Oxfordshire Cotswolds Garden Village Strategic Sustainable Drainage Strategy

Final report

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West Oxfordshire District Council

JBA Project Manager

Fiona Hartland

Revision History

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Contract

This report describes work commissioned by Chris Hargraves by an email dated 31 May 2019. Anna Beasley, Fiona Hartland and Kirstie Murphy of JBA Consulting carried out this work.

Prepared by .... Fiona Hartland MSci

Analyst

Reviewed by .... Anna Beasley BSc MSc CEnv MCIWEM C.WEM

Technical Director

Purpose

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Abbreviations

AAP	Area Action Plan
BGS	British Geological Survey
FEH	Flood Estimation Handbook
NPPF	National Planning Policy Framework
OCGV	Oxfordshire Cotswold Garden Village
SuDS	Sustainable Drainage System(s)

1 Introduction

JBA Consulting was commissioned by West Oxfordshire District Council, as part of the Oxfordshire Cotswold Garden Village (OCGV) Area Action Plan (AAP), to carry out a Strategic Sustainable Drainage Strategy for the OCGV site, near Eynsham, Oxfordshire.

Plans for the site are at an early strategic definition stage, with an issues consultation taking place in 2018 and most recently a community forum design charrette held in May 2019 to gather stakeholder's ambitions and hopes for the site. The vision emerging is one of a climate resilient development with a low carbon footprint and high environmental credentials, which an exemplar sustainable drainage design can help to deliver. WODC is currently producing an Area Action Plan (AAP) to set out in more detail how this will be achieved.

Consideration of 'where the water will go' at design brief/masterplanning stage in the development, alongside early landscape, visual impact and public realm planning will enable a water sensitive design for the development. This will unlock opportunities for the integration of blue and green infrastructure in order to maximise the multiple benefits it can deliver while optimising the use of space.

This report broadly follows the methodology set out in the UK's best practice guidance, the CIRIA SuDS Manual[1] (Chapter 7) for a concept drainage strategy, but at a strategic level.

2 Strategic surface water management objectives

2.1 Strategic planning objectives

The West Oxfordshire Local Plan 2031 outlines a number of core objectives towards which an exemplar sustainable drainage design can contribute:

- CO11 Maximise the opportunity for walking, cycling and use of public transport.
- CO12 Look to maintain or improve where possible the health and wellbeing of the District's residents through increased choice and quality of shopping, leisure, recreation, arts, cultural and community facilities.
- CO14 Conserve and enhance the character and significance of West Oxfordshire's high quality natural, historic and cultural environment – including its geodiversity, landscape, biodiversity, heritage and arts – recognising and promoting their wider contribution to people's quality of life and social and economic well-being both within the District and beyond.
- CO15 Contribute to reducing the causes and adverse impacts of climate change, especially flood risk.
- CO16 Enable improvements in water and air quality.
- CO17 Minimise the use of non-renewable natural resources and promote more widespread use of renewable energy solutions.
- CO18 Improve the sustainable design and construction of new development, including improving energy, water efficiency and water management.

In addition, sustainable drainage can help to meet Policy OS1 - Presumption in favour of sustainable development, in particular by:

- Reducing the current risk of flooding where possible and ensuring that new development does not increase that risk;

1 CIRIA (2015) The SuDS Manual (C753)

- Reducing the impact of development on climate change and ensuring that new development is able to respond to future change through appropriate design and adaptation;
- Improving the health of local communities including tackling obesity;
- Protection and enhancement of the District's rich historic and natural environment.

Sustainable drainage can also contribute to meeting the 'Garden Communities Qualities' set out in the Garden Communities Prospectus[2], including (g) Healthy places, (h) Green space and particularly (j) Future-proofed, which covers 'the impacts of climate change including flood risk and water availability.

Sustainable drainage can help to deliver the aims of other plans and policies such as the Council's Climate Change Policy 2008-2012 and the Oxfordshire Biodiversity Action Plan.

The requirement for sustainable drainage that provides multiple benefits is also set out in the National Planning Policy Framework (NPPF) (para 163 and 165). The emerging Environment Bill will also place much more importance on the delivery of biodiversity net gain by new development and the valuation of natural capital.

2.2 SuDS standards

Under the current system, SuDS are expected to comply with:

- Defra Non-Statutory Technical Standards for Sustainable Drainage Systems (2015)
- CIRIA SuDS Manual (2015)
- Oxfordshire County Council (OCC) Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire (1.0 November 2018)[3]

3 Site characteristics

A desk study of the site characteristics has been carried out for the Level 2 SFRA and developed here, to identify those which will influence the design of the sustainable drainage.

3.1 Site topography

Consideration of the site topography is key in ensuring that surface water can be drained under gravity, without the need for pumps, which are expensive to maintain and have a higher risk of failure.

