Weetwood
Development • Planning • Environment

LAND WEST OF REDDITCH

PRELIMINARY FLOOD RISK ASSESSMENT

Draft Report v1.1

MAY 2013

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1 INTRODUCTION

Weetwood has been instructed by Heyford Developments Ltd to undertake a preliminary Flood Risk Assessment (FRA) for the proposed development of land to the west of Redditch, in accordance with the requirements of the National Planning Policy Framework (NPPF) and its supporting Technical Guidance.

1.1 SITE LOCATION

The site comprises approximately 1.45km^2 of land centred on Ordnance Survey National Grid Reference SP 010 670, as shown in **Figure 1**. The site is to the west of Redditch, in Bromsgrove District.

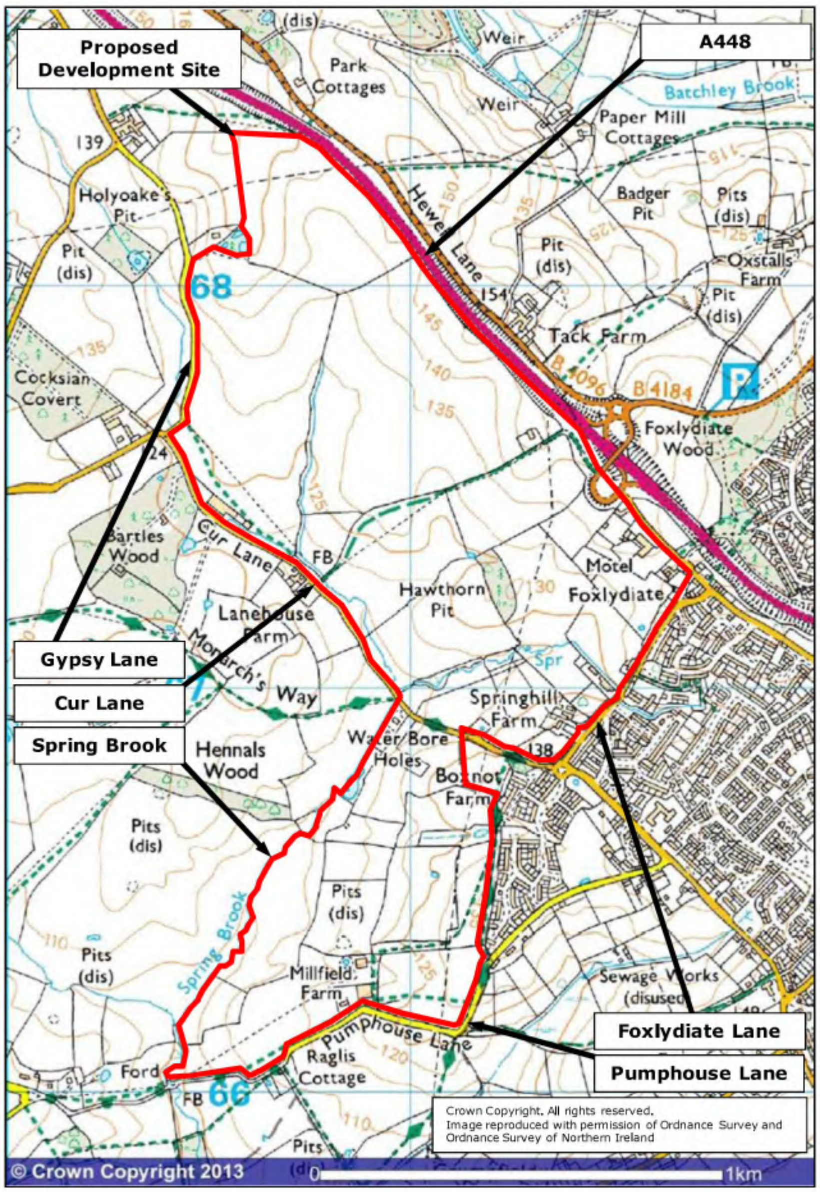

Figure 1: Site Location

The A448 is located along the northeast boundary of the site, whilst Foxlydiate Lane and the Webheath area of Redditch are to southeast of the site. Gypsy Lane, Cur Lane and Spring Brook are located along the west boundary, with Pumphouse Lane to the south.

1.2 EXISTING AND PROPOSED DEVELOPMENT

The site currently comprises agricultural land, with a small number of dwellings and agricultural buildings.

The proposals are for approximately 2830 dwellings, a first school and a local centre.

Residential units and educational establishments are classified as *'more vulnerable development'* in Table 2 of the NPPF Technical Guidance, whilst buildings used for shops, restaurants, cafes and leisure are classified as 'less vulnerable'.

1.3 SITE LEVELS

The Ordnance Survey contour lines indicate that the site levels in the northern portion of the site are in the region of 150 metres Above Ordnance Datum (mAOD) along the northeast boundary, falling in a south-westerly direction to approximately 115 mAOD adjacent to Spring Brook.

In the southern portion of the site, levels are at approximately 135 mAOD in the east, falling in a westerly direction to approximately 105 mAOD adjacent to Spring Brook.

A topographic survey of part of the site was undertaken by Monument Geomatics Ltd in October 2010 and is provided in **Appendix A**.

2 NATIONAL PLANNING POLICY FRAMEWORK (NPPF)

The aim of the NPPF and its supporting Technical Guidance is to ensure that flood risk is taken into account at all stages in the planning process and is appropriately addressed.

2.1 FLOOD ZONE DESIGNATION

Table 1 of the NPPF provides the definitions for each of the flood zones, which are summarised as follows:

- **Flood Zone 1: Low Probability.** Land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year.
- **Flood Zone 2: Medium Probability**. Land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding or between a 1 in 200 and 1 in 1000 annual probability of flooding from the sea in any year.
- **Flood Zone 3a: High Probability.** Land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
- **Flood Zone 3b: The Functional Floodplain.** Land where water has to flow or be stored in times of flood. The identification of the functional floodplain should take account of local circumstance and not be defined solely on rigid probability parameters. However, land which would flood with an annual probability of 1 in 20 or greater in any year should provide a starting point for consideration and discussion.

2.1.1 Environment Agency Flood Map

According to the Environment Agency (EA) Flood Map (**Figure 2**) the majority of the site is located in Flood Zone 1. Whilst some land immediately adjacent to Spring Brook in the southern part of the site is shown to be located in Flood Zones 2 and 3, no development will be proposed within these Flood Zones.

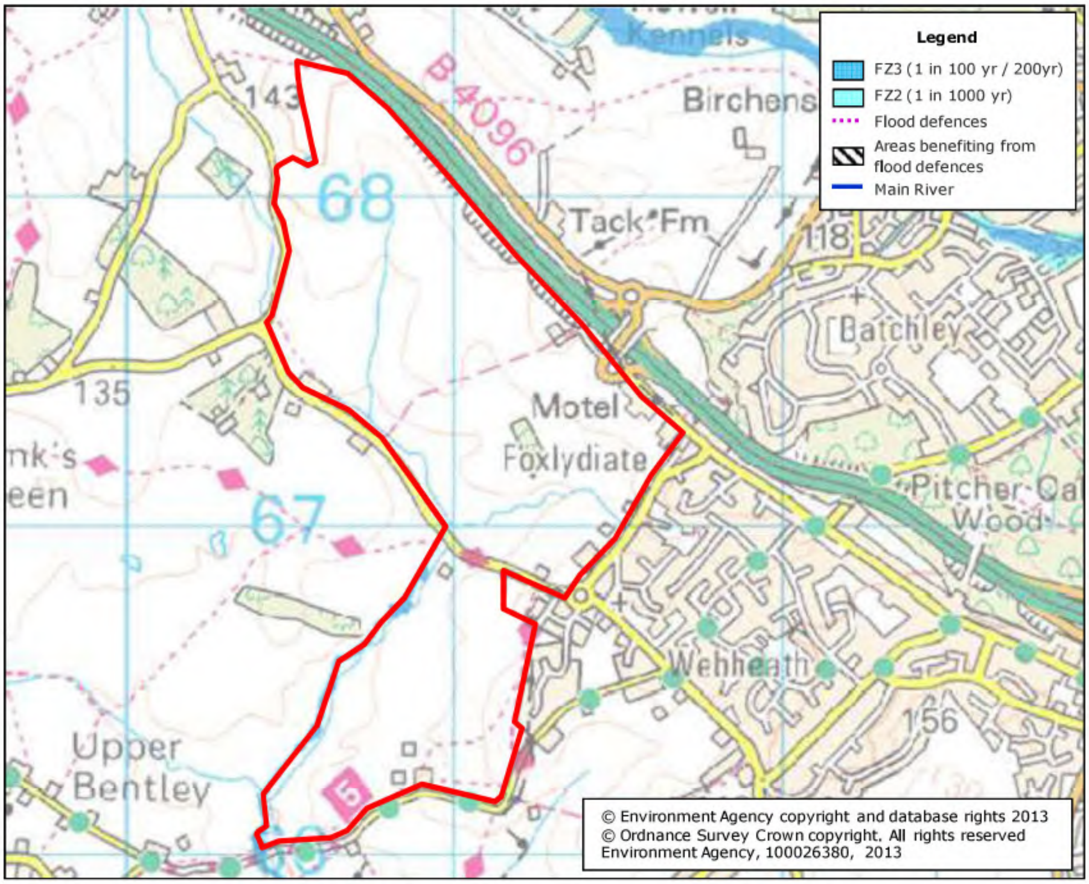

Figure 2: Environment Agency Flood Map

(Source: Environment Agency website)

2.2 SEQUENTIAL TEST

The aim of the Sequential Test (as outlined in Chapter 10 of the NPPF and paragraphs 3-5 of the Technical Guidance) is to encourage development to be located in areas at the lowest probability of flooding. The developable area of the site is situated within Flood Zone 1 and therefore satisfies the requirements of the Sequential Test.

