Homes England

The Housing and Regeneration Agency

West of Ifield, Crawley

Phase 1 Surface Water SUDS & Foul Drainage Design Report

10051123-ARC-050-ZZ-TR-CE-00002
Version 1 - Planning submission

July 2025

WEST OF IFIELD

PHASE 1 HIGHWAYS AND INFRASTRUCTURE

Surface Water SuDS and Foul Drainage Design Report

	10051123-ARC-050-ZZ-TR-CE-00002
Revision:	**P02**
Status:	**SO2 – Issued for Planning**
Security	**Internal**

Contacts

Arcadis Consulting (UK) Limited

80 Fenchurch Street
London EC3M 4BY
United Kingdom

WEST OF IFIELD

PHASE 1 HIGHWAYS AND INFRASTRUCTURE

Surface Water SuDS and Foul Drainage Design Report

Author	Matt Towler
Checker	Tim Fairlie
Reviewer	Martyn Griffiths
Approver	Steve Davies
Document Ref.	10051123-ARC-050-ZZ-TR-CE-00002
Date	30/07/2024

Version Control

Version	Status	Date	Author	Checker	Reviewer	Approver	Changes
P01.1	S0	30/07/2024	MT	TF	MG	SD	First Issue
P01.2	S0	25/10/25	MT	MP	MG	SD	FW section revised
P02	S2	20/06/2025	MT	CH	MP	SD	SW and FW sections updated

Contents

Tables

Figures

Appendices

1 Introduction

1.1 Overview

Arcadis Consulting (UK) Ltd have been commissioned by Homes England to provide a surface and foul water drainage design in support of Phase 1 of the proposed development of a strategic site on land to the West of Ifield. The overall development proposals comprise a residential-led mixed-use scheme to deliver up to 3,000 homes, commercial, business and service spaces, a hotel, a 6-8FE Secondary School and a 3FE Primary School. This proposed new mixed-use community lies within the administrative area of Horsham District Council, adjacent to the administrative boundary with Crawley Borough Council. The site has been identified as a strategic allocation in the draft Horsham Local Plan.

Phase 1 of the overall development comprises the construction of Primary and Secondary Access Roads in the southern area of the overall development site on land currently occupied by Ifield Golf Club, including a junction on to Rusper Road near to the existing golf club entrance, and construction of the new Crawley Western Multi-modal Corridor from Charlwood Road in the north, extending southwards to tie into the proposed Primary Access Road. The Phase 1 infrastructure works also include drainage and landscaping within the detailed element, as well as the provision of foul and surface water drainage and utility infrastructure within these highway corridors to enable the delivery of the Secondary School and provide suitable provision to support the delivery of future development parcels.

An outline Drainage Strategy report for the wider development has been prepared by Ramboll, document ref. 1620007949-RAM-ZZ-XX-RP-D-0001 which has been considered in the preparation of the drainage design for Phase 1 and this drainage design report.

This report includes a review of existing hydrology within and surrounding the site as well as a description of the proposed surface water drainage scheme including design methodology and maintenance considerations for Phase 1 of the development.

2 Existing Site

2.1 Site Location

The overall development site is located to the West of Ifield, approximately 2.75 km northwest of Crawley Town Centre. The site is approximately centred on National Grid Reference (NGR) E 524332, N 137482, and is bound by Charlwood Road in the northeast, a kilometre beyond which lies Gatwick Airport. The site lies to the north of the Horsham-Crawley railway line.

The existing residential areas of Ifield and Langley Green, associated with the town of Crawley, are located to the east. Ifield West and ancient woodland are located to the south, with the River Mole and further ancient woodland present to the west. The site is predominantly occupied by a mixture of arable and pastoral fields and includes the Ifield Golf Course and Country Club in its southernmost portion.

An extract of Ordnance Survey Mapping, overlain with the site location and the indicative masterplan proposals, is shown in Figure 1 below.

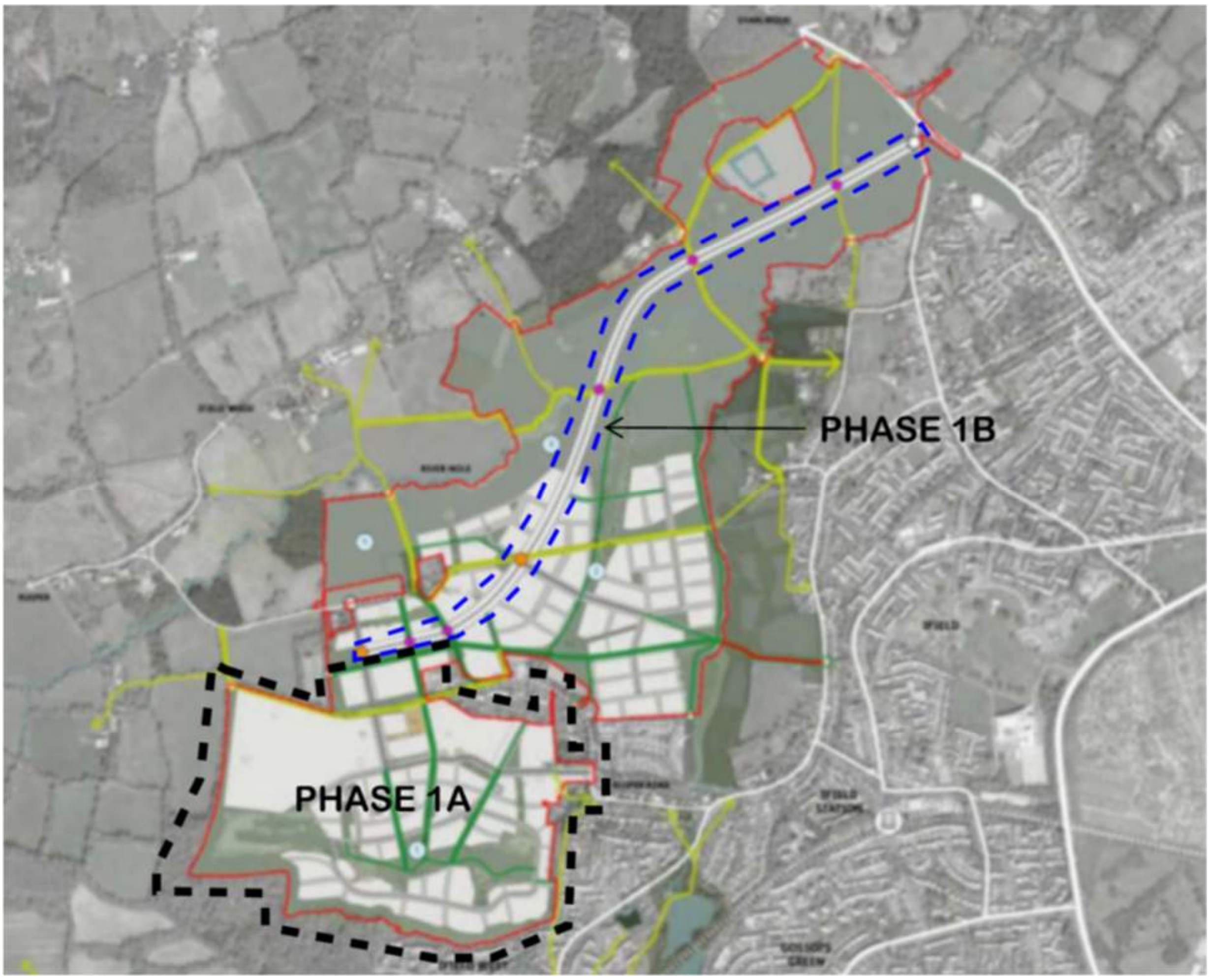


Figure 1: Site Location

Background mapping contains OpenStreetMap data © Crown Copyright and database right 2023

It is proposed that the delivery of the proposed development indicated by the masterplan shown in Figure 1 will be phased. Phase 1 comprises the following, the extents of which are shown in Figure 2 below:

- Construction of Primary and Secondary Access Roads in the southern area of the overall development site on land currently occupied by Ifield Golf Club (Phase 1A), shown in purple and blue respectively in Figure 2, and including a junction on to Rusper Road near to the existing golf club entrance.
- Construction of the new Crawley Western Multi-modal Corridor from Charlwood Road in the north, extending southwards to tie into the proposed Primary Access Road (Phase 1B), shown in orange and magenta in Figure 2.
- Provision of foul and surface water drainage and utility infrastructure within the above Phase 1A and Phase 1B highway corridors to enable the delivery of the Secondary School and provide suitable provision to support the delivery of future upstream development parcels where required.
- Improvement works along Rusper Road to accommodate the bus route into the development site.