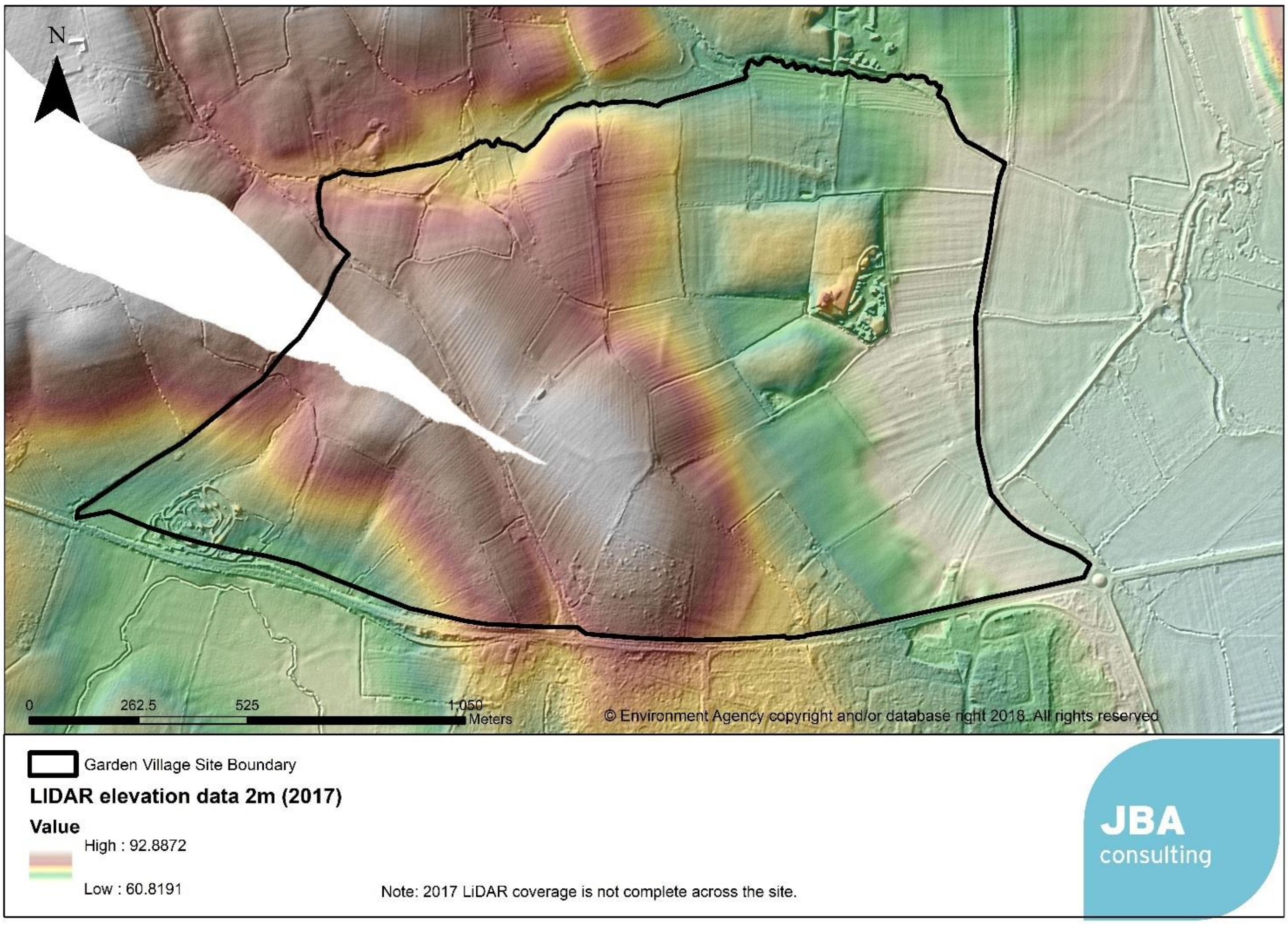
The highest area is in the central part of the site, with an elevation of 86mAOD. This higher ground slopes away in all directions, towards lower ground at the edges of the site and the floodplains of the nearby watercourses.

The available LiDAR data showing ground elevations across the site is shown in Figure 3-1. Contours and flow directions are shown on the plan at in Appendix A.

2 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/805688/Garden_Communities_Prospectus.pdf

3 https://www.oxfordshirefloodtoolkit.com/wp-content/uploads/2018/12/LOCAL-STANDARDS-AND-GUIDANCE-FOR-SURFACE-WATER-DRAINAGE-ON-MAJOR-DEVELOPMENT-IN-OXFORDSHIRE.pdf

Figure 3-1: Topography



3.2 Existing flow routes and potential for surface water discharge

The site is rural and generally in agricultural use and is currently drained mostly by small land drains, discharging to local surface watercourses, as described in the Level 2 SFRA:

- One drain joins the northern Evenlode tributary, east of Cuckoo Wood Farm.
- Two further drains form to the north and south of New Wintles Farm, and flow in an easterly direction below Lower Road, to join Eynsham Mead Ditch and the River Evenlode.
- In the south west of the site, there are five small drains flowing south towards to A40. In the western corner of the site there is a group of small of ponds, which may retain some water generated within the site before discharging under the A40 into Chil Brook.

Some of these land drains may currently slightly alter the natural topographical flow paths.

3.3 Soils, geology and potential for infiltration

3.3.1 Existing information

The majority of the site is underlain by clay bedrock (Oxford Clay Formation and West Walton Formation). A band of sandstone and siltstone (Kellaways Sand Member) runs along the northern and eastern boundary. A small area of Kellaways Clay Member is also present in the north east.

There are no superficial deposits in the western half of the site and soils underlain by the clay are slowly permeable, loamy and clayey, seasonally wet and slightly acid. These soils are likely to have poor to very poor infiltration potential (see Table 25.1 of CIRIA Manual). A map characterising soils and geology across the site based on British Geological Survey (BGS) information is shown in Figure 3-2.

The eastern part of the site is overlain by surface geology deposits. The majority are sands and gravels (Summertown-Radley Member). These deposits are associated with more freely draining, lime-rich loamy soils. In the east there is a small area of river deposits (alluvium) comprising of clay, silt, sand and gravel, which has loamy soil with naturally high groundwater which may limit infiltration. These areas have been identified by the Level 2 SFRA as being at risk from high groundwater levels in the gravels (groundwater emergence at the surface in the 100-year event). The highest risk area is shown in Appendix A.

There are two historic industrial landfill sites of New Wintles Farm and City Farm located within the site (shown in Appendix A). These are located over the eastern more permeable gravel deposits.

The site is not within a Groundwater Source Protection Zone, therefore there are unlikely to be any water quality constraints on shallow infiltration techniques.