2.3 DEVELOPMENT AND FLOOD RISK

Table 1 of the NPPF Technical Guidance states that for development proposals on sites in Flood Zone 1 comprising one hectare or above, the vulnerability to flooding from other sources and the effect of the new development on surface water runoff should be incorporated in a FRA.

Other potential sources of flooding are discussed in **Section 3** of this report. The effect of the new development on surface water run-off is addressed in **Section 4**.

3 FLOOD RISK

3.1 HISTORICAL RECORDS OF FLOODING

A Level 1 Strategic Flood Risk Assessment (SFRA) was published by Redditch Borough Council and Bromsgrove District Council in January 2009. Locations and forms of historic flooding recorded in the SFRA are shown in **Figure 3**. No flooding incidents have been recorded within the site. An incident of foul sewer flooding near the east boundary of the site has been recorded. Historic flooding point 35, located on Church Road in Webheath to the east of the site, was caused by localised surface water flooding in July 2007 when 1 property was flooded internally.

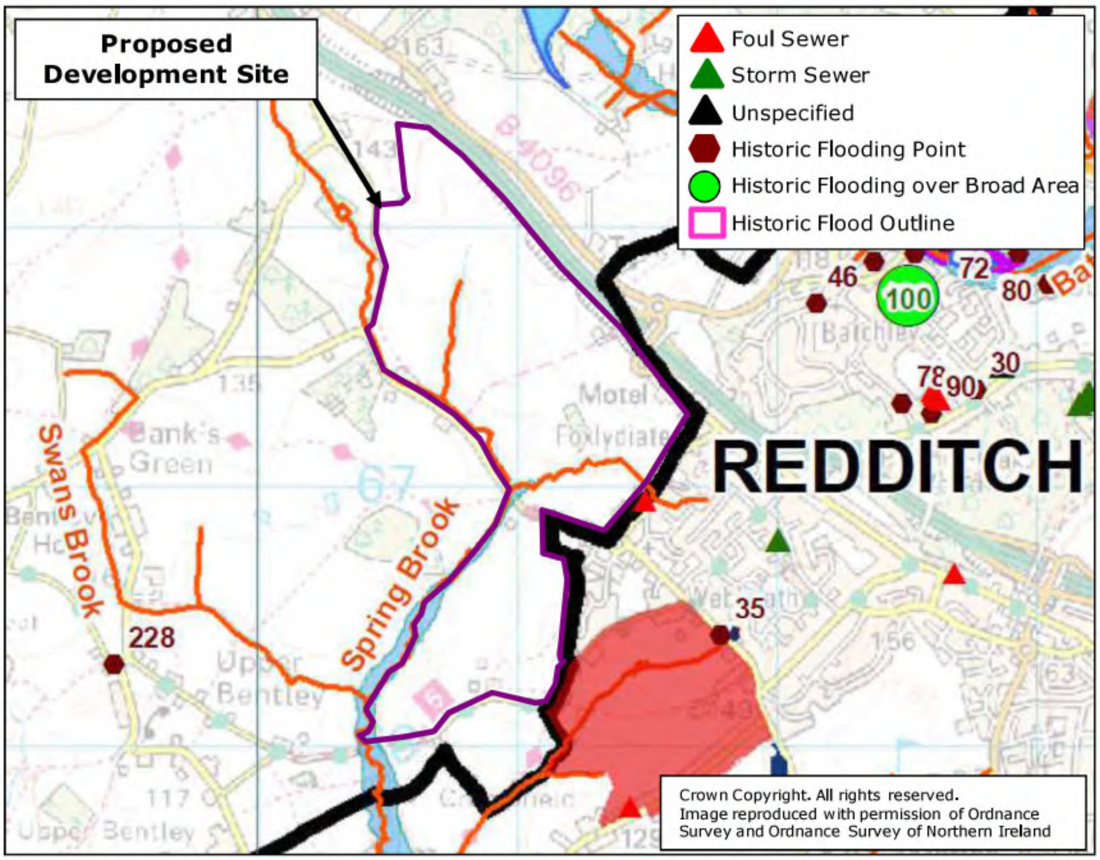

Figure 3: Level 1 SFRA - Historical Flooding

(Source: Level 1 SFRA, Figure 3)

3.2 FLUVIAL

The watercourses within the site boundary are shown in **Figure 4** and discussed in **Sections 3.2.1 to 3.2.4**. A site visit was undertaken on 9 May 2013 following a period of low rainfall.

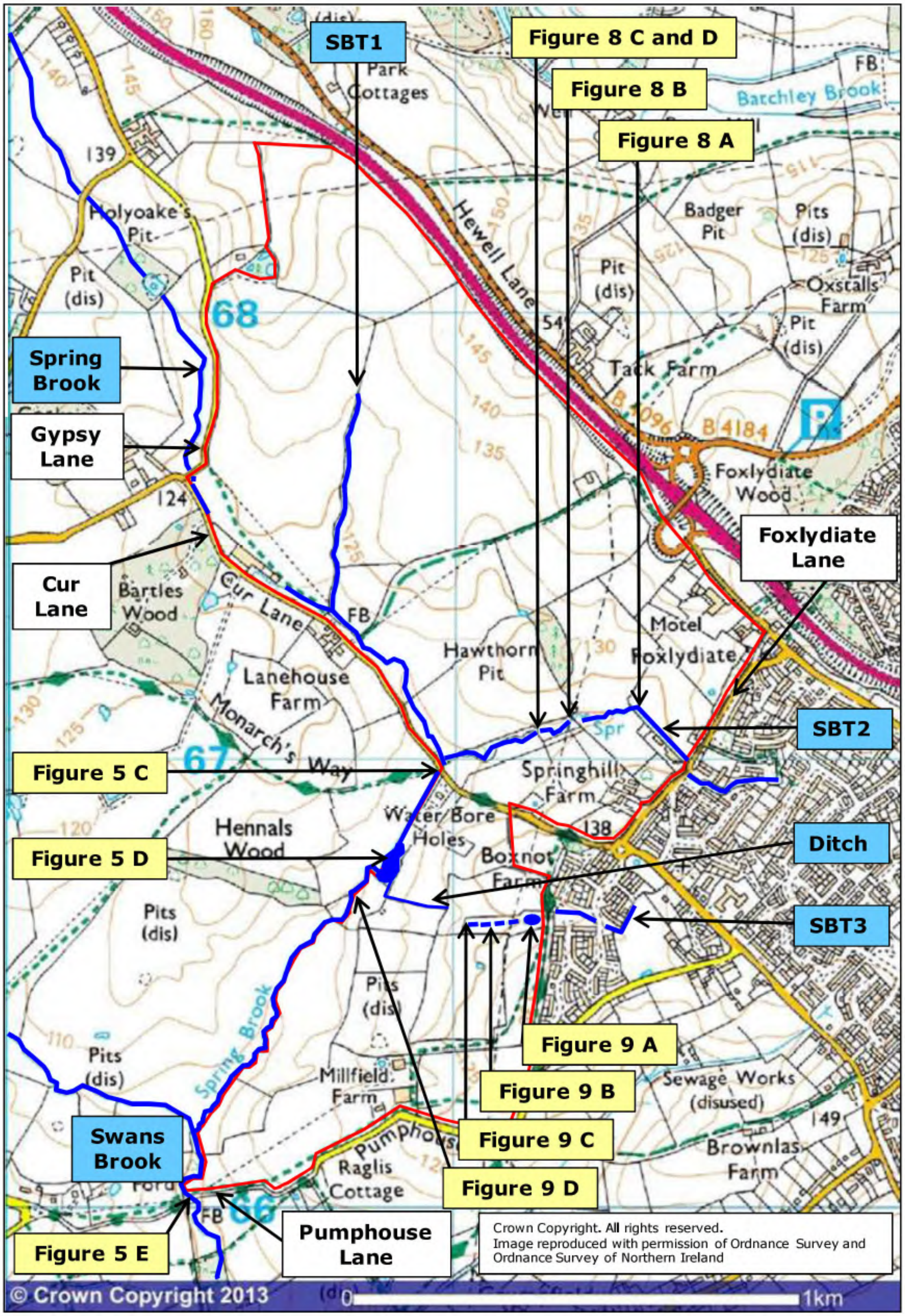

Figure 4: Watercourses and key to photographs

3.2.1 Spring Brook

Spring Brook flows in culvert under Gypsy Lane on the west boundary of the site. Following another short section of culvert within the site, it flows in open channel adjacent to Cur Lane. It is then presumed to flow in culvert under large agricultural buildings and associated hardstanding areas, as no open channel was evident in this area. It then flows in open channel again in a south-easterly direction through several fields (**Figure 5 A and B**), receiving waters from Tributaries 1 and 2 (discussed further in **Sections 3.2.2 and 3.2.3**), before flowing under Cur Lane (**Figure 5 C**). It proceeds in a south-westerly direction, widening at one point to form a small lake (**Figure 5 D**). An outfall structure which is located on the left bank of Spring Brook a short distance downstream of the lake is discussed further in **Section 3.2.4**. Spring Brook flows into Swans Brook approximately 150m upstream of Pumphouse Lane. A ford crossing takes Swans Brook over Pumphouse Lane (**Figure 5 E**).