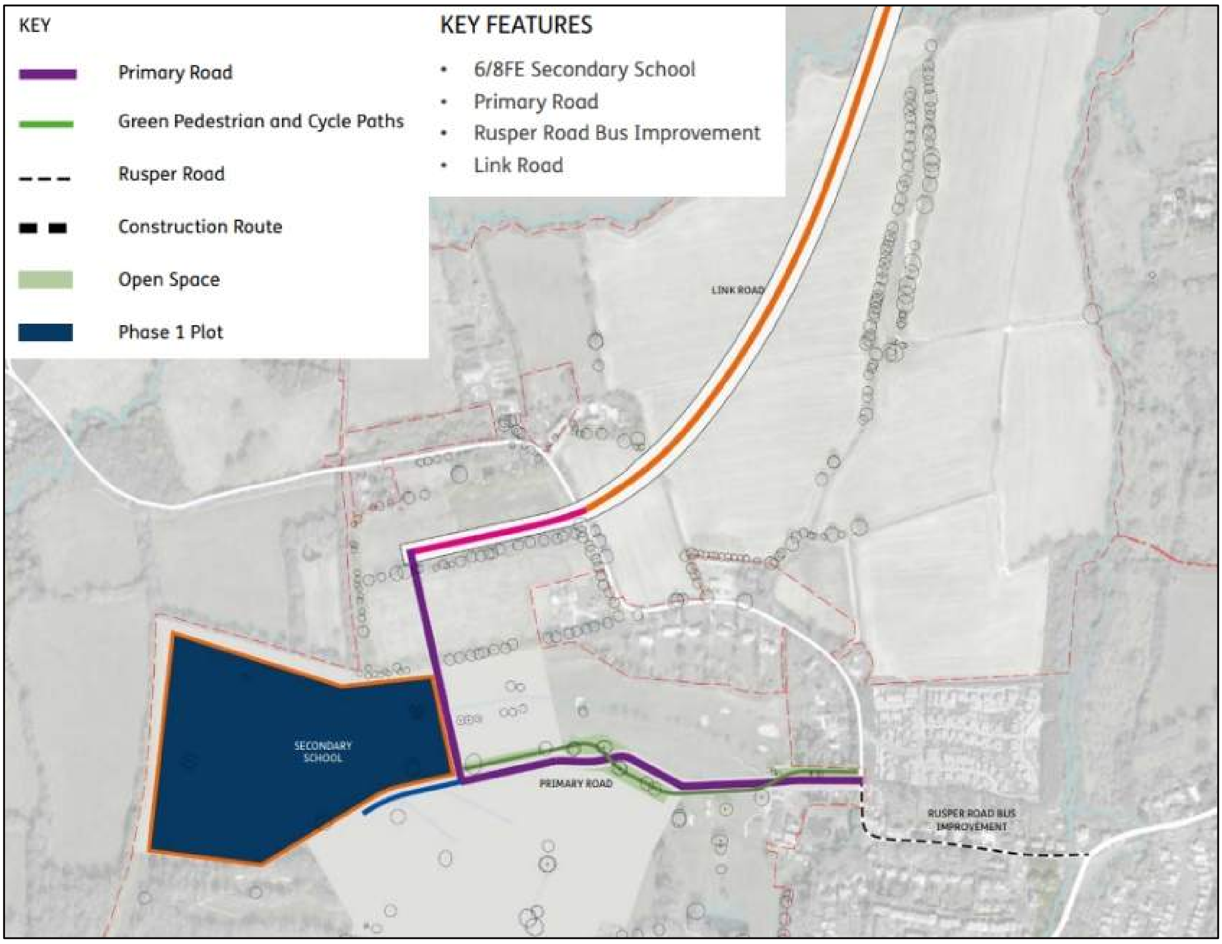


Figure 2: Proposed Development Phase 1 Extents

2.2 Site Topography

2.2.1 Phase 1A

The ground elevations within most of the existing Ifield Golf Club site, which comprises the majority of the Phase 1A area, and some subsequent residential development phases generally fall from south to north, towards an existing drainage ditch which runs between the northern boundary of the Golf Club and the agricultural land to the north. There is a ridge line running through the Golf Club site, with a maximum elevation of approximately 85.0m AOD towards the south-west corner of the Golf Club, with ground elevations falling towards the drainage ditch at the Golf Club's northern boundary where the minimum elevation is approximately 66.0m AOD. To the south of the ridge line, ground elevations in the southernmost part of the Golf Club fall in a southerly direction towards Hyde Hill Brook, which forms the southern boundary of the Golf Club site, reaching a minimum elevation of approximately 70.0m AOD in the far south-east corner of the site.

The drainage ditch described above alongside the northern boundary of the Golf Club site is banked and is a depth of between 0.9m and 1.2m below adjacent ground levels. This ditch extends beyond the site boundary in an easterly direction, passing immediately to the south of Furlong Farm before crossing under Rusper Road, from where it runs northwards through the agricultural fields which form part of the future development phases, before eventually discharging into the River Mole.

To the north of the Ifield Golf Course site, the agricultural land through which the northern part of the Phase 1A Primary Street is proposed falls from north-west to south-east, towards the same ditch described above.

In the north-east corner of the Golf Course site, there is another drainage ditch present along the boundary between the Golf Course and the adjacent existing residential properties which front on to Rusper Road. At the north-east corner of the site Golf Course site the minimum elevation is approximately 66.5m AOD.

A drawing (ref. 10051123-ARC-050-1A-DR-CE-00002) showing the existing topography and watercourses / ditches described above can be found in Appendix B.

2.2.2 Phase 1B

The ground elevations within the agricultural fields towards the north-east of the Site, at the Crawley Western Multi-modal Corridor, slope with a relatively steep gradient in a South Easterly direction with levels ranging from 68.1m AOD to 62.1m AOD. Running through the site, the River Mole is embanked, sitting topographically lower by up to 3m below surrounding ground levels. The existing ditches which bound the agricultural fields throughout the site are also banked and sit topographically lower than the surrounding field ground levels of up to 1.2m. The agricultural fields towards the south-west of the Phase 1B Site are relatively flat with levels ranging from 66.8m AOD to 69.0m AOD.

2.3 Existing Watercourses

The River Mole is the main watercourse in the area, a tributary of the River Thames, which rises near Rusper village in West Sussex and flows northwest through Surrey to the River Thames. The River Mole runs through the proposed overall development site, flowing in a north-easterly direction. Ifield Brook also runs through the eastern part of the proposed development site from south to north, discharging into the River Mole.

As described previously, there are several smaller unnamed watercourses and drainage ditches running through the site which surround the golf club and agricultural field boundaries, prior to discharging into the River Mole or Ifield Brook.

2.4 Existing Ground Conditions

From a review of the British Geological Survey (BGS) online Geological Viewer, the ground conditions generally comprise Weald Clay Formation (predominantly mudstone) bedrock overlain by superficial deposits of Alluvium (Clay, silt, sand and gravel) and River Terrace Deposits (sand and gravel). Extracts from the BGS mapping of bedrock and superficial geology are shown below in Figure 3 and Figure 4, respectively.

Based on current ground investigations it is assumed that the presence of clay bedrock across the site will preclude the use of infiltration SuDS techniques.

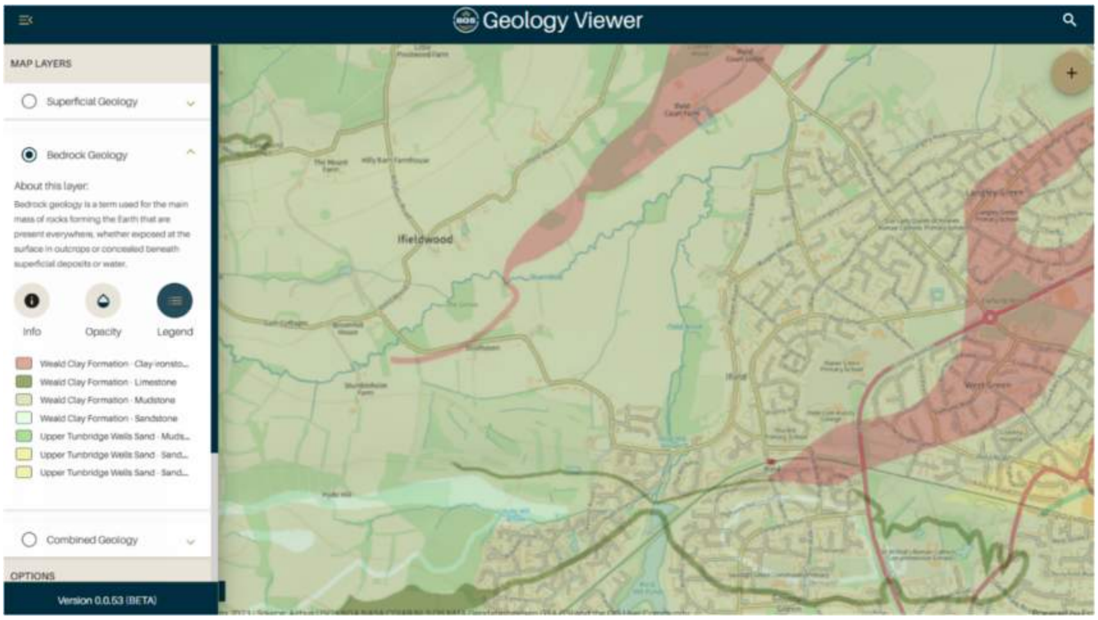


Figure 3 British Geological Survey Mapping (bedrock)

Figure 4 British Geological Survey Mapping (superficial deposits)

2.5 Existing Site Drainage

The site currently comprises a Golf Club and agricultural fields, which drain via field boundary ditches across the site as detailed in section 2.3. There are no recorded public surface water sewers within the site extents.

2.6 Existing Flood Risk

2.6.1 Rivers and Sea

The Environment Agency (EA) categorises flood risk based on zones, delineated by a probabilistic chance of land becoming flooded during a range of events. These are noted below:

Flood Zone 1 – Land having less than 0.1% chance (1in1000) annual probability of flooding

Flood Zone 2 – Land having between 0.1%-1% (1in1000 to 1in100) annual probability of flooding from rivers, or between 0.1%-0.5% (1in1000 and 1in200) annual probability of flooding from the sea

Flood Zone 3 – Land shown to have an equal to or greater than 1% (1in100) annual probability of flooding from rivers, or 0.5% (1in200) or greater annual probability of flooding form the sea.

The EA Flood Map for Planning (Rivers and Sea) (Figure 5) shows that the majority of the Phase 1A & Phase 1B site is located within Flood Zone 1 and therefore at Low Risk of flooding from rivers and seas.

An area to the north of the Phase 1A development, along Rusper Road, is shown to be located within Flood Zones 2 and 3. The flooding is shown to be related to the Rusper Road Drain which crosses the northern half of Phase 1A in a west to east direction, before heading north, as indicated within Figure 5. The Flood Risk Assessment (FRA) undertaken by Ramboll (ref: 162007949-RAM-ZZ-XX-RP-WA-00002-S3-P0_FRA_6) notes this data is currently considered as erroneous, with the evidence suggesting the source of flooding being of a pluvial nature rather than fluvial. The report indicates that the flooding indicated for the Rusper Road drain for this source (rivers and sea) is not to be considered as a fluvial event and is to be treated as such. It is however required to consider this data as a potential pluvial, or surface water, flood risk. Reference to section 4.1 of the Ramboll FRA is to be made for further detailed information on this topic.

A small area of the Phase 1B site, along the River Mole and Ifield Brook show regions within Flood Zone 3, equivalent to an annual chance of flooding greater than 1 in 100 (1%), and Flood Zone 2, between a 1 in 100 and 1 in 1000 annual probability of flooding. A small area of the proposed Phase 1B highway and corresponding drainage will be located within Flood Zone 2 and Flood Zone 3 where the proposed highway crosses the River Mole via a proposed new bridge structure.