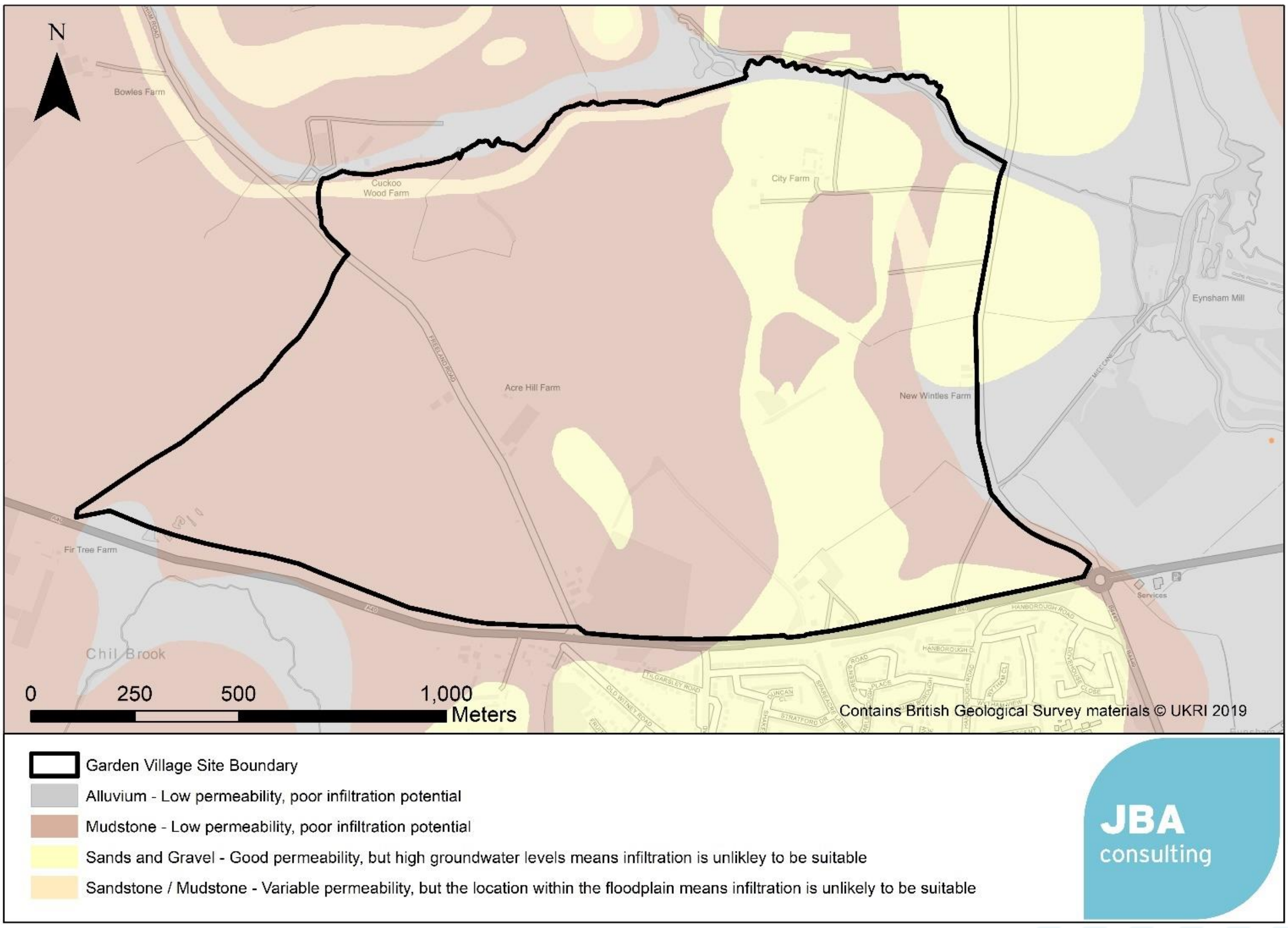
3.3.2 Site investigations

Infiltration potential will vary considerably across the site, even within these different geology/soil type zones. It is recommended that infiltration testing is carried out across the site as early as possible to establish any areas that may be suitable for infiltration SuDS features. Locating and utilising any potential for infiltration will ultimately make the system more cost effective, as it will reduce the need for large scale attenuation storage.

Groundwater monitoring should be carried out over the winter period for as long as possible to establish the potential groundwater levels that may be reached in a normal year, but designs should account for higher levels in an extreme event.

A contaminated land survey will be necessary to establish the condition of the historic landfill sites and any constraints in terms of infiltration/SuDS features in these areas.

Figure 3-2: Soil and geology



3.4 Fluvial and surface water flood risk

The flood risks on site have been outlined in detail in the Level 2 SFRA, and are summarised below:

- The majority of the site is in Flood Zone 1 and at low risk from fluvial flooding. Fluvial flood risk is restricted to the floodplain of the northern Evenlode tributary (Appendix A). Eynsham has experienced flooding in past events.
- There are a number of surface water flow paths that will form in extreme events, radiating away from the highest point towards the site boundaries.
- Reservoir flooding is unlikely to happen and the area at risk is limited to the fluvial flood zone.

For more detail please see the Level 2 SFRA.

3.5 Groundwater risk

Groundwater flood risk is mapped in the Level 2 SFRA. Groundwater flood risk is concentrated in a band with a north-south alignment within and adjacent to, the eastern boundary of the site. These areas correlate with sand and gravel superficial deposits. There is also an isolated area of medium to high groundwater flood risk near the centre of the site. All other areas have negligible flood risk.

High groundwater levels during extreme wet periods may render infiltration SuDS ineffective and pose a direct pollution risk to groundwater. If levels are very high, groundwater may enter the SuDS feature and reduce the storage capacity and structural integrity of the design.

3.6 Existing site land use and infrastructure

The current land use is primarily agriculture. Bordering the fields are developed hedgerows and treelines with watercourses, as well as public rights of way.

The small areas of existing development are predominantly farm buildings, several of which are listed buildings. In the south, a commercial development provides a service area for the A40. These areas are likely to have existing positive drainage systems.

Also, in the south, there is an area of community woodland owned by the Woodland Trust. A well-developed aggregate recycling centre exists in the south, which has planning permission for waste management use in perpetuity (although is recently understood to have closed).

There are a number of minor existing roads within the site.

3.7 Local habitats and biodiversity

The site is not listed within any nationally protected areas. However, as the current land use is well-developed farmland with hedgerows and trees, there are still likely to be well-established habitats and species present.