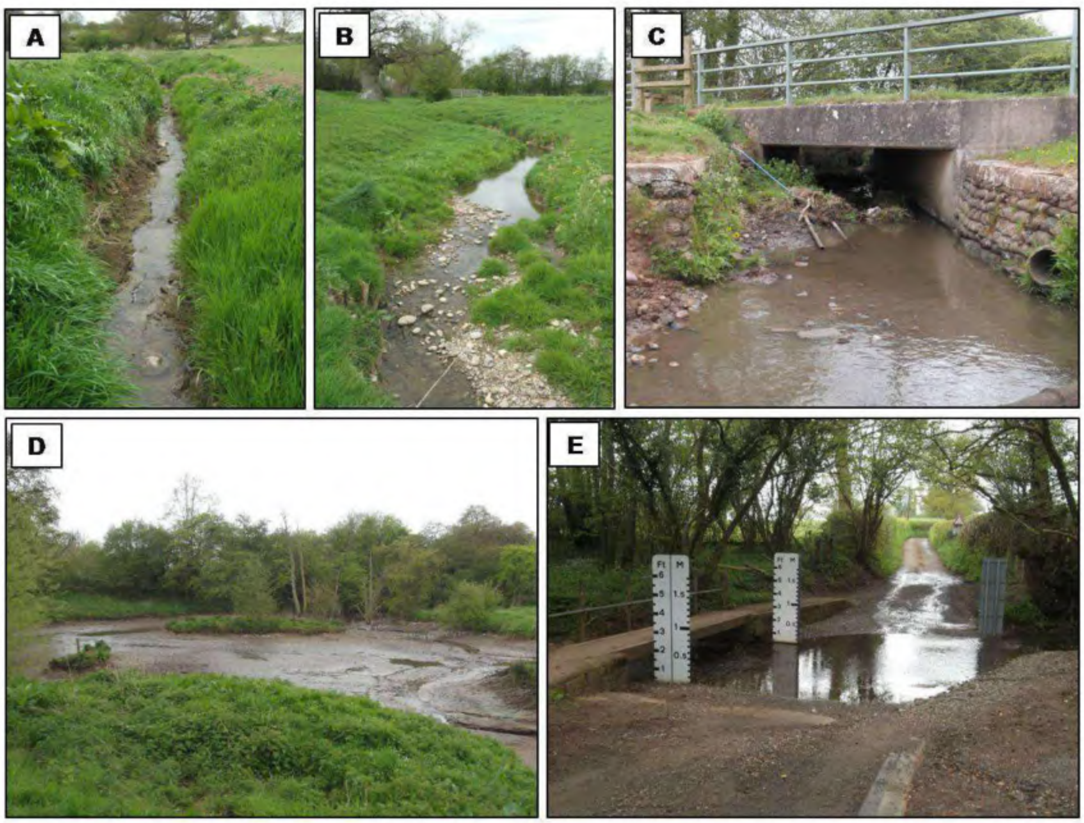

Figure 5: Spring Brook

3.2.2 Spring Brook Tributary 1

On the day of the site visit, Spring Brook Tributary 1 (SBT1, see **Figure 4**) was dry at its confluence with Spring Brook (**Figure 6**). SBT1 could not be accessed upstream of this point on the day of the site visit.

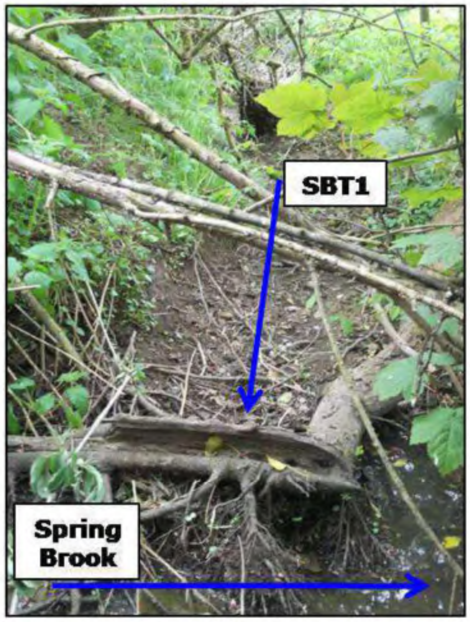

Figure 6: Spring Brook Tributary 1

3.2.3 Spring Brook Tributary 2

Spring Brook Tributary 2 (SBT2; **Figure 4** and **Figure 7**) flows from the Webheath area of Redditch to the east of the site, under Foxlydiate Lane, and proceeds through the site in a north-westerly direction. It then turns to flow in a south-westerly direction and at that point an outfall structure is located (**Figure 8 A**). The route of the culvert(s) which connect to this outfall would need to be identified prior to redevelopment of the site. Further downstream, the watercourse appears to disappear into the ground, re-emerging from a culvert a short distance downstream (**Figure 8 B**). Another culvert was blocked at the upstream face (**Figure 8 C**); the downstream face is shown in **Figure 8 D**. SBT2 discharges to Spring Brook just upstream of the culvert under Cur Lane.

Figure 7: Spring Brook Tributary 2

Figure 8: SBT2 Structures

3.2.4 Spring Brook Tributary 3

A pond is located near the eastern boundary of the site (**Figure 9 A**). The pond's inlet at the eastern end may be connected to the ditch located within the residential area to the east. The pond's outlet appears to discharge to some linear structures (**Figure 9 B**). A culvert is located at the west end of the linear structures (**Figure 9 C**), which may connect to the outfall identified on the left bank of Spring Brook a short distance downstream of the Spring Brook lake (**Figure 9 D**). The route of the culvert should be confirmed prior to redevelopment of the site. A ditch is located in a field a short distance downstream of the linear structures but there was no evidence of any formal drainage into the ditch, which ultimately discharges to the Spring Brook lake (shown in **Figure 5 D**).

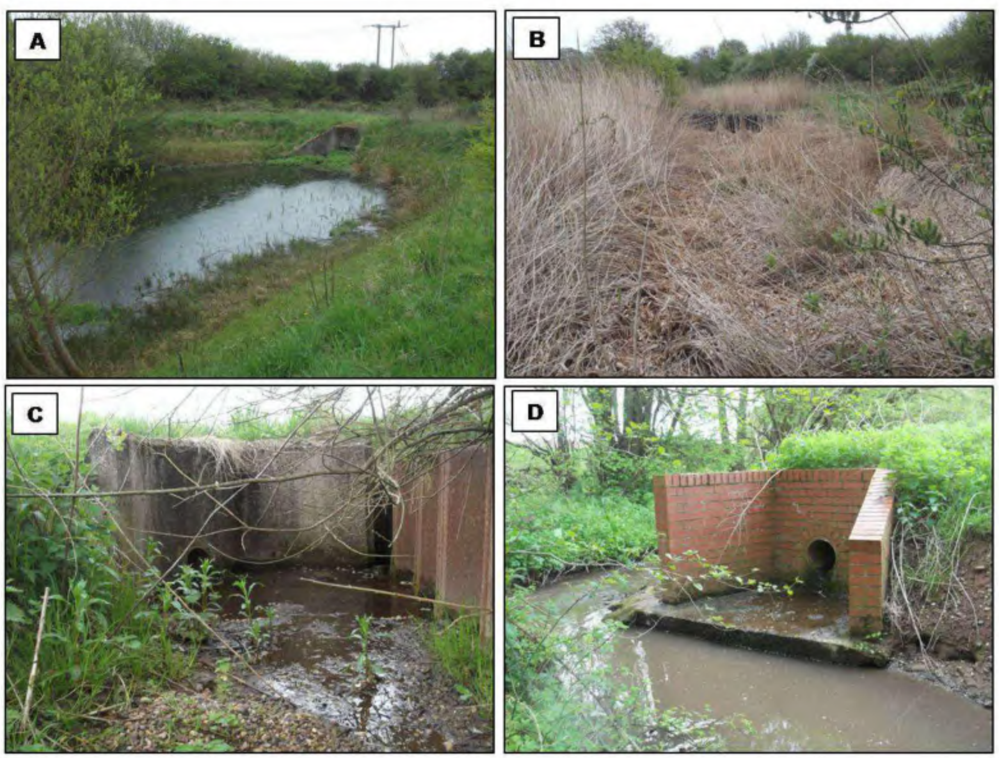

Figure 9: Spring Brook Tributary 3

3.2.5 Fluvial Modelling

The EA has advised[1] that it does not have any modelled data for the watercourses within the site.