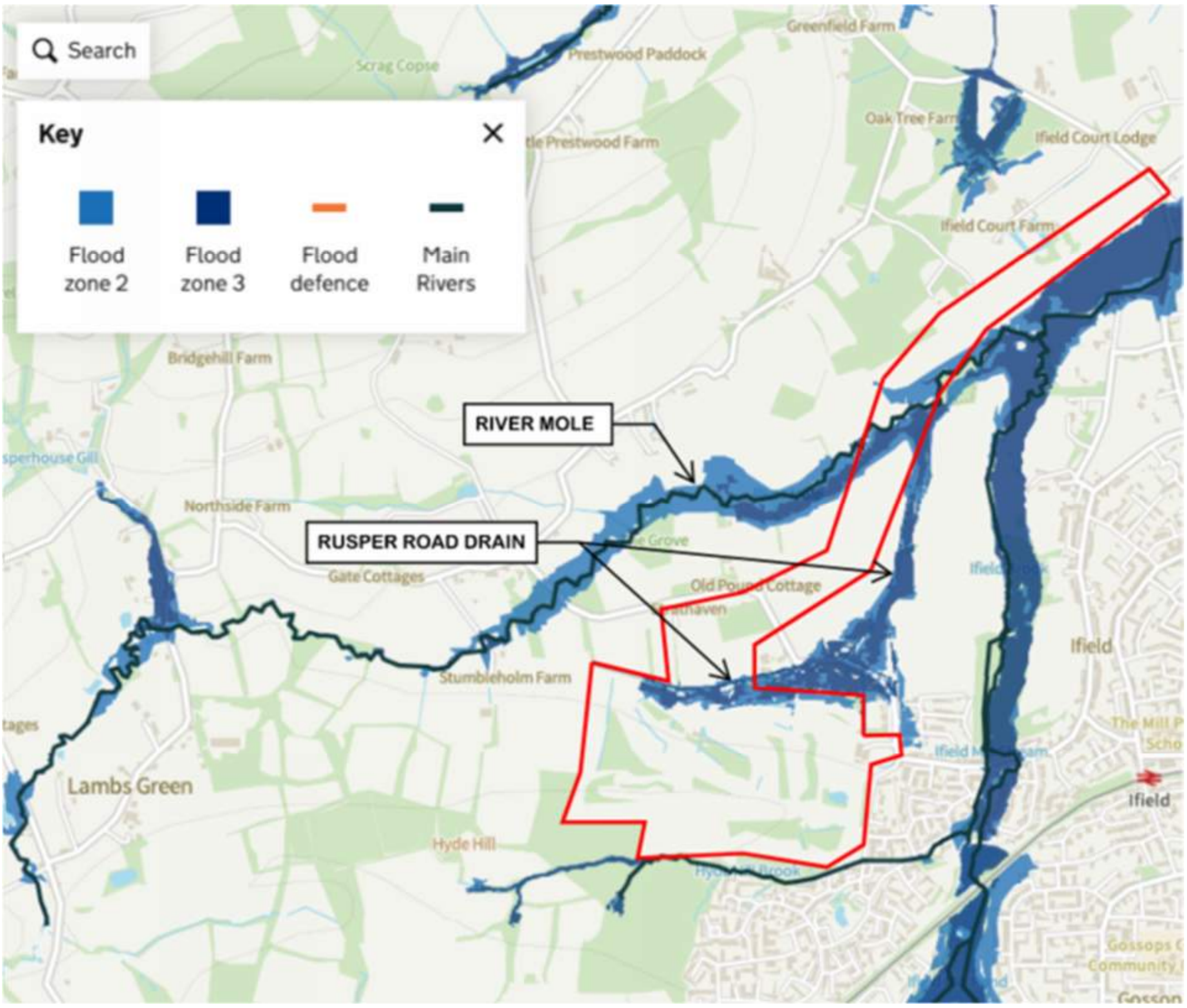


Figure 5 Flood Map for Planning (Rivers and Sea) – Approximate Phase 1A & B Site Boundary in Red

2.6.2 Surface Water

The EA categorises surface water flood risk delineated by a probabilistic chance of land becoming flooded during a range of events. These are noted below:

High Chance – More than 3.3% chance each year (1in30)

Medium Chance – Between 1% and 3.3% chance each year (1in100 to 1 in 30)

Low Chance – Between 0.1% and 1% chance each year (1in1000 to 1in100)

The potential chance of surface water flooding within the Site, to any depth, and therefore the extents of flooding, is presented in Figure 6-1 below and indicates the chance of surface water ponding at a location at any depth and includes climate change factors (from 2040 to 2060). The figure indicates that surface water flooding is possible along the northern boundary of the Phase 1 A area, adjacent to Rusper Road and specifically the Rusper Road drain. As previously discussed in section 2.6.1, it is this location that corresponds with the flood risk associated with the Rusper Road drain.

Furthermore, the EA presents the chance of surface water flooding at specified depths. The depths of flooding up to 200mm and 300mm are presented in *Figure 6- 2* and Figure 6- 3 below and are again inclusive of climate change factors (from 2040 to 2060). The data for depths up to 600mm and 900mm are not presented within this section as the modelling undertaken by the EA indicates that these depths are not reached. It can be seen that along the northern side of the Phase 1A boundary, adjacent to Rusper Road, the chance of flood water reaching a depth of up to 200mm is more likely, with a 3.3% chance, when compared to flood water depths reaching 300mm, which is typical a lower chance occurring during less frequent events (0.1% to 1%).

Localised areas of surface water flooding are noted within the golf course area also, with flooded depths being of similar probability between the 200mm and 300mm depth range.

The FRA, section 4.2, discusses the surface water flooding in detail and should be referred to for further information, but is summarised as below:

- The flood risk is based on modelling that is completed at a national scale and is based on a number of assumptions, and the EA cannot map every localised drainage mechanism if not large enough to be captured accurately in the terrain data they have available.
- A number of below ground drainage pipes and open channels exist within the gold course. It is highly likely the below ground drainage is not considered to provide connectivity to drainage features, and the open channels may be reflected within the modelling if large enough to be captured.
- The culvert beneath Rusper Road has not been considered, which provides connectivity between the south and north side of the road, and ultimately, the modelling indicates that the surface water flows overland, and flood depths increase, until such time that it overtops the carriageway, which is likely to explain the surface water flooding indicated within the mapping.

The figures also correspond with similar results for the Phase 1B area at locations adjacent to the River Mole with a flood depth of up to 200mm more likely to occur in the >3.3% event and a lower chance of flood water depths reaching a 300mm flooded depth, in less frequent storm events between 0.1%-1%. It is likely that the flood modelling information is erroneous in some areas as discussed above.