Immediately to the north of the site there are two Local Wildlife Sites (City Farm and South Freeland Meadows) recognised as of value in supporting local biodiversity.

A Preliminary Ecological Assessment has been carried out which identified great crested newts in the ponds in the south western corner of the site (Appendix A). This represents an opportunity for sustainable drainage to preserve and enhance this habitat.

There are also opportunities for well-designed sustainable drainage features to contribute to the aims of the Oxfordshire Biodiversity Action Plan.

3.8 Design considerations

Design for the site is still at a strategic stage, but the garden village will be a self-sustaining community, with residential, employment, retail, education, and recreation/leisure land uses. Green infrastructure, wildlife corridors and sustainable water management are important considerations in the place-making and design vision.

3.9 Proposed flood risk management strategy

The Level 2 SFRA makes a number of recommendations for making the site safe from flooding and not increasing flood risk downstream, which are summarised below:

- Sequential design of the site to avoid areas at high flood risk from all sources and preserve safe access and egress
- Use of best practice SuDS design, aiming to reduce runoff rates to greenfield runoff or lower.
- Existing surface water flow routes must be accommodated within the masterplan.
- The design of SuDS schemes must take into account the seasonally high groundwater table.
- The site design must ensure that flows resulting from rainfall in excess of a 1 in 100-year event are managed via exceedance routes that minimise the risks to people and property.

4 Water sensitive design criteria

The over-arching philosophy is based on the four pillars of SuDS design. Each pillar is equally important, and each has its own design criteria as set out in Part B of the CIRIA SuDS Manual (summarised in Table 4-1). These criteria ensure the if the development is designed in a water-sensitive way, it will deliver many wider additional benefits.

Specific indicators should be defined at outline stage to ensure that the design meets these criteria.

Table 4-1: SuDS design criteria

Water quantity – control the quantity of runoff
1 Use surface water runoff as a resource
2 Support the effective management of flood risk in the receiving catchment
3 Protect morphology and ecology in receiving surface waters
4 Preserve and protect natural hydrological systems on site
5 Drain the site effectively
6 Manage on-site flood risk
7 Design in system flexibility / adaptability to cope with future climate change
Water quality – manage quality of runoff to prevent pollution
1 Support the management of water quality in receiving surface waters and groundwaters (pollution prevention strategies, management of spillages, delivery of interception and treatment, sediment retention)
2 Design system resilience to cope with future change
Amenity – create and sustain better places for people
1 Maximise multi-functionality
2 Enhance visual character
3 Deliver safe surface water management systems
4 Support development resilience / adaptability to future change
5 Maximise legibility (visibility)
6 Support community environmental learning
Biodiversity - create and sustain better places for nature
1 Support and protect natural local habitat and species
2 Contribute to the delivery of local biodiversity objectives
3 Contribute to habitat connectivity
4 Create diverse, self-sustaining and resilient ecosystems

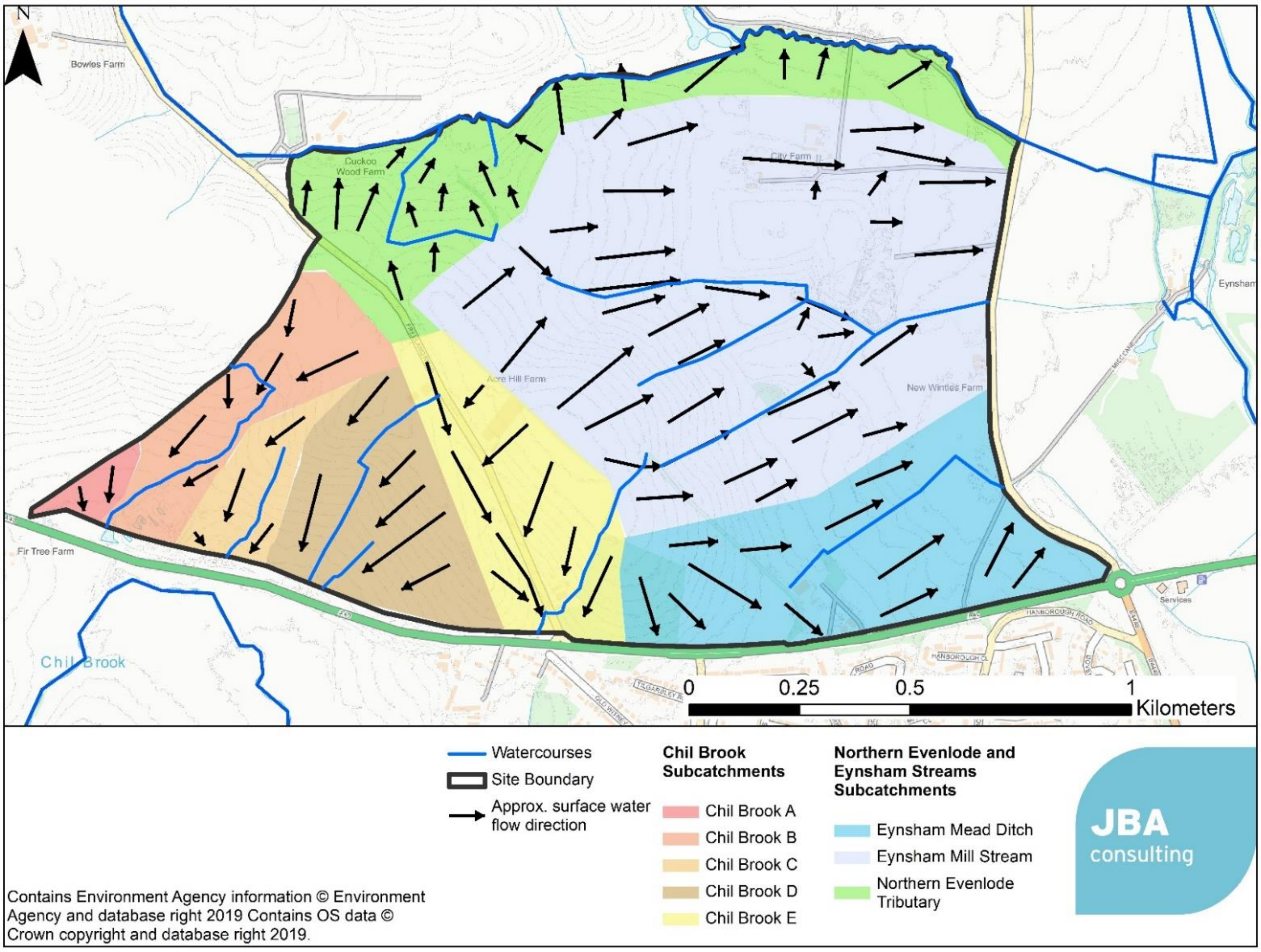
5 Surface water sub-catchments and flow routes

The first step to managing surface water runoff from development is to understand the natural flow routes and sub-catchments within the site.