The EA flood maps are based on a national generalised model (JFlow), or more detailed modelling where available. The national generalised model may not produce flood outlines for watercourses with small catchments. The EA flood map for the site shows flood outlines associated with Spring Brook in the southern section of the site, but not for the watercourses in the northern part of the site. This may be due to their small catchment size.

The layout of the site should ensure that development is avoided in the lowest parts of the site adjacent to watercourses. The ample land available across the site will ensure that development can be delivered within Flood Zone 1. Hydrological and hydraulic modelling of the watercourses may be undertaken at the appropriate stage in the planning process to inform the proposed development layout.

3.3 RESERVOIRS, CANALS AND OTHER ARTIFICIAL SOURCES

Reservoir or canal flooding may occur as a result of the facility being overwhelmed and/or as a result of dam or bank failure.

The following canal and reservoirs are located in the vicinity of the site (**Figure 10**):

- **Worcester and Birmingham Canal** - 1.3 km to the northwest of the site
- **Tardebigge Reservoir** – located adjacent to the Worcester and Birmingham canal approximately 1.8 km to the west of the site
- **The Lake** – 0.5 km to the north of the site

[1] E-mail on 19 March 2013

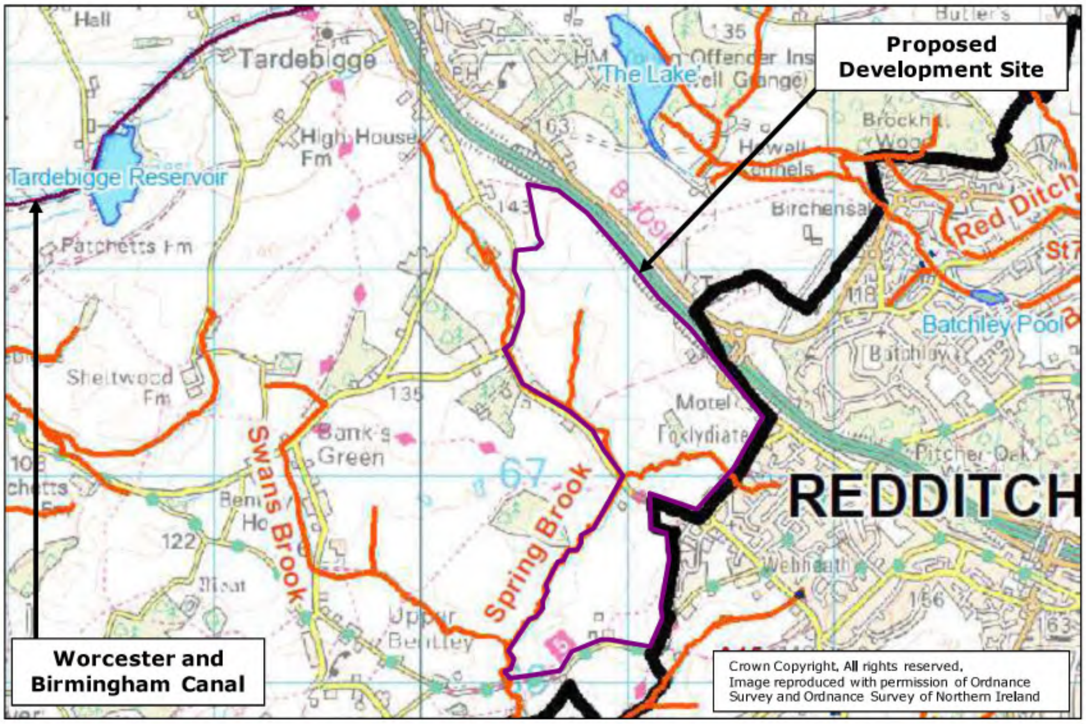

Figure 10: Location of watercourses, canals, reservoirs and lakes

(Source: Level 1 SFRA, Figure 2)

There is higher intervening land between the site and the Worcester and Birmingham Canal and the Tardebigge reservoir, while ground levels decline to the west and south of the canal. The canal descends through the Tardebigge flight of 30 locks towards the south-west. Any floodwater from the canal or reservoir would be directed to the south-west away from the site.

There is also higher intervening land between the site and The Lake. Any floodwaters from The Lake would be directed eastwards, away from the site.

The EA Risk of Flooding from Reservoirs Map (**Figure 11**) indicates that the site is not at risk of flooding from reservoirs.

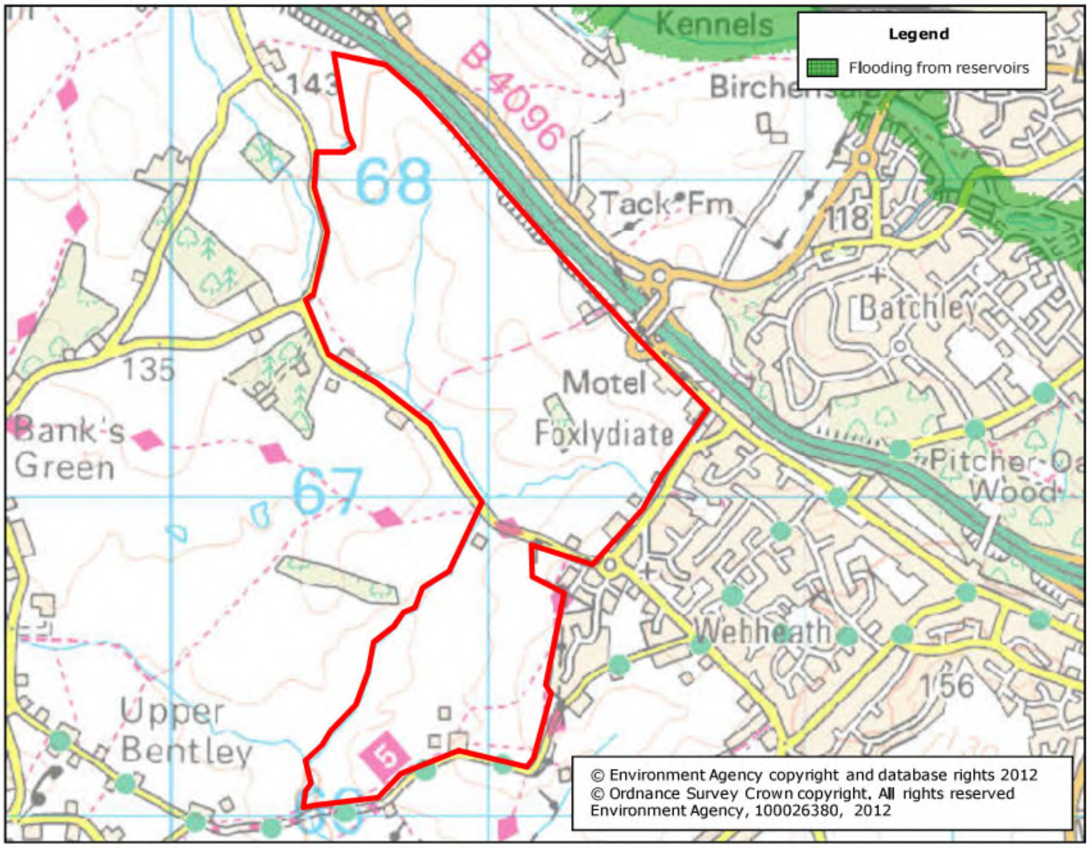

Figure 11: Environment Agency Risk of Flooding from Reservoirs Map

(Source: Environment Agency website)

3.4 GROUNDWATER

Groundwater flooding generally occurs during intense, long-duration rainfall events, when infiltration of rainwater into the ground raises the level of the water table until it exceeds ground levels. It is most common in low-lying areas overlain by permeable soils and permeable geology, or in areas with a naturally high water table.

The EA Aquifer Map indicates that the bedrock underlying the northwest and central portions of the site is classified as a principal aquifer, whilst the bedrock in the northeast and south of the site is a secondary B aquifer (**Figure 12**).