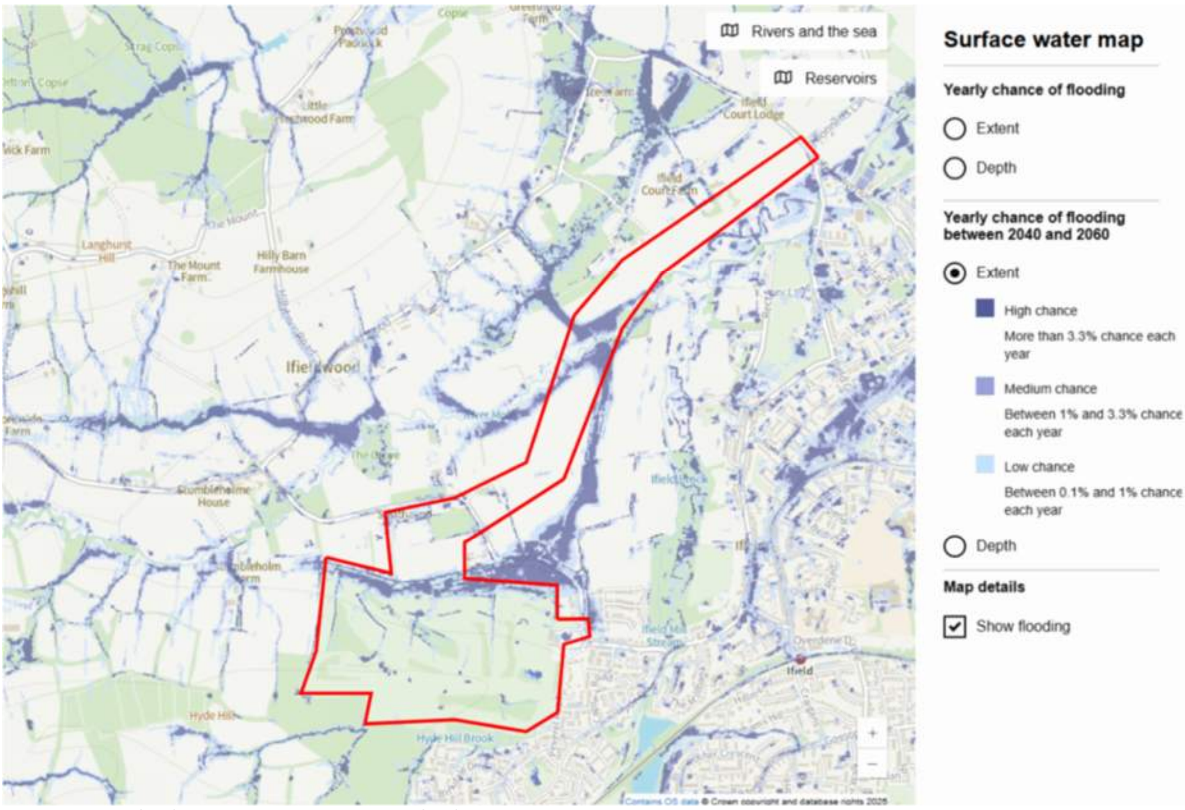


Figure 6- 1 - Surface Water Flood Map – Surface Water Flooding Extents

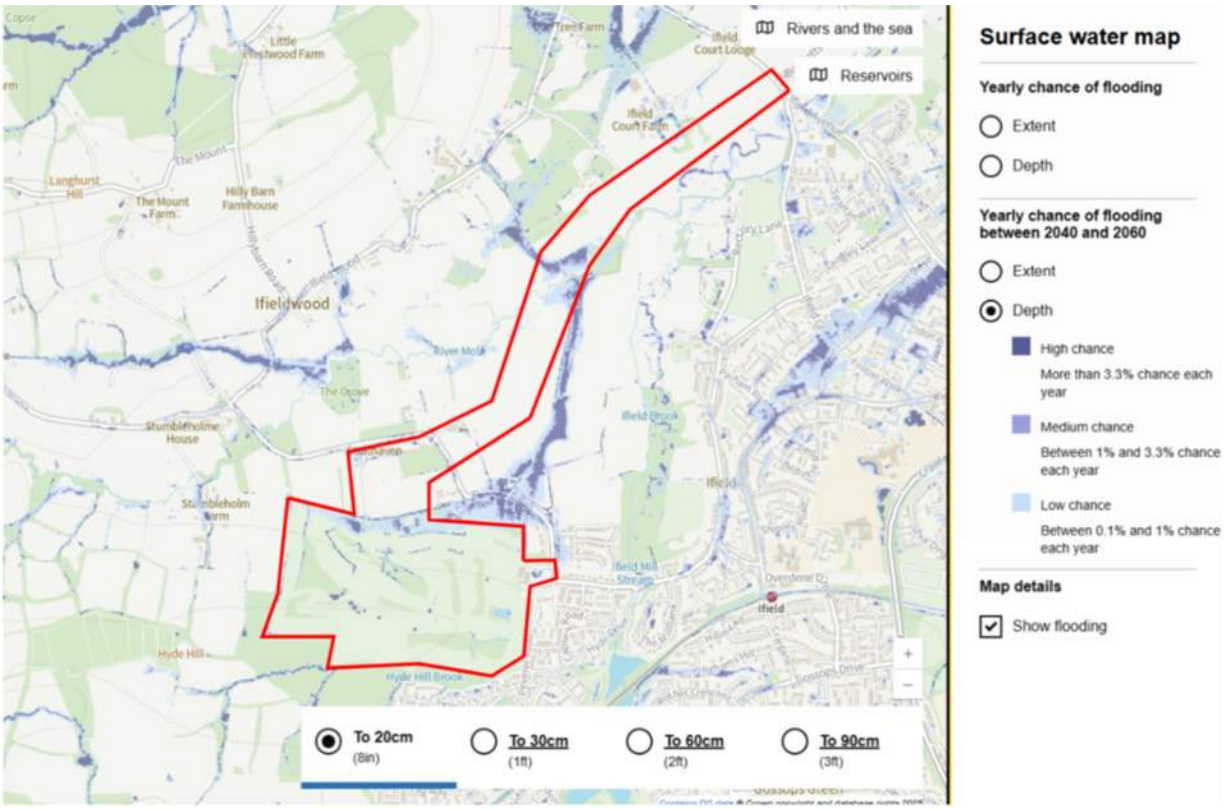


Figure 6- 2 - Surface Water Flood Map - Surface Water depth up to 200mm

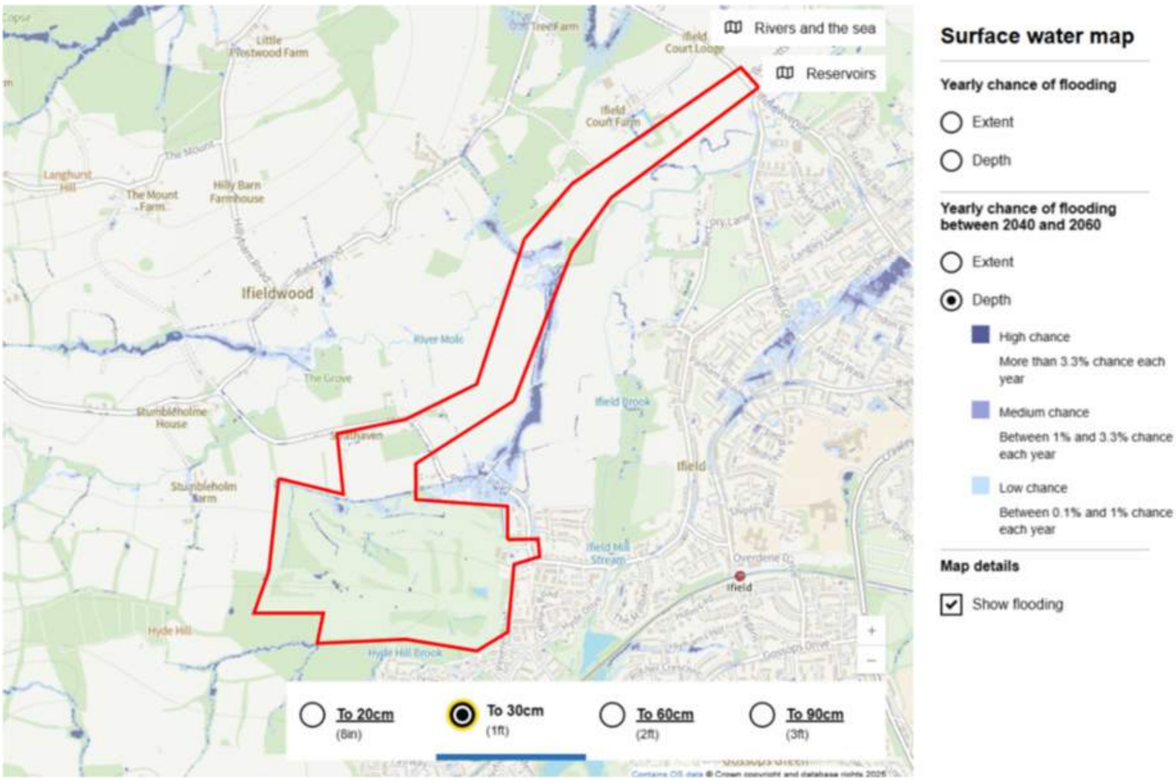


Figure 6- 3 - Surface Water Flood Map - Surface Water depth up to 300mm

3 Proposed Development

West of Ifield is a strategic site for up to 3,000 homes as part of a new, mixed-use community within the administrative area of Horsham District Council, adjacent to the administrative boundary with Crawley Borough Council. The site has been identified as a strategic allocation in the draft Horsham Local Plan. Please refer to **Appendix A** for the 'Illustrative Master Plan'.

As set out in the *'Development Specification and Parameter Plan Framework February 2023 Table 2'* the full development comprises of.

- Class E – Commercial Business and Service – 36,350 sqm
- Class B2 General Industrial – 5,200 sqm
- Class 1 – Hotels – 80 Beds
- Class C2/3 Residential – 3,000 units
- Traveller Pitches – 15No.
- Class F1 Learning Institutions – 11,750 sqm
- Class F2 Local Community – 3,500 sqm

As described in Section 2, it is proposed that the delivery of the proposed development indicated by the Illustrative Masterplan will be phased, with Phase 1 comprising the following, the extents of which are shown in Figure 2 in Section 2 of this report:

- Construction of Primary and Secondary Access Roads in the southern area of the overall development site on land currently occupied by Ifield Golf Club (Phase 1A), shown in purple and blue respectively in Figure 2, and including a junction on to Rusper Road near to the existing golf club entrance.
- Construction of the new Crawley Western Multi-modal Corridor from Charlwood Road in the north, extending southwards to tie into the proposed Primary Access Road (Phase 1B), shown in orange and magenta in Figure 2.
- Provision of foul and surface water drainage and utility infrastructure within the above Phase 1A and Phase 1B highway corridors to enable the delivery of the Secondary School and provide suitable provision to support the delivery of future upstream development parcels where required.
- Improvement works along Rusper Road to accommodate the bus route into the development site.

4 Planning Policy Requirements

4.1 National Planning Policy Framework (NPPF)

The NPPF was first published in 2012 and most recently updated in February 2025. Along with its accompanying Planning Practice Guidance (PPG) on Flood Risk and Coastal Change, the NPPF sets out the national government's planning policies for England and how these are expected to be applied. The principal aim of the NPPF is to achieve sustainable development. This includes ensuring that flood risk is taken into account at all stages of the planning process, avoiding inappropriate development in areas at risk of flooding and directing development away from those areas where risks are highest. Where development is necessary in areas of flooding, the NPPF aims to ensure that it is safe, without increasing flood risk elsewhere.

4.2 Horsham District Council Strategic Flood Risk Assessment (SFRA)

Horsham District Council published a Strategic Flood Risk Assessment Final Report in April 2010. This document includes a review of Sustainable Drainage Systems, and emphasises the need wherever possible for SuDS systems to seek to:

- Reduce flood risk (to the site and neighbouring areas)
- Reduce pollution
- Provide landscape and wildlife benefits.

4.3 West Sussex County Council Highway Drainage Guidance

West Sussex County Council (WSCC) are the highway authority in the area and will be responsible for the future adoption of any roads and associated highway drainage which the developer may want to offer for adoption. WSCC have produced a guidance document titled "Adoptable Highway Drainage and Sustainable Drainage Systems: Guidance for Developers", Version 3 of which was published in March 2019, which gives advice to developers wishing to get highway drainage infrastructure adopted in West Sussex. The document outlines the highway drainage design principles and permitted Sustainable Drainage Systems (SuDS) features which may be acceptable for adoption under S278 and S38 agreements.

The document states that where WSCC are adopting SuDS, their preference is for:

- SuDS using "Open" soft engineering techniques:
  - Storage ponds, balancing ponds, retention and infiltration basins,
  - Swales, ditches, and infiltration strips.
- SuDS using hard engineering techniques:
  - Attenuation of drainage by oversize pipework and throttles,
  - Underground attenuation and storage tanks (provided adequate inspection and maintenance access is provided,
  - Soakaways and filter drains with adequate infiltration design rates.

The document also states that permeable paving and underground cellular based systems are not preferred due to inherent difficulties with long term maintenance. However, the document adds that if it can be demonstrated that the system has been designed to minimise siltation then WSCC will consider adoption on a case-by-case basis.

4.4 West Sussex County Council LLFA Guidance

West Sussex County Council are the Lead Local Flood Authority (LLFA) in the area. Together with several other LLFA's in the Southeast of England, they published a guidance document in September 2013 titled "Water. People. Places. A guide for master planning sustainable drainage into developments". The document presents what needs to be considered when designing SuDS at the initial and concept design stages of a masterplan and refers to further guidance documents to confirm the next stages of design, including the CIRIA SuDS Manual (CIRIA C753).

Flood & Water Management Act

The Government intends to require Sustainable Drainage Systems for all projects in England under Schedule 3 of the Flood and Water Management Act with the establishment of a SuDS Approval Body (SAB). The SAB is intended to undertake an approval role for surface water drainage proposals and act as an adopting authority for SuDS features. The involvement of the SAB would relate to the development of surface water drainage with the exception of adoptable highway drainage and the timing for implementation is pending confirmation.