5.1 Flow routes and sub-catchments

Sub-catchments have been defined using the Flood Estimation Handbook (FEH) Website and a tool in ArcGIS, based on a coarse elevation grid (Figure 5-1). These will need to be refined at outline stage, using the 1m LiDAR and topographical survey, and more detailed sub-division within these broader sub-catchments will be necessary. The natural direction of flow is also shown by arrows.

Figure 5-1: Surface water sub-catchments



The site can be broadly divided into four main sub-catchments, each draining to a different watercourse. The area draining to Chil Brook under the A40 has been subdivided further due to the number of existing small drains draining south. The area of each sub-catchment is shown in hectares in Table 5-1.

Table 5-1: Sub-catchment areas

Subcatchment		Area (ha) (within site boundary)
Northern Evenlode Tributary		30
Eynsham Mill Stream		93
Eynsham Mead Ditch		33
Chil Brook	Chil Brook A	2
	Chil Brook B	14
	Chil Brook C	6
	Chil Brook D	18
	Chil Brook E	20

5.2 Greenfield runoff rates

An initial estimate of greenfield runoff rates has been calculated using the FEH Statistical method for each catchment. A specific discharge (l/s/ha) was calculated for each FEH catchment and then multiplied by sub-catchment area. This gives indicative rates of runoff which will be permitted from the site by the LLFA, whose standards[3] stipulate that peak runoff rates should not exceed greenfield runoff rates.

These calculations should be refined at outline stage, with more detailed information on sub-catchment areas, and further validation using local data and watercourse survey.

Table 5-2: Indicative greenfield runoff rates for each sub-catchment

	Northern Evenlode Tributary		Eynsham Mill Stream		Eynsham Mead Ditch	
	Runoff rate (l/s/ha)	Runoff rate for sub catchment (l/s)	Runoff rate (l/s/ha)	Runoff rate for sub catchment (l/s)	Runoff rate (l/s/ha)	Runoff rate for sub catchment (l/s)
1 in 2-year	1.7	50	1.8	166	1.3	43
1 in 30-year	3.9	114	3.7	345	2.7	88
1 in 100-year	5.1	152	4.9	455	3.6	117
1 in 100-year + 40%CC	7.2	212	6.8	637	5.0	164

	Chil Brook (all)	Chil Brook A	Chil Brook B	Chil Brook C	Chil Brook D	Chil Brook E
	Runoff rate (l/s/ha)	Runoff rate for sub-catchment (l/s)	Runoff rate for sub-catchment (l/s)	Runoff rate for sub-catchment (l/s)	Runoff rate for sub-catchment (l/s)	Runoff rate for sub-catchment (l/s)
1 in 2-year	2.2	4	30	13	40	43
1 in 30-year	4.8	9	65	29	87	95

1 in 100-year	6.2	12	85	38	114	124
1 in 100-year + 40%CC	8.7	17	120	54	159	174

5.3 Storage volumes

An indicative estimate of the volume of storage of surface water that may be required on site based on these greenfield runoff estimates has been made using the UK SuDS tool[4]. The following assumptions were made:

- There is no site plan, and densities of development are not yet known. The baseline assumes 60% developed area, with the remaining 40% greenspace. This was sensitivity tested for +-10% difference in impermeable area (50%, 70%).
- The tool was updated with catchment-specific FEH catchment descriptors (SAAR, BFIHOST and SPRHOST)
- Assumed use of long-term storage
- 40% climate change allowance
- 10% urban creep allowance

These initial estimates must be reviewed and refined as part of the outline drainage strategy, particularly once infiltration capacity has been determined.

The results are summarised in Table 5-3. The UK SuDS tool gives a useful break-down of the potential split between interception storage, attenuation storage, long-term storage, and treatment storage. The use of long-term storage and interception storage in the design reduces the size of attenuation storage required.

On such a large site, it is helpful to express storage volumes by unit area, as this allows the designer to consider how the capacity for storage might be distributed in suitable locations across the sub-catchment, rather than simply putting all the storage in one large basin at the lowest point. Table 5-3 includes a breakdown of storage per m² and per ha for each sub-catchment.

Table 5-3: Indicative storage requirements for OCGV site sub-catchments

Sub-catchment	Inter-ception storage (m³)	Attenuation storage (m³)	Long-term storage (m³)	Treatment storage (m³)	Total Storage (m³)	Unit storage (m³ per m²)	Unit storage (m³ per ha)
Northern Evenlode Tributary	708	11,450	4,683	2,124	16,841	0.06	571
Eynsham Mill Stream	2,232	43,338	10,004	6,696	55,573	0.06	598
Eynsham Mead Ditch	790	14,580	4,290	2,369	19,660	0.06	598
Chil Brook (all)	1,440	22,631	7,053	4,320	31,124	0.05	518

4 http://www.uksuds.com/

The results were sensitivity tested with an increase in impermeable area (i.e. denser development) to 70%. This increased unit storage per hectare required to between 605m³ and 697m³ per hectare depending on the sub-catchment. A reduction to 50% impermeable area gave a unit storage per hectare of 432-497m³.