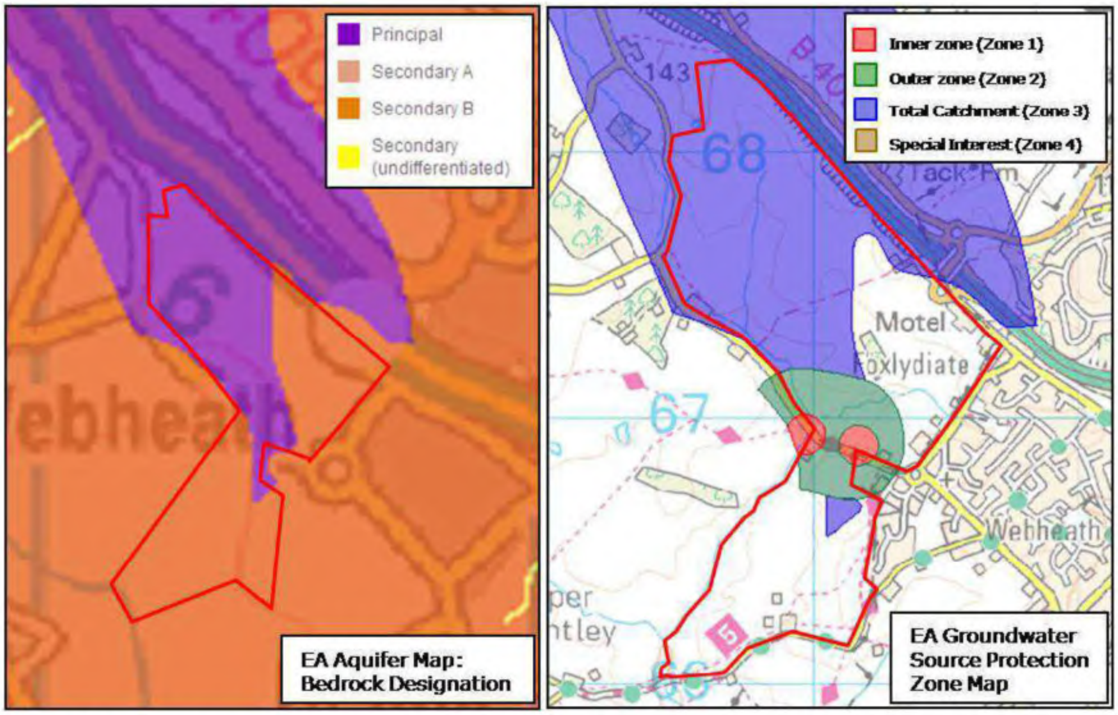

Figure 12: EA Aquifer Map (Bedrock Designation) and EA Groundwater Source Protection Zone Map

(Source: Environment Agency website)

According to the Soilscapes maps produced by the National Soils Research Institute[2], soil conditions in the northwest and central areas of the site are described as *'Freely draining loamy soils'*. The soils in the east are described as '*Loamy and clayey soils with impeded drainage*', whilst in the south the soils are '*Slowly permeable seasonally wet loamy and clayey soils*'. Given the permeability of the underlying soil conditions, the propensity for groundwater flooding may be highest in the northwest and central areas of the site. However, due to the topography of the site, any floodwaters would be expected to flow towards Spring Brook rather than accumulating to any significant depth within the areas proposed for development.

According to the British Geological Survey (BGS) Groundwater Flooding Hazard map (**Figure 13**) the susceptibility to groundwater flooding is low across the majority of the site, but moderate to significant in the centre of the site.

[2] Soilscapes www.landis.org.uk/soilscapes/

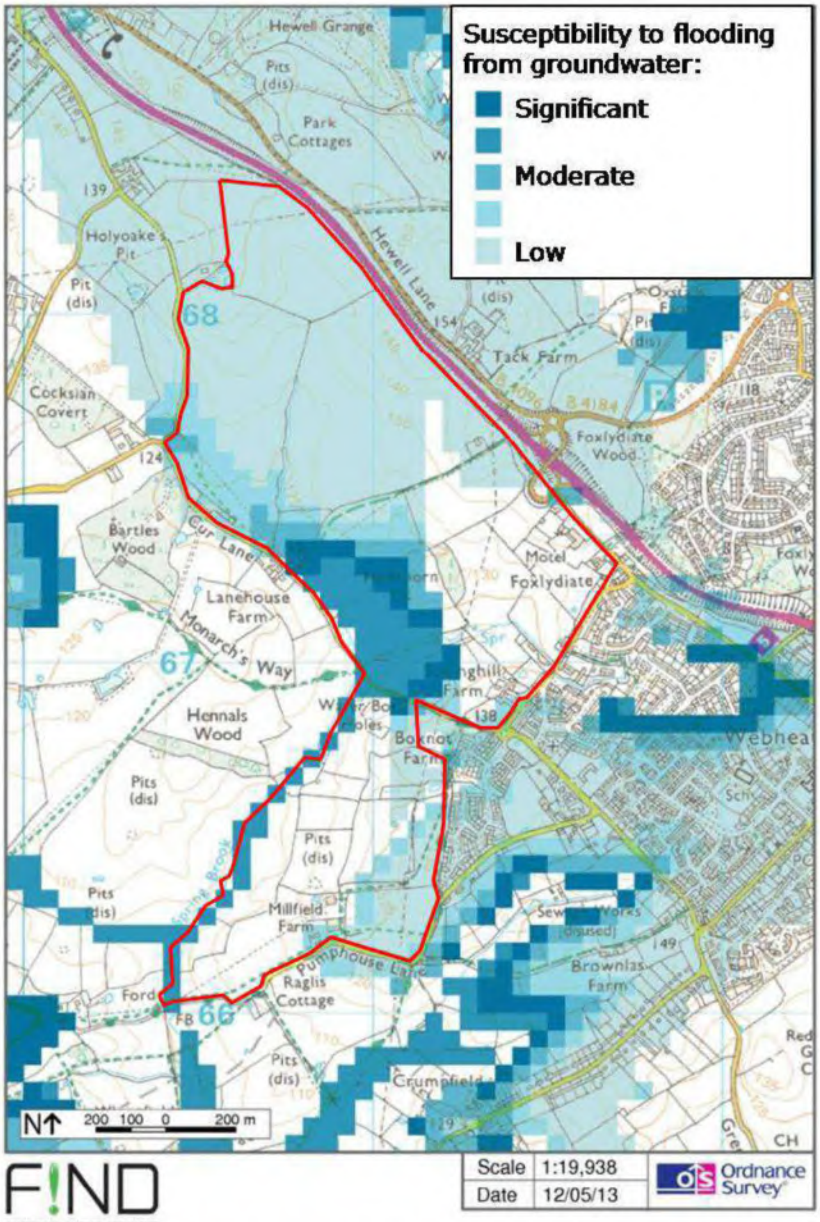

Figure 13: BGS Groundwater Flooding Hazard Map

(Source: www.findmaps.co.uk)

Section 3.1.5 of the Level 1 SFRA states "*Groundwater flooding is not a particular cause for concern within Bromsgrove District as the underlying aquifer tends to drain when water levels within it become too high. The Environment Agency has also stated that due to the high levels of abstraction from this aquifer for water supply, the groundwater levels have never reached the surface. There are no reports of groundwater flooding within the District*".

The EA Groundwater Protection Zone map indicates that two abstraction points are located off Cur Lane, near the central area of the site (**Figure 12**).

Any residual risk of groundwater flooding may be mitigated by raising finished floor levels above ground level and incorporating appropriate flood resilient construction techniques below ground floor level.

3.5 SURFACE WATER

Surface water flooding comprises pluvial flooding, and flooding from sewers and highway drains and gullies.

Pluvial flooding results from rainfall-generated overland flow, before the runoff enters any watercourse or sewer, or where the sewerage/drainage systems and watercourses are overwhelmed and therefore unable to accept surface water. Pluvial flooding is usually associated with high intensity rainfall events but may also occur with lower intensity rainfall where the ground is saturated, developed or otherwise has low permeability resulting in overland flow and ponding within depressions in the topography.

The surface water drainage system within the proposed development site will be designed to accommodate flows arising from the 1 in 100 annual probability event including an allowance for climate change, as discussed in **Section 4**.

Any overland flows arising from surrounding areas, or within the site for an event which exceeds the design capacity of the drainage system, would be expected to flow across the site towards Spring Brook without accumulating to any significant depth within the site. The proposed site layout should be designed to ensure that any overland flows may be directed safely across the site without affecting properties.

Sewer flooding can occur when the capacity of the sewer system is overwhelmed by heavy rainfall, becomes blocked or is of inadequate capacity, resulting in flooding of land and/or property. Normal discharge of sewers and drains through outfalls may be impeded by high water levels in receiving waters. Severn Trent Water Ltd has been consulted to ascertain whether it holds any records of sewer flooding at the site. A response is awaited.

The propensity for surface water flooding at the site is considered to be low. However, any residual concern regarding flood risk from this source may be addressed through appropriate site layout, which should take account of potential overland flow routes.

4 SURFACE WATER DRAINAGE

4.1 REQUIREMENTS FOR SURFACE WATER DRAINAGE

The NPPF and supporting Technical Guidance requires developers and local authorities to seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage systems (SuDS). Recognising the requirements of the NPPF, the EA[3], Building Regulations Approved Document H and the Code for Sustainable Homes Technical Guide (Category 4), surface water runoff from the proposed site should demonstrate:

- No increase in existing flow rates discharged to watercourse/public sewer
- The use of SuDS as the preferred method of dealing with surface water
- How runoff up to the 1 in 100 year event plus an allowance for climate change will be dealt with without increasing flood risk elsewhere

The Flood and Water Management Act received Royal Assent on 8 April 2010 and is being implemented by a series of ministerial orders. Schedule 3 relates to sustainable drainage and is expected to come into force in April 2014. Under Schedule 3 of the Act, drainage systems for managing rainwater in new or re-development must be approved by a SuDS Approving Body (SAB) before construction begins. National Standards will be published for the design, construction, operation and maintenance of SuDS.

