preferred connection point is upstream of the rail crossing on Ferrers Road where there is considered to be adequate capacity for the full development. The second point of connection which can accommodate partial flows from the development is in the network to the west of the development.

The split of the development into separate AW foul networks (one on the east and one on the west of the proposed development) has been undertaken to reduce the impact of the incoming flows into the existing network as much as possible. Further offset of approximately 140 existing homes from the western network into the eastern network via the proposed Pumping Station has been discussed and agreed with AW to reduce the impact on the capacity in the western network. Figure 5 illustrates the proposed foul drainage strategy.

Phase 1 of the development, the western catchment, is proposed to discharge into the existing foul water pipe that runs under Burnham Road (B1012). The catchment will drain into a manhole in vicinity of the roundabout between B1012 and B1418 (manhole reference 1101). It is not feasible to drain this section of the development to the east due to the ground levels of the site.

The remainder of the development, central and eastern catchments are proposed to discharge into a manhole located in Ferrers Road (manhole reference 5802). The western catchment will drain via gravity into the existing foul water network.

The central catchment could drain by gravity to the existing network to the east but would result in excessively deep manholes and pipe runs which would not be feasible from both a construction and a maintenance perspective. It has therefore been agreed with AW that this area will be pumped. The pumping station has been proposed to be installed within DA101 with direct access from Burnham Road. The access is suitable from a highways perspective and will be solely for the pumping station. A rising main will be laid to direct the flows from the pumping station to the highest point of Burnham Road, and then the sewage will gravitate to the manhole located in Ferrers Road. The eastern catchment is proposed to drain into the gravity sewer from the central catchment.

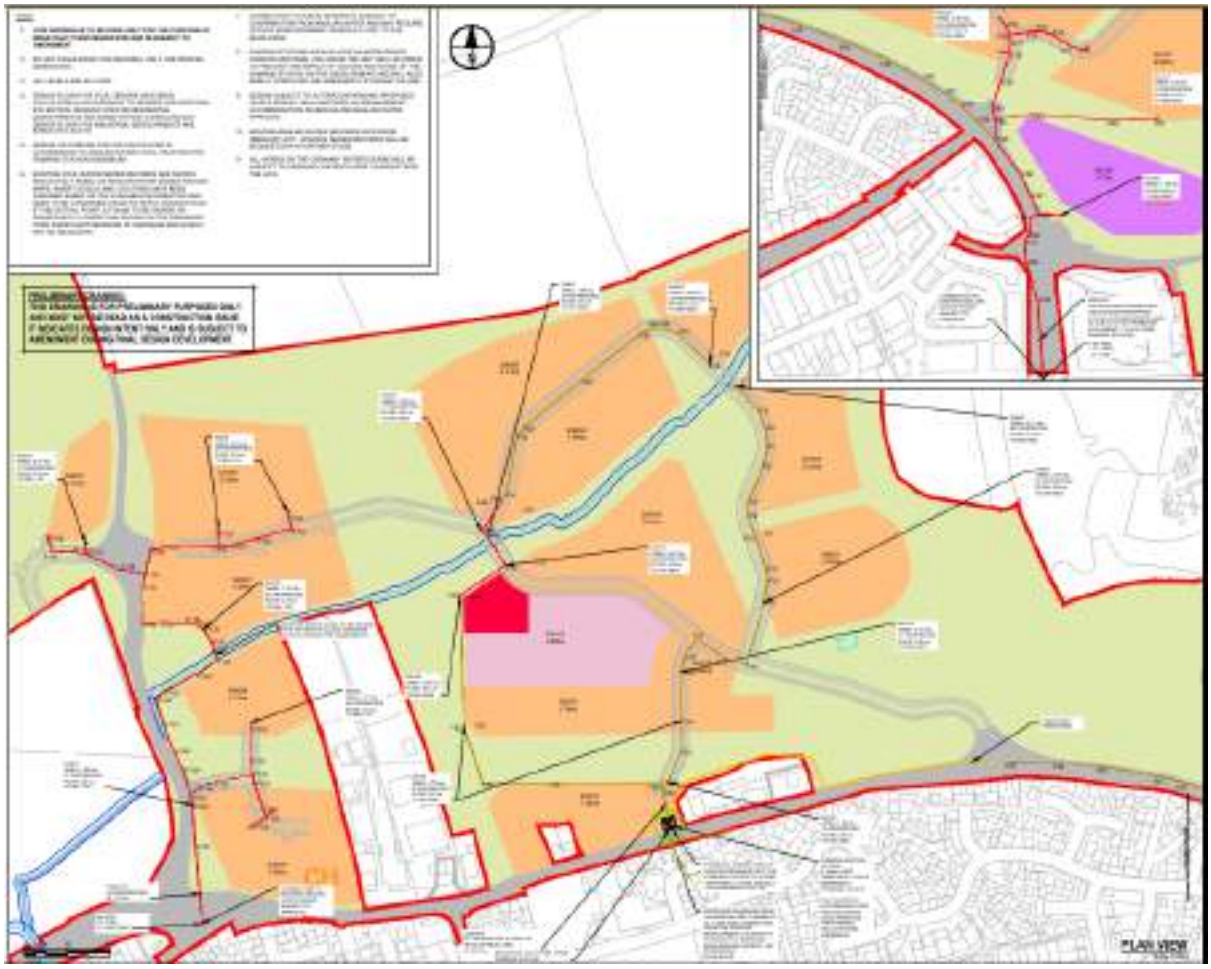
A preliminary design of the pumping station has been undertaken in accordance to Anglian Water Local Practice for Pumping Calculation Addendum. The addendum criteria differ from Sewers for Adoption, but Anglian Water guidance states they are based on actual water consumption figures and represent a realistic assessment of foul flows generated by new developments. The criteria to be used are:

- Dry weather flow should be calculated assuming 2.35 persons per property, 125 litres per head per day and 25% infiltration
- Pump rate = 4 x DWF
- Emergency storage = 4 hours at 1DWF
- The peak inflow is considered to be 2.12 x DWF

Following our discussions with Anglian Water, the foul water network serving the existing development located in the west bound verge of Burnham Road, directly opposite the proposed Pumping Station (approx. development size c.140 homes), will be diverted downstream of AW chamber Ref. TQ80986101. Connection will be made to the eastern network via the proposed Pumping Station, to alleviate the known capacity issues within the western network. Invert level of AW chamber Ref. TQ80986101 is 9.45 AOD, for 150diam pipe.

The manhole invert levels for the AW manholes at connection points, where not available from AW sewer records, have been assumed, taking into consideration levels of upstream & downstream manholes. The rising mains and associated pumping stations have not been designed in detail at this stage, however they will be designed in accordance to Sewer for Adoption 7th edition and AW design standards.

Figure 5 Foul water drainage strategy



The bullet points below summarize the total flows discharging into the existing manholes. Manhole 1101 is the outlet of the western network whereas manhole 5802 is the outlet of the central and eastern catchments. Following the requirements as set out in Sewers for Adoption 7th Edition:

- The flow from the western catchment discharging into manhole 1101 is 11.3 l/s, in accordance with the criteria from SFA 7th Edition.
- The flow from the central catchment discharging into the pumping station is 32.7 l/s.
- The flow from the existing development to the south of Burnham Road (c.140 properties) has been calculated at 6.5 l/s
- The peak inflow into the pumping station (comprising existing and proposed development inflows) has been calculated as 7.9 l/s, with the pump rate of 14.8 l/s. These values have been calculated in accordance with Anglian Water Local Practice for Pumping Calculation Addendum.
- The total emergency storage has been calculated at approx. 53,340l.
- The flow from the eastern catchment discharging into manhole 5802 is 18.7 l/s, in accordance with the criteria from SFA 7th Edition.

Therefore, the total flow discharging into the western network is 11.3 l/s and 33.5 l/s discharging into the eastern network. The connections into the existing Anglian Water assets are expected to be 150mm and 225mm dia. respectively.

From the latest conversations with Anglian Water, it has been assumed that there is sufficient capacity in the existing foul runs to accommodate the proposed development without the need for off-site reinforcement. However, a capacity assessment in being undertaken by Anglian Water to confirm this.

8. Ownership and Maintenance

As the outfall from the proposed surface water drainage system is discharging into a watercourse, it will be necessary to discuss with AW whether they will adopt any pipework discharging to it. If they are unable to adopt the pipework, the pipe network will be maintained by a management company.

Regarding the foul drainage network, conversations have started with AW about the drainage strategy and capacity of the existing network. It is expected that AW will adopt the pipe network, however this will be discussed at a further stage.

The adopted highway drainage is expected be the responsibility of the Highway Authority and the private drains and channels will be responsibility of the individual property owners.

In the absence of any public bodies to adopt the proposed retention basin and other SuDS within the proposed development, a management company will be employed to undertake the required maintenance of these features. Details of these arrangements are subject to confirmation during the detailed design process

9. Conclusion

The flood risk assessment undertaken on the site highlighted that there are some potential flood risks related to the site. However, an appropriate surface water drainage strategy has been produced in agreement with the LLFA, taking into consideration all risks to/from the proposed development. The strategy demonstrates that it is feasible to drain surface water from the site and that the requirements of the FRA and Planning Policies can be fully complied with.

As stated in Section 6.6 of this report, an approximate 37% proportion of the site, is developable land that will be attenuated down to 1in1 Greenfield Runoff Rate. Therefore, the drainage strategy will provide a betterment to the surface water flood extends for the 1in100 and the 1in1000 and also the provision of swales will provide additional storage and delay the concentration of surface runoff at the low point close to the confluence of the ordinary watercourse and the main river, at the west of the site by the B1418, due to the longer drainage paths. Therefore, it is expected that the drainage strategy will manage overland flows reducing the risk of surface water flooding and reduce the existing runoff of the site for peak flows. Therefore providing betterment to the existing surface water drainage regime downstream the site.

The proposed drainage strategy for the whole site is compliant with the national and local standards for water quantity and quality, each individual development parcel will be required to prepare and submit information to demonstrate the drainage strategy is in compliance with this document and any additional SuDs components will be designed within the individual parcels if feasible.

Following liaison with Anglian Water a proposed foul water strategy has been produced which demonstrates it is feasible to drain foul flows from the proposed development.

Hence, it is considered likely that risks and impacts can be managed to an appropriate level with the adoption of mitigation measures employed as part of the proposed development.

Given the above and based on the information provided within this drainage strategy, the development proposals for the site are in accordance with both National and Local Planning Policies, and therefore Planning Consent should not be withheld on due to flood risk or drainage requirements.