6 Discharge destination

This section addresses the 'destination hierarchy' for surface water runoff, in order of priority as set out in the CIRIA SuDS Manual Chapter 3.

6.1 Using surface water as a resource

Rainwater should be treated first as a resource, in line with water quantity design criteria 1, and the West Oxfordshire Local Plan Core Objective CO18. OCGV is in an area of water stress, which will become exacerbated by climate change in the future. Rainwater harvesting and water re-use should therefore be a priority for a climate resilient development.

This can be undertaken on a small-scale using water butts and domestic harvesting systems, but forward-thinking developments are starting to develop community scale integrated water management systems e.g. North West Cambridge (see below).

Case study: North West Cambridge Development water recycling system

The North West Cambridge Development includes the largest water recycling system in the country that aims to minimise the risk of localised flooding in an area that is already prone to flooding, whilst also reusing the water to reduce potable water consumption per person across the whole development.

https://www.nwcambridge.co.uk/vision/sustainability/water-recycling

6.2 Infiltration

The general site soil and geology characteristics are relatively impermeable, and certain areas of the site have potentially high groundwater and contaminated land. This will limit the infiltration potential.

However, if detailed site investigations are carried out at an early stage, it may be possible to identify some parts of the site that have the potential for some infiltration, which could be utilised for long-term storage for example. Locating and utilising any potential for infiltration will ultimately make the system more cost effective, as it will reduce the need for large scale attenuation storage. Any infiltration storage features must be designed to half-empty within 24 hours of a rainfall event[3].

6.3 Discharge to surface waters

Discharge to surface waters is likely to be the main discharge destination for the remaining runoff that is not intercepted or infiltrated into the ground. There are currently nine locations where existing surface water drainage (small drains and ordinary watercourses) exit the site and discharge to the local watercourses.

There is a potential for additional discharge points to be added if needed once the design develops, particularly into the northern Evenlode tributary.

The existing and potential discharge points are shown in Appendix A.

6.4 Discharge to surface water sewer

There are no existing surface water sewers on site. Discharge to a surface water sewer is unlikely to be a viable or acceptable option for this site.

7 SuDS components and the management train

7.1 Overview

The large scale and mixed use nature of the proposed site allows for a truly integrated water sensitive design, and exemplar SuDS scheme.

The natural environment is integral to the site, and important to stakeholders. Sensitively landscaped nature-based SuDS features can be implemented along blue-green corridors to enhance the natural environment. Storage and conveyance of surface water should be above-ground, 'natural' SuDS features wherever possible, such as ponds, swales and basins.

If the natural drainage paths and low spots are incorporated into the masterplan at an early stage, this allows space for SuDS to be combined with public open space and green infrastructure provision, and distributed across the site. The consideration of the management train, water treatment and native planting in the design will help to deliver high quality amenity and biodiversity net gain for the site.

Opportunities should be taken to promote education of water resources and sustainability, within the planned science park area of the development. Visible, well-signed SuDS features should be designed, and to promote community stewardship, engagement with local residents and groups should be sought on designs, where possible.

Case study: Singleton Hill, Ashford Kent (CIRIA SuDS Manual Ch 7)

Singleton Hill, Ashford, Kent

Figure 7.5 Singleton Hill (courtesy Kent County Council)

Singleton Hill is a development that considered drainage from the outset of the master plan. As a result, buildings were designed around the existing drainage routes. Maintaining these natural flow routes eliminated the need to engineer conveyance routes. The main drainage channels were developed as a greenway for pedestrian and cycle access through the development to a local commercial area. This makes walking and cycling safer on the development and reduces car usage by residents and visitors.

Case study: Houndwood, Street, Somerset (from JBA Consulting review SuDS schemes on behalf of Somerset County Council)

High quality design and place-making was clearly an important objective of this development from the very beginning as set out in the client's design brief, and this allowed the designers to include open space and surface SuDS features in the masterplan. Open SuDS features are utilised to provide amenity and biodiversity benefits, including reed bed channels, tree pits and bioretention planters in public and semi-public amenity areas.

Case study: Kingsbrook, Aylesbury

Developers are working with the RSPB to deliver a wildlife friendly development, with wildlife corridors, additional green space, planting for wildlife and wildlife homes. Sustainable drainage is helping to deliver this: "Rather than channelling rainwater straight underground into pipes, in many places it will be directed along 'rills' and 'swales' on the surface: great homes for wildlife, slowing the flow and using nature to clean the water"

https://www.kingsbrook-aylesbury.co.uk/rspb

7.2 Runoff collection and interception

Water sensitive design should aim to intercept the first 5mm of rainfall events, in order to mimic natural catchment behaviour through evapotranspiration and source control, capturing the 'first flush' of pollutants in small events.

These features will not necessarily all contribute to the storage for the site[3], but play an important role in meeting the water quality, biodiversity and amenity design criteria:

- Harvest clean roof runoff on both residential and commercial buildings wherever possible for re-use (see section 6.1)

- Use green roofs, for example on apartment blocks, commercial buildings, community buildings and other buildings in the public realm (bike stores, garages, bus stops etc)
- Source control features such as raingardens, filter strips and permeable paving.

7.3 Infiltration

Locating and utilising any potential for infiltration will ultimately make the system more cost effective, as it will reduce the need for large scale attenuation storage:

- Permeable paving on parking areas, pavements and lightly trafficked roads - OCC have a progressive stance on adopting permeable pavements and engagement should be sought at an early stage. Due to the low natural permeability, permeable paving may allow slow infiltration but will also be required to provide storage.
- Infiltration features (bioretention areas, basins and collection swales) can be used in areas where infiltration potential is higher.
- The area at risk from elevated groundwater levels is noted in Appendix A. The base of an infiltration system should be located at least 1m above the likely maximum water table. Groundwater quality protection must be considered for infiltration SuDS.