5 General Surface Water Drainage Design Principles

5.1 Design Guidance

The following design guidance was considered in developing the surface water drainage strategy for the control of surface water runoff from the proposed development on the Phase 1 site:

- National Planning Policy Framework (NPPF) & accompanying Planning Practice Guidance
- Sewers for Adoption
- SuDS Manual, CIRIA C753
- Building Regulations Part H

5.2 Climate Change

The NPPF and Water UK – Sewerage Sector Guidance (Appendix C) require that surface water drainage systems provided for the new development site should be designed to retain all runoff for events up to the 1 in 100-year rainfall event, with an appropriate allowance for climate change. This is to prevent downstream flooding and an allowance of 40% will be made for climate change.

5.3 Sustainable Drainage Systems Treatment Train

The proposed surface water drainage system that will serve the proposed development will need to be in accordance with national and local planning policy, and relevant sections of the Sustainable Drainage Systems (SuDS) Manual (CIRIA C753). The proposed SuDS components will aim to emulate the natural drainage of the site as closely as is practicably achievable.

SuDS are water sensitive drainage systems which mimic natural catchment processes to manage urban runoff. A 'treatment train' of various SuDS is required to capture, detain, convey and discharge water from an urban environment. The treatment train philosophy uses drainage techniques to systematically control the three elements of runoff. A 'treatment train' of various SuDS is required to capture, detain, convey and discharge water form an urban environment. The treatment train philosophy uses drainage techniques to systematically control the three elements of runoff: pollution, flow rates and volume. This is achieved in the three main steps: Source Control, Conveyance Control and Discharge Control as shown in Figure 8 below. Source control is preferred to those further down the train as they lead to the retention of pollutants and control of water before it enters the proposed or existing drainage network or watercourse. All of the methods suggested are recommended controls considered for SuDS and will be utilised where practical.

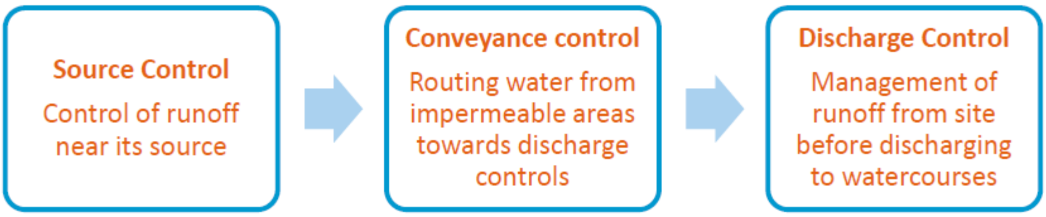


Figure 6 SuDS Treatment Train

Individual SuDS components are not treated in isolation but work together as a suite of drainage features. The SuDS components suggested for inclusion into the proposed drainage system reflect the desirability to have a mix of SuDS components across the site, as different components have different capacities for treatment of individual pollutants.

6 Surface Water Drainage Design – Crawley Western multi-modal corridor

The design of a surface water drainage system to serve the proposed Crawley Western multi-modal corridor has been designed in accordance with the SuDS Manual (CIRIA C753). The proposed SuDS components aim to emulate the natural drainage of the site as closely as is practicably achievable.

The surface water drainage design within this area consists of four networks, created considering the vertical profile of the highway corridor along with the existing surface water drainage channels which cross the route. Due to highway modifications at the Charlwood Road junction, surface water networks are required to accommodate the increase in impermeable area.

6.1 Greenfield Runoff Rates

Both national and local planning policies state that for any development, peak rates of discharge to either a watercourse or a sewer should be restricted to as close as is reasonably practicable to the equivalent greenfield rates of runoff from the site especially if the existing site is a greenfield site.

A greenfield runoff rate calculation has been undertaken for the site using the ICP SuDS methodology, resulting in a QBAR rate of 5.2l/s/ha which has been used for the preliminary design stage. The runoff rate for each catchment area is summarised in the Table 1 below.

Table 1 Greenfield Runoff Rates

Catchment Area	Drainage Catchment Area (ha)	QBAR Greenfield Runoff Rate (l/s)
Catchment Area 1	4.83	25.4
Catchment Area 2	1.706	9.0
Catchment Area 3	2.17	11.4
Catchment Area 4	0.157	0.8
Charlwood Road Network 1	0.0375	0.195
Charlwood Road Network 2	0.0164	0.085

6.2 Proposed Surface Water Drainage Design

To the eastern end of the Crawley Western Multi-modal Corridor, the highway corridor contains a dual carriageway separated by a 2m SuDS strip. Both directions of traffic are bounded by an additional 3m SuDS strip. Surface water falling on the carriageway will drain directly to the adjacent SuDS strips which are prepared in the form of a bioretention system. Within these Bioretention systems, water will percolate through the plant and filter material at the surface, to an open graded granular material and eventually to a perforated pipe which will convey flows downstream. A number of check dams with drain-down holes will store water during flood events to contain flood waters from the more typical storm events.

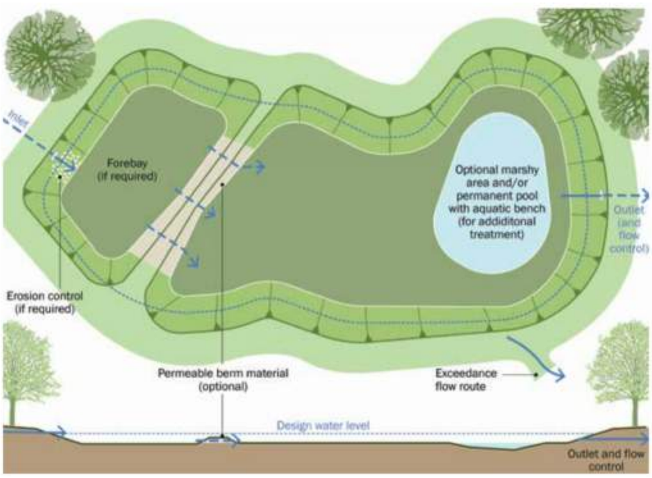
During larger storm events up to and including the 100-year event with an allowance of 40% of additional flows for climate change, there is insufficient capacity within the road network SuDS system alone and the water will be stored within regional detention basins adjacent to the eventual outfalls to the existing land drainage network in the area. The detention basins are designed to drain down rapidly to ensure standing water is not created to attract birds, which could impact on Gatwick Airport to the northeast.

The proposed highway crosses over existing ditches in a number of locations. Culverts and concrete pipes have been proposed under the highway to convey the water within the existing ditches. Based on the size properties and design flows of the existing ditches, the proposed culverts have been sized to ensure adequate flow capacity.

The proposed drainage drawings utilising SuDS techniques, reference 10051123-ARC-050-1B-DR-DE-00001 to 00004, are included in Appendix F.

A summary of each of the proposed SuDS techniques is shown in Table 5 below.

Table 2 Suitable SuDS Components to be Incorporated into Crawley Western multi-modal corridor design

DETENTION BASINS	
 Image Ref: CIRIA Report C753 – The SuDS Manual v6	Detention basins are landscaped depressions that are normally dry except during and immediately following storm events. They can be on-line components where surface runoff from regular events is routed through the basin and when the flows rise, because the outlet is restricted, the basin fills and provides storage of runoff and flow attenuation. They can also be off-line components into which runoff is diverted once flows reach a specified threshold. A flow control system at the outfall controls the rates of discharge for a range of water levels causing the basins volume to fill during storm events. Runoff from each rainfall event is detained and treated in the basin. Basins should always be designed with suitable upstream pre-treatment systems in place. This prevents open water features from becoming unsightly and odorous and reduces the risk of rapid silt accumulation.

BIORETENTION SYSTEM / RAIN GARDEN

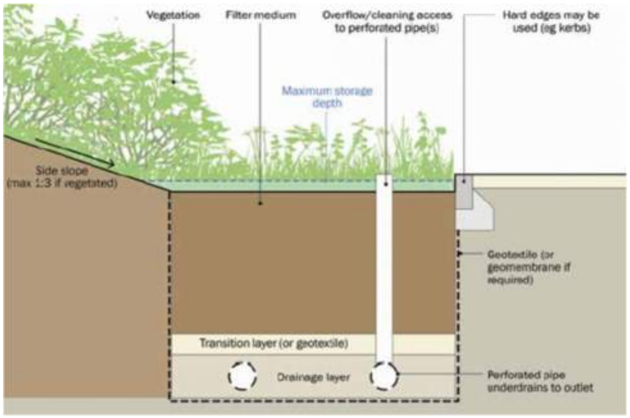


Image Ref: CIRIA Report C753 – The SuDS Manual v6

Bioretention features (including rain gardens) are shallow landscaped depressions that can reduce runoff rates and volumes and treat pollution through the use of engineered soils and vegetation. The filtered runoff is either collected using an underdrain system or allowed to infiltrate to the underlying substrata.

They are particularly effective in delivering interception and can also provide attractive landscape features that are self-irrigating and fertilising, provide habitat and biodiversity, and provide colling of the local microclimate due to evapotranspiration.

The filtered runoff is either collected using an underdrain system or allowed to infiltrate to the underlying substrata. They are generally used for managing and treating runoff from frequent rainfall events, and where larger events are directed to the system, it may be more appropriate to pass runoff from extreme events directly to downstream components further downstream via an overflow or bypass.

Within the Charlwood Road junction upgrade and widening works, large diameter pipes have been designed, concurrent with flow control, to provide attenuation and to regulate discharge to a total of 4.39 l/s (2.25 and 2.14 l/s) as shown on drawing 10551123-ARC-050-1B-DR-DE-00001. The QBar value for the widened carriageway extents, and thus increased impermeable area, has been applied to provide a 50% betterment when compared to the existing flow rates.

The proposed temporary access track to the attenuation pond would have a permeable surface so that there is no direct change to the drainage regime compared to the pre-development state.

6.3 Proposed Surface Water Modelling

For development of the Crawley Western multi-modal corridor design, a surface water drainage design has been developed based on adoptable highway design standards with flow modelling to determine how the surface water network and points of outfall for discharging into the existing watercourses will fit within the proposed scheme. The required land take for SuDS features will need to be considered as a constraint and will need to be accommodated within any further development of the proposed masterplan arrangement.