Draft National Standards for Sustainable Drainage Systems were published for consultation in December 2011. The indicative drainage strategy for the site has taken the draft National Standards into consideration, as outlined in the following sections.

4.2 SURFACE WATER RUNOFF FROM THE EXISTING SITE

According to the Soilscapes maps produced by the National Soils Research Institute[4] soil conditions in the northwest and central areas of the site are described as *'Freely draining loamy soils'*. The soils in the east are described as '*Loamy and clayey soils with impeded drainage*', whilst in the south the soils are '*Slowly permeable seasonally wet loamy and clayey soils*'. This indicates that surface water may infiltrate into the ground in the northwest and central areas of the site with lower rates of run-off, whilst run-off rates in the east and south are expected to be higher. However, this should be confirmed through site investigations.

The land across the site slopes towards Spring Brook and its tributaries. These are the receiving waterbodies for any surface water run-off which does not infiltrate into the ground.

[3] Preliminary Rainfall Runoff Management for Developments, R&D Technical Report W5-074/A/TR/1 Revision C, 2005

[4] Soilscapes www.landis.org.uk/soilscapes/

4.3 SURFACE WATER MANAGEMENT – NORTHWEST AND CENTRE

4.3.1 Disposal of Surface Water

The draft National Standards indicate that surface water should be discharged to ground where possible. It may be feasible to infiltrate surface water in the northwest portion of the site. However this would need to be confirmed through soakaway tests at the detailed design stage.

4.3.2 Water Quality

The draft National Standards indicate that a series of treatment stages should be included before the surface runoff reaches the infiltration device.

According to the EA aquifer map, the northwest and central portions of the site overlie a principal aquifer. The majority of this area is classified as groundwater source protection zone 3 (total catchment), with some areas in source protection zone 1 (inner zone) or zone 2 (outer zone).

Run-off from roofs is classified as a '*low hazard*', while run-off from residential, amenity, commercial, industrial uses including car parking and roads is classified as a '*medium hazard*'.

Table C2 of the draft National Standards indicates that sites within source protection zones 1, 2 or 3 or a principal aquifer require one treatment stage for low hazard run-off, while medium hazard run-off should undergo three treatment stages.

4.3.3 SuDS Options

SuDS aim to mimic natural drainage and can achieve multiple objectives such as removing pollutants from urban runoff at source, controlling surface water runoff from developments, and ensuring that flood risk is not increased downstream. Combining water management with green space can provide amenity and biodiversity enhancement.

Potential SuDS components which may be considered include house soakaways, rain gardens, permeable paving, filter strips, swales, infiltration trenches and infiltration basins.

Run-off from roof areas may be discharged to rain gardens or soakaways located in rear gardens of houses. Overflow from the soakaways may be conveyed to other SuDS components.

Permeable surfaces can be used for car parking areas or residential roads. Surface water storage may be provided within an aggregate sub-base with 30% voids, which offers good water quality treatment. This may be used as a first stage of surface water treatment.

As an alternative first stage of treatment, run-off from roads and parking areas may be directed over a filter strip. Filter strips are vegetated strips of land designed to accept run-off as overland sheet flow. They treat run-off by vegetative filtering and promote settlement of particulate pollutants. The SuDS Design and Adoption Guide produced by Cambridge City Council indicates that small filter strips 1-2m wide may be effective.

Surface water may be directed from the permeable pavement or filter strip into a swale or infiltration trench, to provide a second level of treatment.

Swales are shallow channels designed to store and convey runoff and remove pollutants. Dry swales include a filter bed which overlays an under-drain system. The preferred gradient for swales is no steeper than 1 in 100. It is, however, possible to position swales perpendicular to the slope, keeping the gradients within acceptable limits. Alternatively, check dams may be used.

Infiltration trenches are gravel-filled trenches which store and convey water and remove pollutants.

Flows from swales and infiltration trenches may be directed to infiltration basins. Infiltration basins are vegetated depressions designed to store runoff and infiltrate it gradually into the ground. Surface water from other SuDS components may ultimately be directed here for a final storage and treatment stage.

4.3.4 Storage Volume

The volume of storage required will depend upon the SuDS components used as part of the treatment train, the infiltration rates and the surface area available for infiltration. However, in order to provide a rough indication of the potential storage requirements for this part of the site, the total storage volume needed to accommodate all the run-off from 1 ha of impermeable surfaces within an infiltration basin has been estimated. The modelled infiltration basin has a very low infiltration area : volume ratio, resulting in higher storage volume estimates.

The surface water storage volume has been modelled using the *Detailed Design* module of MicroDrainage Source Control. A conservative infiltration rate of 0.1 m/hr has been assumed. If soakaway tests performed in accordance with BRE 365: Soakaway Design (2003) demonstrate that higher rates of infiltration can be achieved at the site, the storage volume will reduce accordingly.

The required storage volume has been sized to store the 1 in 100 year storm event including a 30% increase in rainfall intensity in order to allow for climate change in accordance with Table 5 of the NPPF Technical Guidance.

The parameters used in the storage calculation along with the MicroDrainage Source Control output results are provided in **Appendix B**. This indicates that a storage volume of **528 m^3** may be required for every 1 ha of new impermeable surface.

4.4 SURFACE WATER MANAGEMENT – EAST AND SOUTH

4.4.1 Disposal of Surface Water

As detailed previously, infiltration is unlikely to be feasible in the east and south portions of the site. The draft National Standards (paragraph A3) indicates that surface water runoff not discharged to the ground must be discharged to a surface water body where possible. Surface water runoff from the east and south portions of the site naturally drain to Spring Brook or its tributaries.

4.4.2 Water Quality

The draft National Standards state that a series of treatment stages are required prior to the discharge of runoff to a surface water body.

Run-off from roofs is classified as a '*low hazard*', while run-off from residential, amenity, commercial, industrial uses including car parking and roads is classified as a '*medium hazard*'.

Catchments less than 50km^2 are classified as sensitive surface water bodies. Table C3 of the draft National Standards indicates that sites discharging to a sensitive water body require one treatment stage for low hazard run-off, while medium hazard run-off should undergo three treatment stages.

4.4.3 SuDS Options

Potential SuDS components which may be considered include permeable paving, filter strips, swales, filter drains and detention basins.

As for the northwest and central parts of the site, permeable surfaces can be used for car parking areas or residential roads as a first stage of surface water treatment. As an alternative first stage of treatment, run-off from roads and parking areas may be directed over a filter strip. Surface water may be directed from the permeable pavement or filter strip into a swale or filter drain, to provide a second level of treatment. Filter drains are gravel-filled trenches which store and convey water and remove pollutants. Run-off from roofs may be directed into the permeable pavement sub-base, or directly into the swales or filter drains.

Flows from swales and filter drains may be directed to detention basins for a final storage and treatment stage. Detention basins are vegetated depressions designed to store runoff prior to discharge to a watercourse or other water body.

4.4.4 Existing Areas

The site largely comprises permeable areas, with a small proportion of impermeable surfaces associated with existing dwellings and agricultural buildings.

For the purposes of this indicative drainage strategy, the higher run-off rates associated with the existing impermeable surfaces have not been taken into account to determine overall run-off rates from the site. Instead, greenfield run-off rates have been calculated for the entire site. This is in line with the draft National Standards[5], which indicate that the run-off rates from previously developed sites should be as close to the greenfield run-off rates as reasonably practicable.

4.4.5 Greenfield Runoff Rate

Greenfield runoff rates from permeable surfaces have been calculated using the ICP SUDS method within MicroDrainage. Details of the MicroDrainage input parameters and the output results are provided in **Table 1** and **Appendix C**.

Table 1: Greenfield Runoff Rate

Return Period	Runoff Rate (l/s/ha)
1 in 1 year	3.7
Qbar	4.5
1 in 30 year	8.8
1 in 100 year	11.5

4.4.6 Storage Volume

The draft National Standards provides two approaches to managing surface water runoff, as follows:

- **Approach 1: Restricting both the peak flow rate and the volume of runoff.** Peak flow rates for the 1 in 1 year and 1 in 100 year rainfall events must not be greater than the equivalent greenfield runoff rates for these events. The critical duration rainfall event must be used to calculate the required storage volume for the 1 in 100 year rainfall event. The volume of runoff must not be greater than the greenfield runoff volume from the site for the 1 in 100 year, 6 hour rainfall event.