7.4 Storage

Storage should be provided within each sub-catchment for the excess greenfield runoff volume. Following interception and any infiltration, the remaining volume will need to be stored in attenuation storage:

- Permeable paving can provide a significant amount of storage under car parks and roads.
- Local detention areas and ponds
- Cascaded storage e.g. using baffles or cascades of ponds along potential green-blue corridors (see Appendix A)
- In the area at risk from elevated groundwater, shallow surface features can be lined with an impermeable layer to isolate SuDS from groundwater.
- Underground tanks and geocellular storage should not be necessary in a large greenfield site.

The volume of water generated by the development over and above the greenfield volume in a given event which cannot be infiltrated can be diverted to ‘long-term storage’ areas. These will not be filled regularly, and can have primary use as for example playing fields or parks in lower flatter areas. These are designed to be drained slowly via slow infiltration or a low discharge rate.

Location of storage within each sub-catchment should be chosen at the masterplanning stage based on natural low points and convergence points, with consideration of the needs for public open space and other site layout drivers. Distributing storage within multifunctional spaces makes the system more natural, reduces land take and the need for unsightly ‘bomb crater’ storage areas at the downstream end of the system.

Storage should not be located within the fluvial floodplain (see Appendix A), and careful consideration should be given to the design of storage in areas with high groundwater or contaminated land (see section 3.3 and 3.5).

7.5 Conveyance

Following source control, linking the remainder of the runoff to the storage requires conveyance SuDS features. For OCGV, the visual design is more likely to be 'natural' features rather than more 'urban' constructed channels and rills, for example:

- Vegetated swales
- Linear wetlands
- Naturalised channels

Conveyance features will form natural blue-green corridors through the site and can be combined with habitat corridors to deliver biodiversity, and walking/cycling routes to provide amenity benefits.

Swales and channels can be designed to act as a 'leaky system', slowly permeable to allow for some losses during conveyance.

Slopes vary across the site, with steeper areas in the centre and west and flatter areas towards the eastern border. Baffles/barriers can slow the flow and attenuate water within conveyance features in steeper locations if necessary.

The network of conveyance features within each sub-catchment should be designed at masterplanning stage. Conveyance may start small at a street level, and join larger flow routes through the site forming blue-green corridors. Potential blue-green corridors based on existing drains and natural exceedance flow paths and natural flow directions across the site are shown in Appendix A.

7.6 Exceedance routes

The designer must consider the exceedance of the system and allow designated routes for this water to flow and collect safely, without flooding any properties:

- Roads and foot/cycle paths can be used to convey exceedance flows, with adjustments to kerb heights etc, but care must be taken that thresholds of properties are not lower than road level along these routes.
- Water can be allowed to collect in areas such as car parks and public open space, as long as it remains safe and does not flood properties.

7.7 Treatment delivery

The simple index approach should be followed when designing the SuDS system (see CIRIA SUDS Manual Chapter 26), to ensure that there is sufficient treatment of the likely pollutants from the runoff surface:

- Keeping SuDS on the surface increases treatment through breakdown by exposure to light and uptake by vegetation
- Residential areas are likely to be low risk, and vegetated SuDS such as swales, basins and bioretention areas as already proposed, should provide adequate treatment
- Car parks and roads may require some additional steps such as filter strips draining to swales or permeable paving.
- If any industrial development is planned, additional consideration of water treatment will be required.
- In the vicinity of the two historic landfill sites, drainage components may need to be lined, to prevent leaching of pollutants into soils and watercourses.
- Mixing clean and more polluted runoff should be avoided.
- A larger number of treatment stages allows isolation of spillages.

8 Development phasing

At outline stage, a clear strategic surface water management strategy is required for the whole site, which sets out how the development can be carried out in phases while meeting the design criteria and ensuring the system works, managing strategic storage with plot scale storage, and addressing issues of adoption and construction. Water quality management should be delivered on individual plots.

9 Maintenance and adoption

Detailed maintenance plans should be provided at outline stage. Maintenance of on-the-surface SuDS features can be considerably less expensive than traditional drainage, as features can be kept visible and easily accessible (unlike tanks and pipes), and maintenance can generally be incorporated into normal landscaping activities, as long as the function of the features is explained to the contractor.

Permeable paving should require minimal maintenance (cosmetic sweep annually) as long as it is designed correctly for the likely loading, and constructed correctly. Suction cleaning should not be used as it weakens the structure of the paving.

Adequate and safe access to SuDS features for maintenance activities must be provided.

Adoption should be considered at as early stage as possible. Under the current system, it is likely that different parts of the system may be adopted by different organisations:

- Local Authority – public realm
- Highways Authority – highway swales and some permeable paving
- Thames Water **–** Sewers for Adoption 8 is due to be released this year, which allows water companies to adopt certain SuDS features built to specific standards.
- Management companies – can maintain remaining features under normal management contracts