InfoDrainage software has been used to determine the size of the detention basins located immediately prior to the outfalls to the existing watercourses. Additional storage is also included within the model in the form of bioretention systems, which use check dams with drain down pipes to make benefit of the storage where the Crawley Western Multi-modal Corridor is on a steeper longitudinal slope. A full set of calculation results for the Crawley Western multi-modal corridor area are available in Appendix G.

6.4 Water Quality

Pollution control measures will need to be included to minimise the risk of contamination or pollution, emanating from surface water runoff from the development, entering the receiving watercourse. The onsite surface water drainage system will need to be designed to comply with the requirements of the SuDS treatment train as laid out in the CIRIA SuDS Manual.

The proposed highway, with inherent high numbers of vehicular traffic, will likely require additional treatment stages compared to other development areas. Using the SuDS Treatment Train approach is shown in Figure

7 and will consist of bioretention systems (for conveyance and storage) and a detention basin feature (discharge control), which could be used in combination to provide both the required attenuation volume and separate treatment stages to improve the quality of runoff from these areas.

7 Surface Water Drainage Design – Remainder of Phase 1

The surface water drainage system to serve the proposed highway within Phase 1A of the development has been designed in accordance with the SuDS Manual (CIRIA C753). Provision has also been made for the future discharge of surface water from adjacent development parcels, which fall towards the existing watercourses / drainage ditches within the Phase 1A area of the site, including the Secondary School and Primary School parcels.

The proposed SuDS components aim to emulate the natural drainage of the site as closely as is practicably achievable.

7.1 Greenfield Runoff Rates

Both national and local planning policies state that for any development, peak rates of discharge to either a watercourse or a sewer should be restricted to as close as is reasonably practicable to the equivalent greenfield rates of runoff from the site especially if the existing site is a greenfield site.

A QBAR greenfield runoff rate of 5.25l/s/ha has been used for the preliminary design stage for Phase 1A.

7.2 Proposed Surface Water Drainage Design

7.2.1 Outline Drainage Strategy

The Surface Water Strategy suggested in Ramboll's outline Drainage Strategy report (Ref. 1620007949-RAM-ZZ-XX-RP-D-0001-P02) treats the whole of the Phase 1A area, as well as a significant number of future development parcels further south and north, as one catchment. The strategy for this area, as shown on the Ramboll outline Surface Water Drainage Strategy drawings in Appendix C, proposes a single piped network running predominantly within proposed road corridors. This proposed pipe network is indicated as conveying flows from the whole of this area to a single point of discharge to the River Mole identified as Outfall 2, which is situated approximately 500m north of the proposed junction between the Phase 1A Primary Street and the Phase 1B Crawley Western Multi-modal Corridor.

The Ramboll outline Drainage Strategy report provides an estimate of 96,110m^3 for the overall volume of attenuation required across the overall development, based on a MicroDrainage Quick Storage Estimate. The strategy provides only limited attenuation within larger strategic SuDS features (detention basins) and is reliant on the majority of required attenuation being provided by a variety of SuDS techniques within individual future development parcels. For the system draining to Outfall 2, the overall catchment area is stated as 37.14ha, resulting in an allowable discharge rate of 193.32l/s.

7.2.2 Developed Drainage Proposals

The developed drainage proposals have taken forward the global parameters in the outline strategy and developed them further considering Phase 1 only. In development of the design, the raising of plot levels to assist gravity drainage has been avoided with increasing sub catchments set to closely mimic the existing hydrology of the site, utilising the existing land drainage network of ditches through the site, which results in additional catchments each with a corresponding outfall. Each outfall therefore requires a reduced discharge rate, when compared to having a reduced, and therefore larger, number of catchments requiring larger discharge rates. . These outfalls eventually connect to the River Mole to the North following the broad principles in the outline strategy. The pre-development run off from the Phase 1A area does not flow directly to the River Mole and connects via minor watercourses and the pre-development flow paths, with dispersed flows carried through to the proposed Phase 1A drainage scheme in line with SuDS best practice.

The developed proposed design for the Phase 1A area is shown on Arcadis drawing 10051123-ARC-050-1A-DR-CE-00001 and drawings 10051123-ARC-050-1A-DR-DE-00013-00018, contained in Appendix D. The drawing shows four separate drainage catchment areas, which are summarised below:

- Catchment Area 1: Comprises the area north of the existing unnamed watercourse running through the middle of the Phase 1A site area, which naturally drains towards this watercourse, and contains adjacent lengths of the proposed Primary & Secondary Roads.
- Catchment Area 2: Comprises the area south of the existing unnamed watercourse running through the middle of the Phase 1A site area, which naturally drains towards this watercourse, and contains future development parcels H4-H5, O1-O6, K1-K3, L1, and adjacent lengths of the proposed Primary Road.
- Catchment Area 3: Comprises the area towards the north-east of the Phase 1A site area, which naturally drains towards the existing drainage ditch forming the boundary between the golf course and the existing dwellings fronting on to Rusper Road, and contains future development parcels J1-J6, K4-K6, L2-L4, and, and adjacent lengths of the proposed Primary Road.
- Catchment Area 4: Comprises the area at the far eastern end of the Phase 1A site area towards the proposed Rusper Road junction, which naturally drains towards an existing drainage ditch believed to be present alongside Rusper Road and contains adjacent lengths of the proposed Primary Road.

For each of these four catchments, the catchment area and resultant QBAR greenfield runoff rate are stated in Table 3 below.

Table 3 Summary of Phase 1A Surface Water Drainage Catchments

Catchment	Proposed Drainage Catchment Area (ha)		QBAR Greenfield Runoff Rate (l/s)
	Primary / Secondary Roads	Future Development Parcels	
Catchment Area 1	0.578	0	3.3
Catchment Area 2	1.406	7.869	47.4
Catchment Area 3	0.788	9.069	51.4
Catchment Area 4	0.440	0	2.3

The drainage sub catchments are shown on drawing 1005113-ARC-050-XX-DR-00003 in Appendix D. The drawing also shows the extents of retained existing vegetation outside of the Phase 1 boundary and associated land drainage connections.

The layout of piped surface water drainage networks has been further developed, with a separate network for each of the four catchment areas described above proposed generally within the Phase 1A Primary & Secondary Road corridors. It is presumed that the future development parcels adjacent to the Primary & Secondary Roads will attenuate surface water runoff via various SuDS techniques, and only discharge surface water at the equivalent QBAR greenfield runoff rate into the strategic piped networks proposed within the Phase 1A road corridors. In addition to the four catchment areas described above, a small number of development parcels have been identified that naturally fall towards unnamed watercourses / ditches which form part of the boundary of these parcels. In these cases, it would suit the topography and proposed drainage levels for these parcels to fully attenuate themselves and have separate outfalls directly to the adjacent watercourses / ditches. These parcels are H1-H3, I1, I2, P1 (Secondary School) and Q1 (Primary School).

Runoff from the Phase 1A highways will typically be conveyed to the SuDS zones proposed along both sides of the Primary and Secondary Roads. In these SuDS zones, it is proposed that bio-retention / rain garden features are provided, interspersed with trees, which will reflect the design intent understood to be proposed in the West of Ifield Design Code (refer Figure 8). The SuDS features would manage flooding from the lower range of storm events and aim to retain the first 5mm of runoff. These features will be designed to discharge flows to the main piped networks but will intercept flows and significantly increase times of entry.

Each of the four main piped networks will convey flows towards the existing unnamed watercourses / ditches within or immediately adjacent to the Phase 1A site area. Close to the point of discharge to these existing watercourses, additional attenuation will be required. This would be in the form of either detention basins, and/or below ground attenuation tanks to suit the development proposals in each plot.

A proposed Surface Water Drainage Layout for Phase 1A, utilising the different SuDS techniques described above, is shown on Arcadis drawing 10051123-ARC-050-1A-DR-CE-00001 and drawings 10051123-ARC-050-1A-DR-DE-00013-00018, which is included in Appendix D. A summary of each of the proposed SuDS techniques is shown in Table 2 on the following page.

The proposed Primary and Secondary roads towards the north of the Phase 1A area cross over the existing unnamed watercourse that forms the northern boundary of the existing golf course. Culverts have been proposed under these two roads to convey the water within the existing watercourse and based on the size and assessed flows of the existing watercourse, the proposed culverts have been sized to ensure adequate flow capacity. These two culvert locations are shown on the Phase 1A Surface Water Drainage drawing in Appendix D.

The West of Ifield Design Code (Draft V0.3, dated 5th June 2023) contains a typical street cross-section for the Phase 1A Primary Street, which indicates the presence of a SuDS / planting / parking zone on both sides of the road. This typical section indicates these zones being 5.5m wide, although the road corridor widths indicated on the Illustrative Masterplan shows this width varying between 3.0m and 5.5m. The image extract below indicates a SuDS scheme including a variety of planting including bio-retention, rain garden type features.

Figure 7 Typical Primary Street Cross-Section (taken from West of Ifield Design Code, Draft V0.3)

7.3 Proposed Surface Water Modelling

Hydraulic network models for the Phase 1A area have been prepared using InfoDrainage software. This has enabled a determination of the volume and required land take for the main SuDS features to be calculated, based on providing sufficient storage volume to safely restrict rates of runoff from the development to QBAR greenfield rates for all storm events up to and including 1 in 100-year storm events, including a 40% allowance for climate change, as required by national and local planning policies. The required land take for these SuDS features will need to be considered as a constraint which will need to be accommodated within any further development of the masterplan layout for the proposed development. Details of the calculation results for the Phase 1A modelling are contained in Appendix E.

Within these calculations additional storage is included within the proposed bio-retention features within the SuDS zones along the main highway corridors.

Table 4.1 below sets out the principles for the SuDS features to be used in Phase 1A.