- **Approach 2: Restricting the peak flow rate.** The critical duration rainfall event must be used to calculate the required storage volume for the 1 in 100 year rainfall event. The flow rate discharged for the 1 in 1 year event must not be greater than either the greenfield 1 in 1 year runoff rate or 2 l/s/ha; and for the 1 in 100 year event, must not be greater than either the greenfield mean annual flood for the site, or 2 l/s/ha

Approach 2 has been used in order to provide an initial estimation of the storage volumes required for the site. However, Approach 1 may be used at the detailed design stage. Whilst Approach 1 requires slightly more complex storage and discharge arrangements, the overall storage volumes are usually reduced.

[5] Paragraph B7

The required storage volume has been sized to store the 1 in 100 year storm event including a 30% increase in rainfall intensity in order to allow for climate change in accordance with Table 5 of the NPPF Technical Guidance. A discharge rate of **4.5 l/s/ha** has been used. This is the existing mean annual greenfield flow rate from the site, as shown in **Table 1**.

The parameters used in the storage calculation along with the MicroDrainage Source Control output results are provided in **Appendix D**. This indicates that <u>a storage volume of **652 m^3** may be required for every 1 ha of new impermeable surface</u>.

4.5 MAINTENANCE OF SUDS

In the past local planning authorities and water companies have been reluctant to adopt SuDS. With no arrangements in place that require local planning authorities or water companies to adopt SuDS their maintenance has subsequently been the responsibility of the developer.

Schedule 3 of the Flood and Water Management Act (2010) introduces:

- New standards for the design, construction, operation and maintenance of new rainwater drainage systems
- A new 'approving body' (generally a unitary, county or county borough local authority)
- A requirement for the approving body to approve most types of rainwater drainage systems before any construction work with drainage implications can start, subject to: (i) the system being constructed in line with an approved drainage plan to national standards; (ii) the approving body being satisfied the drainage system has been built and functions in accordance with the drainage plan, and (iii) the system being a sustainable drainage system, as defined by regulations.
- A requirement for the Lead Local Flood Authority to adopt and maintain new SuDS which serve more than one property, when the work has been completed satisfactorily. Highways authorities will be responsible for maintaining SuDS in public roads.

Bromsgrove District Council should be consulted regarding the adoption and maintenance of SuDS features at the appropriate stage of the planning process.

4.6 FINAL DRAINAGE LAYOUT

The purpose of this FRA is to demonstrate that a surface water drainage strategy is feasible for the site given the development proposals and the land available. The proposals provide the opportunity for the inclusion of SuDS elements, ensuring that there will be no increase in surface water runoff from the proposed development.

Appendix E provides an indication of potential locations for larger surface water storage elements within the site. Sizes and exact locations of SuDS features will be determined at the detailed design stage.

This FRA has demonstrated that, not only can the required storage be accommodated within the site layout, but that various options are feasible and ample land is available, providing flexibility for the final drainage solution. A final decision on the types of storage to be provided will be made at the detailed drainage design stage.

5 FOUL DRAINAGE AND WATER SUPPLY

Severn Trent Water Ltd has welcomed early discussions regarding foul drainage and potable water supply. Further modelling will be undertaken in order to determine the current capacity within the existing networks and the timescales for implementing upgrades required in order to accommodate the full extent of development proposed.

6 SUMMARY

There are proposals for approximately 2830 dwellings, a first school and a local centre on an area of land to the west of Redditch, in Bromsgrove District.

According to the EA flood map, the areas proposed for development are located outside the 1 in 1000 year flood outline and are therefore defined as being situated within Flood Zone 1 under the NPPF and its supporting Technical Guidance. The proposed development site, being located in Flood Zone 1, satisfies the requirements of the Sequential Test.

Spring Brook flows in a south-easterly then south-westerly direction along the western boundary of the site. Three tributaries have been identified within the site.

The EA flood maps may not show flood outlines for watercourses with small catchment areas. Development should be avoided in the lowest parts of the site adjacent to watercourses. The ample land available across the site for redevelopment will ensure that development can be delivered within Flood Zone 1. Hydrological and hydraulic modelling of the watercourses may be undertaken at the appropriate stage in the planning process to inform the proposed development layout.

The risk of groundwater flooding is low across most of the site, although may be moderate to significant in the central and northwest areas. Any floodwaters would be expected to flow towards Spring Brook without accumulating to significant depth. Any residual risk may be mitigated by setting finished floor levels above ground levels, and incorporating appropriate flood resilient construction below ground floor level.

The propensity for surface water flooding at the site is considered to be low. However, any residual concern regarding flood risk from this source may be addressed through appropriate site layout, which should take account of potential overland flow routes.

Following development the overall impermeable areas at the site are expected to increase. A scheme for the provision and implementation of a surface water regulation system following the principles set out in this FRA should be submitted to and approved in writing by the local planning authority, prior to the commencement of development.

7 RECOMMENDATIONS

This FRA has demonstrated that the proposed development may be completed without conflicting with the requirements of the NPPF and its supporting Technical Guidance subject to the following:

- Development to be avoided in the lowest parts of the site adjacent to watercourses. Hydrological and hydraulic modelling of the watercourses may be undertaken at the appropriate stage in the planning process to inform the proposed development layout

- Finished floor levels to be set at 150mm above adjacent ground levels

- Within areas where there is an increased risk of groundwater flooding, the latest best practice flood resilient construction techniques to be incorporated below ground floor level.

- Site layout to take into consideration potential overland flow routes

- The detailed drainage design, developed in accordance with the principles set down in this FRA, should be submitted to and approved by the local planning authority prior to the commencement of development with a view to allowing phased development of the site to proceed without compromising the holistic approach to dealing with surface water across the whole site.

APPENDIX A: Topographic Survey

APPENDIX B: MicroDrainage Storage Volume Calculation - Infiltration

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 553 minutes

Storm Duration (mins)	Maximum Filtration (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Maximum Volume (m³)	Status
15 Summer	7.8	7.8	0.4427	0.4427	233.6	O K
30 Summer	8.0	8.0	0.5732	0.5732	302.7	O K
60 Summer	8.1	8.1	0.6983	0.6983	368.8	O K
120 Summer	8.2	8.2	0.8048	0.8048	424.9	O K
180 Summer	8.3	8.3	0.8468	0.8468	447.2	O K
240 Summer	8.3	8.3	0.8618	0.8618	455.0	O K
360 Summer	8.3	8.3	0.8593	0.8593	453.6	O K
480 Summer	8.3	8.3	0.8383	0.8383	442.6	O K
600 Summer	8.3	8.3	0.8168	0.8168	431.1	O K
720 Summer	8.2	8.2	0.7953	0.7953	419.8	O K
960 Summer	8.2	8.2	0.7553	0.7553	398.9	O K
1440 Summer	8.1	8.1	0.6833	0.6833	360.7	O K
2160 Summer	8.0	8.0	0.5838	0.5838	308.1	O K
2880 Summer	7.9	7.9	0.4922	0.4922	259.9	O K
4320 Summer	7.7	7.7	0.3367	0.3367	177.8	O K
5760 Summer	7.6	7.6	0.2172	0.2172	114.7	O K
7200 Summer	7.5	7.5	0.1328	0.1328	70.1	O K
8640 Summer	7.4	7.4	0.0788	0.0788	41.5	O K
10080 Summer	7.4	7.4	0.0517	0.0517	27.3	O K
15 Winter	7.9	7.9	0.4967	0.4967	262.4	O K
30 Winter	8.1	8.1	0.6453	0.6453	340.7	O K
60 Winter	8.2	8.2	0.7888	0.7888	416.5	O K
120 Winter	8.4	8.4	0.9138	0.9138	482.5	O K
180 Winter	8.4	8.4	0.9673	0.9673	510.8	O K
240 Winter	8.5	8.5	0.9903	0.9903	523.0	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
15 Summer	128.29	19
30 Summer	84.23	33
60 Summer	52.66	64
120 Summer	31.80	122
180 Summer	23.35	182
240 Summer	18.64	242
360 Summer	13.54	360
480 Summer	10.79	438
600 Summer	9.04	492
720 Summer	7.82	556
960 Summer	6.22	682
1440 Summer	4.49	952
2160 Summer	3.24	1360
2880 Summer	2.57	1756
4320 Summer	1.85	2508
5760 Summer	1.46	3224
7200 Summer	1.22	3888
8640 Summer	1.05	4496
10080 Summer	0.92	5144
15 Winter	128.29	19
30 Winter	84.23	33
60 Winter	52.66	62
120 Winter	31.80	120
180 Winter	23.35	178
240 Winter	18.64	236

Summary of Results for 100 year Return Period (+30%)