10 Summary

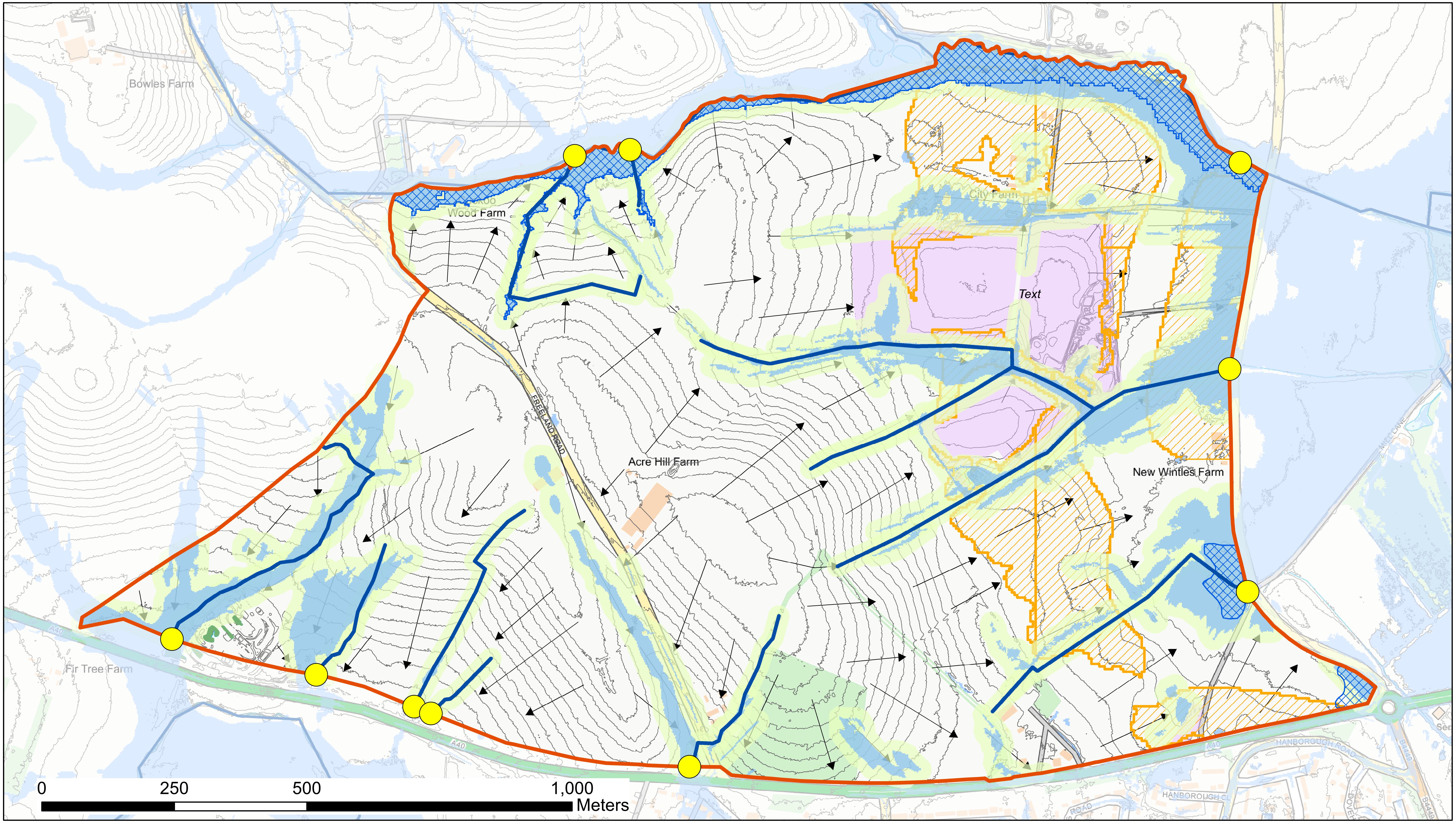
Opportunities and constraints for sustainable drainage and blue-green infrastructure at OCGV are summarised below and in Appendix A:

- Natural drainage paths and storage areas should be incorporated into the masterplan at an early stage (Appendix A). This allows space for SuDS to be combined with public open space and blue-green infrastructure provision, and distributed across the site, helping to deliver high quality amenity and biodiversity net gain for the site, while optimising the use of space.
- There are four main sub-catchments within the site (Figure 5-1), draining radially out from the highest point in the centre of the site, towards the northern Evenlode tributary, Eynsham Mill Stream, Eynsham Mead Ditch and Chil Brook. Drainage should be designed to mimic these natural drainage patterns using the topography and gravity. There are multiple discharge points to these watercourses (Appendix A).
- OCGV is in an area of water stress, which will become exacerbated by climate change in the future. Rainwater should be treated as a resource, and rainwater harvesting and water re-use should be a priority.
- Interception of runoff using green roofs and source control such as raingardens, permeable paving and filter strips should be incorporated into the design, to help mimic natural catchment behaviour through evapotranspiration and source control, capturing the 'first flush' of pollutants in small events.

- Infiltration potential is relatively low across the site. Early infiltration testing is required to locate areas with potential and maximise the infiltration from the system. Risk of elevated groundwater levels will limit the use of infiltration in the more permeable gravel areas (Appendix A).
- Location of storage within each sub-catchment should be chosen at masterplanning stage based on natural low points and convergence points, with consideration of the needs for public open space and other site layout drivers. Storage and conveyance of surface water should be above-ground, 'natural' SuDS features wherever possible, such as ponds, swales and basins, designed to deliver biodiversity and amenity benefits.
- Storage should be distributed across each sub-catchment within multifunctional spaces. The 'long-term storage' approach should be used to make the system more natural, reducing land take and the need for excessively large attenuation storage areas at the downstream end of the system.
- Storage should not be located within the fluvial floodplain, and careful consideration should be given to the design of storage in areas with high groundwater or contaminated land (Appendix A).
- Areas of contaminated land associated with the historic landfill sites (Appendix A) will limit the use of infiltration, and surface SuDS features may need to be lined.
- Conveyance features should be used to form natural blue-green corridors through the site and can be combined with habitat corridors to deliver biodiversity, and walking/cycling routes to provide amenity benefits.
- Visible, well-signed SuDS features should be designed. To promote community stewardship, engagement with local residents and groups should be sought on designs, where possible.
- At outline stage, a clear strategic surface water management strategy is required for the whole site, which sets out how the development can be carried out in phases while meeting the design criteria and ensuring the system works, managing strategic storage with plot scale storage, and addressing issues of adoption and construction. Water quality management should be delivered on individual plots.
- Maintenance plans and adopting organisations should be carefully considered at outline stage. Detailed, site-specific maintenance plans and adequate access to features should be provided.

Appendices

A SuDS opportunities and constraints map



Oxfordshire Cotswold Garden Village Sustainable drainage and blue-green infrastructureopportunities and constraints

- Potential discharge points
- Site Boundary
- Watercourses
- Flood Zone 2 - surface water storage to be located outside this zone
- Surface water flow paths (1 in 1,000-year event)
- Existing pond
- Potential blue-green corridors
- High groundwater flood risk may reduce infiltration potential
- Historic landfill site - water quality implications
- Approx. surface water flow direction

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SKIPTON
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BD23 3AE
United Kingdom

+44(0)1756 799919
info@jbaconsulting.com
www.jbaconsulting.com
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