Table 4.1 Suitable SuDS Components to be Incorporated into Proposed Phase 1A Design

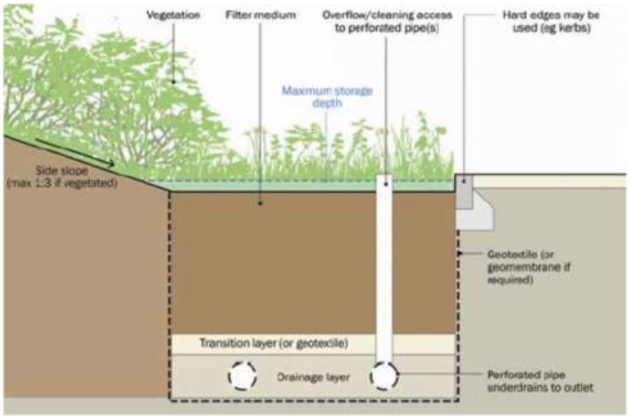
<table>
<tr>
<td>BIO-RETENTION / RAIN GARDENS


Image Ref: CIRIA Report C753 – The SuDS Manual v6</td>
<td>Bioretention features (including rain gardens) are shallow landscaped depressions that can reduce runoff rates and volumes and treat pollution through the use of engineered soils and vegetation. The filtered runoff is either collected using an underdrain system or allowed to infiltrate to the underlying substrata.

They are particularly effective in delivering interception and can also provide attractive landscape features that are self-irrigating and fertilising, provide habitat and biodiversity, and provide colling of the local microclimate due to evapotranspiration.

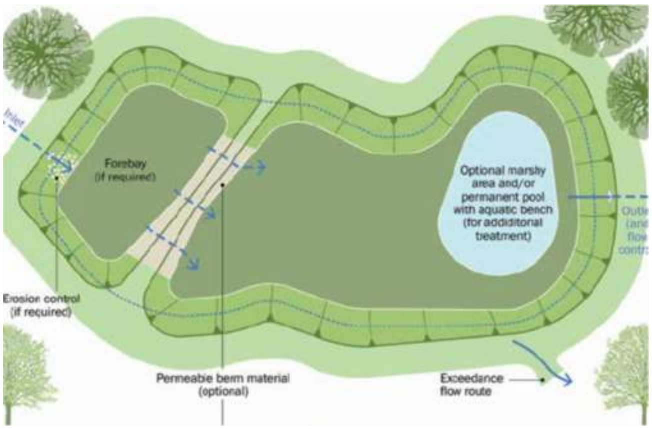
The filtered runoff is either collected using an underdrain system or allowed to infiltrate to the underlying substrata. They are generally used for managing and treating runoff from frequent rainfall events, and where larger events are directed to the system, it may be more appropriate to pass runoff from extreme events directly to downstream components further downstream via an overflow or bypass.</td>
</tr>
<tr>
<td>DETENTION BASINS


Image Ref: CIRIA Report C753 – The SuDS Manual v6</td>
<td>Detention basins are landscaped depressions that are normally dry except during and immediately following storm events. They can be on-line components where surface runoff from regular events is routed through the basin and when the flows rise, because the outlet is restricted, the basin fills and provides storage of runoff and flow attenuation. They can also be off-line components into which runoff is diverted once flows reach a specified threshold.

Where the basin is vegetated, the soil surface can absorb some runoff, so can be used to support the prevention of runoff from the site for small rainfall events (interception). Water quality benefits of vegetated detention basins are principally associated with the removal of sediment and buoyant materials, but levels of nutrients, heavy metals, toxic materials and oxygen demanding materials may also be significantly reduced. Where designed appropriately, some or all of the basin area can also be used as a recreational or other amenity facility. Off-line detention basins can also be created in hard landscaped amenity areas, although these will not provide any treatment of runoff.</td>
</tr>
</table>

BELOW GROUND ATTENUATION TANKS  Image Ref: CIRIA Report C753 – The SuDS Manual v6	Attenuation storage tanks are used to create a below-ground void space for the temporary storage of surface water before infiltration, controlled release or re-use. The storage structure is usually formed using one of the following methods: • Geocellular “crate” systems • Oversized pipes • Plastic corrugated arch structures (constructed over and backfilled with an open-graded aggregate base) • Precast or in situ concrete box culverts / tanks • GRP tanks Their inherent flexibility in size and shape means that they can be tailored to suit the specific characteristics and requirements of any site. However, when used in isolation, they do not provide any effective treatment of runoff. Careful consideration also needs to be given to the maintenance requirements as access to many such systems is limited.

7.4 Future development flows

Within the hydraulic model, an allowance has been made for incoming flows from the future development parcels adjacent to Phase 1A. These flows have been introduced by adding an inflow to the network at the expected point of connection between the future phase and the Phase 1A network. Due to the size of these incoming catchments, a time of concentration has been determined using Friend’s equation within the InfoDrainage software to provide a more accurate estimate of the incoming rainwater from the future phases. A flow control device is also included along with a storage tank in order to limit flows to the QBAR rate as per the development drainage design criteria. These flow control devices and storage tanks are used for modelling purposes only and the future phase drainage design will need to be modelled as part of the future phase design.

.

7.5 Water Quality

Pollution control measures will need to be included to minimise the risk of contamination or pollution emanating from surface water runoff from the development entering the receiving watercourse. The onsite surface water drainage system hase been designed to comply with the requirements of the SuDS treatment train as laid out by CIRIA SuDS Manual.

The proposed highway, with inherently higher numbers of vehicular traffic, will require additional treatment stages compared to the other development areas. The proposed bio-retention zones would provide initial treatment and conveyance of runoff from the highways, and downstream detention basins would provide a further treatment stage as well as final attenuation (discharge control). The level of treatment provided by alternative below ground attenuation tanks would be reduced, and additional treatment by proprietary systems would be included if required.

8 Operation and Maintenance

8.1 SuDS Maintenance Schedule

The maintenance of drainage and SuDS features is vital to ensure that they work as efficiently as intended during operation. Maintenance activities can be broadly defined as:

- Regular maintenance – basic tasks carried out regularly.
- Occasional maintenance – tasks that are required periodically but on a much less frequent basis.
- Remedial maintenance – tasks required when a fault needs rectifying and often includes unforeseen events.

This section highlights the typical maintenance requirements for the SuDS systems incorporated into the proposed drainage system for the development, as set out in the SuDS manual. During construction the contractor will be responsible for the maintenance of the drainage system. Upon completion of the construction work that responsibility would pass to the adopting highway authority (WSCC) on handover and opening of the highways. Unadopted features would be maintained by a management company and a more detailed site-specific SuDS Maintenance Schedule will need to be developed as part of the next stage.

8.1.1 Trees

Table 4.2: Typical Operation and Maintenance Requirements, Trees

Trees – Operation and maintenance requirements in accordance with CIRIA C753 – The SuDS Manual		
Maintenance Schedule	**Required Action**	**Frequency**
Regular Maintenance	Remove litter and debris	Monthly (or as required)
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets and outlets	Inspect monthly
Occasional maintenance	Check tree health and manage tree appropriately	Annually
	Remove silt build-up from inlets and surface and replace mulch as necessary	Annually, or as required
	Water	As required (in periods of drought)
Monitoring	Inspect silt accumulation rates and establish appropriate removal frequencies	Half yearly
Trees will be maintained by the adopting authority		

8.1.2 Bioretention Systems

Table 5: Typical Operation and Maintenance Requirements, Bioretention Systems

Bioretention systems – Operation and maintenance requirements in accordance with CIRIA C753 – The SuDS Manual		
Maintenance Schedule	**Required Action**	**Frequency**
Regular inspections	Inspect infiltration surfaces for silting and ponding, record de-watering time of the facility and asses standing water levels in underdrain (if appropriate) to determine if maintenance is necessary	Quarterly
	Check operation of underdrains by inspection of flows after rain	Annually
	Assess plants for disease infection, poor growth, invasive species etc and replace as necessary	Quarterly
	Inspect inlets and outlets for blockage	Quarterly
Regular maintenance	Remove litter and surface debris and weeds	Quarterly (or more frequently for tidiness or aesthetic reasons)
	Replace any plants, to maintain planting density	As required
	Remove sediment, litter, and debris build-up from around inlets or from forebays	Quarterly to biannually
Occasional maintenance	Infill any holes or scour in the filter medium, improve erosion protection if required	As required
	Repair minor accumulations of silt by raking away surface mulch, scarifying surface of medium and replacing mulch	As required
Remedial actions	Remove and replace filter medium and vegetation above	As required but likely to be > 20 years
Bioretention systems will be maintained by the adopting authority		

8.1.3 Detention Basins

Table 6: Typical Operation and Maintenance Requirements, Detention Basins

Detention basins – Operation and maintenance requirements in accordance with CIRIA C753 – The SuDS Manual		
Maintenance Schedule	**Required Action**	**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 yearly (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, & appropriate 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, outlet and forebay	Annually (or as required)
	Managed wetland plants in outlet pool – where provided	Annually (as set out in chapter 23)
Occasional maintenance	Reseed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every 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 for effective upstream source control is provided)
Remedial actions	Repair erosion or other damage by reseeding or re-turfing	As required
	Realignment of riprap	As required
	Repair/ rehabilitation of inlets, outlets, and overflows	As required
	Revel uneven surfaces and reinstate design levels	As required
Detention basins will be maintained by the adopting authority		

8.1.4 Attenuation Storage Tanks

Table 7: Typical Operation and Maintenance Requirements, Attenuation Storage Tanks

Attenuation storage tanks – Operation and maintenance requirements in accordance with CIRIA C753 – The SuDS Manual		
Maintenance Schedule	**Required Action**	**Frequency**
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae, or other matter; remove and replace surface infiltration medium as necessary	Annually
	Remove sediment from pre-treatment structures and/ or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows, and vents	As required
Monitoring	Inspect/ check all inlets, outlets, vents, and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required
Refer to manufacturer's requirements for detailed specification and frequencies for the required maintenance		
Attenuation storage tanks will be maintained by the adopting authority if acceptable, if not by suitable estates management company		

8.2 SuDS Construction

The construction of SuDS usually only requires the use of standard civil engineering and landscaping operations, such as excavation, filling, grading, top soiling, seeding, planting etc. These operations are specified in various standard construction documents, such as the Civil Engineering Specification for the Water Industry (CESWI) and specification for Highway Works (SHW).

Water contaminated with silt must not be allowed to enter drains as it may cause pollution. All parts of the drainage system must be protected from construction runoff to prevent silt clogging the system and causing pollution downstream. Measures to prevent this include soil stabilisation, early construction of sediment management basins, channelling runoff away from surface water drains, and erosion prevention measures.

After the end of the construction period and prior to handover to the site owner/operator:

- Subsoil that has been compacted during construction activities should be broken up prior to the reapplication of topsoil to garden areas and other areas of public open space.
- Any areas of the SuDS that have been compacted during construction but are intended to permit infiltration must be completely refurbished,
- Checks must be made for blockages or partial blockages of flow controls or pipe systems,
- Any silt deposited during the construction must be completely removed,
- Soils must be stabilised and protected from erosion whilst planting becomes established.