Storm Duration (mins)	Maximum Filtration (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Maximum Volume (m³)	Status
360 Winter	8.5	8.5	0.9998	0.9998	528.0	O K
480 Winter	8.4	8.4	0.9863	0.9863	520.8	O K
600 Winter	8.4	8.4	0.9603	0.9603	507.0	O K
720 Winter	8.4	8.4	0.9303	0.9303	491.2	O K
960 Winter	8.3	8.3	0.8798	0.8798	464.5	O K
1440 Winter	8.2	8.2	0.7768	0.7768	410.1	O K
2160 Winter	8.0	8.0	0.6268	0.6268	330.9	O K
2880 Winter	7.9	7.9	0.4897	0.4897	258.6	O K
4320 Winter	7.6	7.6	0.2637	0.2637	139.4	O K
5760 Winter	7.5	7.5	0.1093	0.1093	57.7	O K
7200 Winter	7.2	7.2	0.0487	0.0487	25.6	O K
8640 Winter	6.2	6.2	0.0417	0.0417	22.0	O K
10080 Winter	5.4	5.4	0.0367	0.0367	19.4	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
360 Winter	13.54	350
480 Winter	10.79	458
600 Winter	9.04	560
720 Winter	7.82	590
960 Winter	6.22	734
1440 Winter	4.49	1038
2160 Winter	3.24	1472
2880 Winter	2.57	1876
4320 Winter	1.85	2632
5760 Winter	1.46	3232
7200 Winter	1.22	3664
8640 Winter	1.05	4408
10080 Winter	0.92	5144

Rainfall Details

Region	ENG+WAL	Shortest Storm (mins)	15
Return Period (years)	100	Longest Storm (mins)	10080
M5-60 (mm)	20.000	Summer Storms	Yes
Ratio-R	0.400	Winter Storms	Yes
Cv (Summer)	0.750	Climate Change %	+30
Cv (Winter)	0.840		

Time / Area Diagram

Total Area (ha) = 1.000

Time from:	**(mins) to:**	**Area (ha)**
0	4	1.000

Infiltration Basin Details

Infil Coef - Base (m/hr)	0.100000	Porosity	1.00
Infil Coef - Sides (m/hr)	0.100000	Invert Level (m)	0.000
Safety Factor	2.0	Ground Level (m)	1.500

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.00	528.0	0.60	528.0	1.20	528.0	1.80	528.0	2.40	528.0
0.10	528.0	0.70	528.0	1.30	528.0	1.90	528.0	2.50	528.0
0.20	528.0	0.80	528.0	1.40	528.0	2.00	528.0		
0.30	528.0	0.90	528.0	1.50	528.0	2.10	528.0		
0.40	528.0	1.00	528.0	1.60	528.0	2.20	528.0		
0.50	528.0	1.10	528.0	1.70	528.0	2.30	528.0		

APPENDIX C: MicroDrainage Outputs for Greenfield Runoff

ICP SUDS Mean Annual Flood

Input

Return Period (years)	1	Soil	0.450
Area (Ha)	1.000	Urban	0.000
SAAR (mm)	710.000	Region Number	4

Results	**l/s**
QBAR Rural	4.5
QBAR Urban	4.5
Q 1 year	3.7
Q 1 year	3.7
Q 30 years	8.8
Q 100 years	11.5

APPENDIX D: MicroDrainage Storage Volume Calculation - Pond

Summary of Results for 100 year Return Period (+30%)

Storm Duration (mins)	Maximum Control (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Maximum Volume (m³)	Status
15 Summer	3.6	3.6	0.3652	0.3652	238.0	O K
30 Summer	3.6	3.6	0.4772	0.4772	311.0	O K
60 Summer	3.6	3.6	0.5908	0.5908	385.2	O K
120 Summer	3.8	3.8	0.7003	0.7003	456.6	O K
180 Summer	4.0	4.0	0.7578	0.7578	494.0	O K
240 Summer	4.1	4.1	0.7928	0.7928	516.8	O K
360 Summer	4.2	4.2	0.8348	0.8348	544.3	O K
480 Summer	4.2	4.2	0.8583	0.8583	559.5	O K
600 Summer	4.2	4.2	0.8698	0.8698	567.2	O K
720 Summer	4.3	4.3	0.8743	0.8743	570.2	O K
960 Summer	4.2	4.2	0.8698	0.8698	567.1	O K
1440 Summer	4.2	4.2	0.8483	0.8483	553.2	O K
2160 Summer	4.1	4.1	0.8123	0.8123	529.6	O K
2880 Summer	4.0	4.0	0.7743	0.7743	505.0	O K
4320 Summer	3.8	3.8	0.7003	0.7003	456.6	O K
5760 Summer	3.7	3.7	0.6323	0.6323	412.1	O K
7200 Summer	3.6	3.6	0.5693	0.5693	371.0	O K
8640 Summer	3.6	3.6	0.5102	0.5102	332.7	O K
10080 Summer	3.6	3.6	0.4537	0.4537	295.9	O K
15 Winter	3.6	3.6	0.4092	0.4092	266.8	O K
30 Winter	3.6	3.6	0.5347	0.5347	348.7	O K
60 Winter	3.8	3.8	0.6628	0.6628	432.1	O K
120 Winter	4.1	4.1	0.7873	0.7873	513.2	O K
180 Winter	4.2	4.2	0.8528	0.8528	556.1	O K
240 Winter	4.3	4.3	0.8933	0.8933	582.5	O K
360 Winter	4.4	4.4	0.9438	0.9438	615.3	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
15 Summer	128.29	19
30 Summer	84.23	34
60 Summer	52.66	64
120 Summer	31.80	124
180 Summer	23.35	182
240 Summer	18.64	242
360 Summer	13.54	362
480 Summer	10.79	482
600 Summer	9.04	602
720 Summer	7.82	720
960 Summer	6.22	952
1440 Summer	4.49	1166
2160 Summer	3.24	1552
2880 Summer	2.57	1960
4320 Summer	1.85	2772
5760 Summer	1.46	3624
7200 Summer	1.22	4400
8640 Summer	1.05	5192
10080 Summer	0.92	5952
15 Winter	128.29	19
30 Winter	84.23	33
60 Winter	52.66	64
120 Winter	31.80	122
180 Winter	23.35	180
240 Winter	18.64	240
360 Winter	13.54	356

Summary of Results for 100 year Return Period (+30%)

Storm Duration (mins)	Maximum Control (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Maximum Volume (m³)	Status
480 Winter	4.5	4.5	0.9728	0.9728	634.4	O K
600 Winter	4.5	4.5	0.9898	0.9898	645.2	O K
720 Winter	4.5	4.5	0.9983	0.9983	650.7	O K
960 Winter	4.6	4.6	1.0003	1.0003	652.0	O K
1440 Winter	4.5	4.5	0.9738	0.9738	634.8	O K
2160 Winter	4.4	4.4	0.9288	0.9288	605.5	O K
2880 Winter	4.3	4.3	0.8778	0.8778	572.3	O K
4320 Winter	4.0	4.0	0.7733	0.7733	504.0	O K
5760 Winter	3.8	3.8	0.6743	0.6743	439.7	O K
7200 Winter	3.6	3.6	0.5828	0.5828	380.1	O K
8640 Winter	3.6	3.6	0.4957	0.4957	323.2	O K
10080 Winter	3.6	3.6	0.4107	0.4107	267.8	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
480 Winter	10.79	472
600 Winter	9.04	586
720 Winter	7.82	700
960 Winter	6.22	922
1440 Winter	4.49	1324
2160 Winter	3.24	1644
2880 Winter	2.57	2108
4320 Winter	1.85	3024
5760 Winter	1.46	3912
7200 Winter	1.22	4752
8640 Winter	1.05	5544
10080 Winter	0.92	6352

Rainfall Details

Region	ENG+WAL	Shortest Storm (mins)	15
Return Period (years)	100	Longest Storm (mins)	10080
M5-60 (mm)	20.000	Summer Storms	Yes
Ratio-R	0.400	Winter Storms	Yes
Cv (Summer)	0.750	Climate Change %	+30
Cv (Winter)	0.840		

Time / Area Diagram

Total Area (ha) = 1.000

Time (mins) from:	to:	Area (ha)
0	4	1.000

Tank/Pond Details

Invert Level (m) 0.000 Ground Level (m) 1.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.00	652.0	0.60	652.0	1.20	652.0	1.80	652.0	2.40	652.0
0.10	652.0	0.70	652.0	1.30	652.0	1.90	652.0	2.50	652.0
0.20	652.0	0.80	652.0	1.40	652.0	2.00	652.0		
0.30	652.0	0.90	652.0	1.50	652.0	2.10	652.0		
0.40	652.0	1.00	652.0	1.60	652.0	2.20	652.0		
0.50	652.0	1.10	652.0	1.70	652.0	2.30	652.0		

Hydro-Brake Outflow Control

Design Head (m) 1.000 Hydro-Brake Type MD6 Invert Level (m) 0.000
Design Flow (l/s) 4.5 Diameter (mm) 89

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.10	2.6	0.80	4.1	2.00	6.4	4.00	9.1	7.00	12.0
0.20	3.6	1.00	4.6	2.20	6.7	4.50	9.7	7.50	12.5
0.30	3.4	1.20	5.0	2.40	7.1	5.00	10.2	8.00	12.9
0.40	3.3	1.40	5.4	2.60	7.3	5.50	10.7	8.50	13.3
0.50	3.4	1.60	5.8	3.00	7.9	6.00	11.1	9.00	13.7
0.60	3.6	1.80	6.1	3.50	8.5	6.50	11.6	9.50	14.0

APPENDIX E: Indicative Drainage Layout