Detailed guidance on the construction related issues for SuDS is available in the SuDS Manual (CIRIA C753 2015).

9 Foul Drainage

9.1 Existing Foul Water Network

Thames Water are the public sewerage undertaker in the area, and their asset record plans show that there is a foul/combined 675mm diameter trunk sewer running northwards adjacent to Ifield Brook, close to the eastern boundary of the outline application site, and approximately 275m east of the eastern end of the Phase 1 Primary Street. The trunk sewer connects to the Crawley Sewage Treatment Works located 6km northeast of the site. Initial enquires with Thames Water have confirmed that the trunk sewer would form a suitable point of connection subject to phasing and upgrade.

The asset plans also show the presence of an existing foul connection extending into the eastern end of the Phase 1 site, which appears to serve the existing Ifield Golf Club clubhouse. This is a 150mm diameter pipe, and whilst the asset plans do not state an invert level at this point on the sewer network, it is the head of a run and being relatively shallow, it has been discounted as a possible point of connection for flows from the development.

9.2 Design Criteria

The foul water (FW) drainage design has been based on criteria stated within Water UK – Sewerage Sector Guidance (Appendix C) for dwellings and guidance within the British Services Research and Intelligence Association (BSRIA – 5^{th} Edition), used to calculate flow rates for the commercial development parcels.

Within Sewerage Sector Guidance, Clause B3.2 states the design flow rates for dwellings is to be 4000 litres per dwelling per day with the below formula used to calculate the flow rate:

$$\text{Foul flow rate (l/s)} = \frac{Flow\ per\ dwelling \times number\ of\ Dwellings}{86400}$$

Within the BSRIA, Rule of Thumb 5th Edition, the below formula has been utilised to calculate the flow rates and is detailed below:

$$\text{Flow rate (l/s)} = \frac{\frac{Gross\ floor\ area}{Assumed\ building\ population\ density} \times Daily\ water\ consumption\ per\ person}{Water\ consumption\ daily\ hours \times 60 \times 60}$$

The calculation for the flow rate for the school parcels is as per the below formula:

$$\text{Foul flow rate (l/s)} = \frac{Total\ population \times estimated\ water\ consumption \times peaking\ factor}{\text{Water consumption daily hours} \times 60 \times 60}$$

9.3 Foul Drainage Strategy

Foul sewerage infrastructure is to be constructed within the Phase 1 Primary and Secondary Streets to serve future adjacent development parcels shown on the Indicative Masterplan for the outline elements of the application. This system is designed to discharge via a new connection to the existing Thames Water 675mm diameter public sewer network further east on Rusper Road.

The foul sewer system within the Phase 1 Primary and Secondary Streets will provide for future foul flows from the following parcels shown on the Indicative Masterplan and Appendix H for the outline elements of the application:

Table 8: Land parcel designated development type

Plot Reference	Plot Use
O1-O6	Housing development
L1-L4	Housing development
K1-K6	Housing development
J1-6	Housing development
I1	Housing development
G1-5	Housing development
H1-2 and H4-5	Housing development
H1-5	Commercial development
P1	School plot
Q1	School plot

In overview, the proposed foul drainage system would comprise of main sewers located within the Phase 1 road corridor, sewer pipe number 23.000-23.018 and 1.019- 1.024, with sewers spurs extending to the plot boundaries for gravity connections of the future development areas. Due to the site topography relative to the levels of the existing Thames Water sewer at the proposed point of connection, foul flows from the future development parcels located to the north of the Phase 1 Primary Street will need to discharge to a proposed pumping station, with the remaining foul water sewers to the south of the main spine road connecting and discharging via a gravity sewer system

The pumping station is located to the west of the Phase 1 Primary Street, adjacent to Parcel H1 (referenced on the Indicative Masterplan of the outline elements of the application). The proposed pumping station is approx. 5.5m deep and would incorporate emergency storage in an adjacent offline tank sewer. The outlet from the pumping station transfers the flows from the northern plots via a pumping main in the Phase 1A road corridor which discharges to the proposed main gravity sewer at chamber F107a. The main gravity sewer is located within the Phase 1A spine road and flows eastwards to the proposed point of connection into the existing Thames Water trunk sewer.

The FW drainage strategy layouts for the Phase 1 development are included in Appendix H. Drawing 10051123-ARC-050-1A-DR-DE-00030 shows the FW drainage overview for Phase 1, with drawing 10051123-ARC-050-1A-DR-DE-00042 showing the modelled FW network including the future plot catchments.

Appendix I contains the design calculation and Microdrainage model that has been prepared to size the FW sewers and spurs within Phase 1.

Based on the quantum of development proposed in the above parcels, as listed in the proposed Development Schedule for the outline elements of the application, the foul sewerage system being constructed as part of the Phase 1 works will be designed to eventually convey a peak flow rate of 90l/s. Based on the equations contained within section 9.2, the flow rate for each development parcel is indicated in tables 9, 10 and 11 below.

A Pre-Planning Enquiry has been submitted to Thames Water relating to the Phase 1 foul flows and the proposed Point of Connection on Rusper Road, which is to Thames Water manhole 4601. Thames Water have advised that there may be insufficient spare capacity in their existing foul sewer network for the proposed Phase 1 development flows and have been carrying out modelling assessments to consider potential options for upgrade works in response to an earlier Pre-Planning Enquiry submitted for the full and outline elements of the application.

Residential Developments

Table 9: Residential Development calculated flow rates

Plot	Number of dwellings	Flow rate (l/s)	Plot	Number of dwellings	Flow rate (l/s)
O1	32	1.48	**J1**	22	1.01
O2	12	0.50	**J2**	43	1.99
O3	5	0.23	**J3**	22	1.01
O4	25	1.15	**J4**	17	0.78
O5	22	1.01	**J5**	18	0.83
O6	26	1.20	**J6**	10	0.46
L1	27	1.25	**I1**	14	0.64
L2	40	1.85	**H1**	131	6.06
L3	18	0.83	**H2**	189	8.75
L4	27	1.25	**H4**	83	3.84
K1	26	1.20	**H5**	93	4.30
K2	29	1.34	**G1**	22	1.01
K3	21	0.97	**G2**	12	0.90
K4	34	1.57	**G3**	26	1.20
K5	37	1.71	**G4**	45	2.08
K6	15	0.69	**G5**	22	1.01

Commercial Development Flow Rates

Table 10: Commercial Development calculated flow rates

Plot	Land use	Gross floor area (m^2)	Assumed population density (m^2 per person)	Water consumption per person (l/person)	Flow Rate (l/s)
H1 (Pipe 35.008)	Mixed use	15365	20	45	1.2
H2 (Pipe 48.000)	Mixed use (food store and commercial uses)	24000	20	45	2
H3 (Pipe 46.002)	Mixed use (Innovation centre)	3500	30	6	0.1
H4 (Pipe 51.000)	Mixed use (Nursery, community centre, commercial)	14080	20	45	1.1
H5 (Pipe 50.000)	Mixed use (Leisure centre, Health centre, Commercial)	12750	30	88	1.3

School Development Flow Rates

Table 11: School Plot calculated flow rates

Plot	Land use	Estimated total population	Estimate water consumption (l/person/day)	Flow Rate (l/s)
P1 (Pipe 49.000-49.003)	School	600	50	18.8
Q1 (Pipe 45.000)	School	1800	50	6.2

9.4 Adoption and Maintenance

The piped gravity drainage will be designed in accordance with Sewerage Sector Guidance for Adoptable Sewers and will be offered for adoption to Thames Water. The pumping station and rising main would be delivered to an adoptable standard for future maintenance by Thames Water.

10 Conclusions and Recommendations

This report has set out the principles of the developed drainage strategy for management of surface water and foul drainage from the development for Phase 1.

The key design principles for the surface water design are:

- The site is mostly within Flood Zone 1 and therefore at minimal risk of fluvial flooding. Some localised areas of surface water flooding are present related to smaller unnamed watercourses and drainage ditches within the site, but these are not considered to pose a significant risk to the development.
- Reasons have been discussed as to why some elements of the outline strategy for the discharge of surface water from Phases 1A and 1B required further development for deliverability. The developed drainage proposals have taken forward the global parameters in the outline strategy further considering Phase 1 phasing. It is proposed to more closely mimic the existing hydrology of the site by utilising the existing land drainage network of ditches through the site, resulting in additional catchments and outfalls with lower discharge rates.
- Strategies have been presented utilising various Sustainable Drainage Systems, to manage and attenuate the increase in surface water runoff onsite. The SuDS features proposed for Phase 1 are positioned relative to the Illustrative Masterplan arrangement and SuDS proposals within individual plot areas will be developed in detail as part of the respective future phases.

The key design principles for the foul water design are:

- There is an existing Thames Water foul/combined 675mm diameter trunk sewer running northwards adjacent to Ifield Brook, close to the eastern boundary of the outline application site, and approximately 275m east of the eastern end of the Phase 1 Primary Street.
- A pumping station is proposed to lift foul water flows to a level that is able to connect to the existing Thames Water foul sewer by gravity. A portion of the future development area is able to make a connection without passing through this pumping station and connects to the proposed main gravity sewer.
- Thames Water have advised that there may be insufficient spare capacity in the existing foul sewer network for the proposed flows depending on phasing and are carrying out modelling assessments to consider potential options for upgrade works in response to an earlier Pre-Planning Enquiry submitted for the full and outline elements of the application.

.

Appendix A

Illustrative Masterplan

Appendix B

Arcadis Phase 1A Existing Topography & Hydrology Drawing

Appendix C

Ramboll Outline Surface Water Drainage Strategy Drawings

Appendix D

Proposed Phase 1A Surface Water Drainage Drawings

Appendix E

Proposed Phase 1A Surface Water Drainage Calculations

Appendix F

Proposed Phase 1B Surface Water Drainage Drawings

Appendix G

Proposed Phase 1B Surface Water Drainage Calculations

Appendix H

Phase 1 Foul Water Strategy Layout

Appendix I

Phase 1 Foul Water Drainage Calculations

Arcadis Consulting (UK) Limited

80 Fenchurch Street
London EC3M 4BY
United Kingdom

T: +44 (0)20 7812 2000

arcadis.com