Flood Risk Assessment & Drainage Strategy

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Bordesley, Redditch. Worcestershire

Gallagher Estates Limited

November 2013

CH2MHILL.
Halcrow

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Bordesley, Redditch, Worcestershire

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Document history

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This document has been issued and amended as follows:

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Rev.02	20/12/10	Treatment data added	GAW	(signed)GAW	
03	Oct 2013	Extent of development masterplan amended	JRR	SP	GW
04	Nov 2013	Comments incorporated	GF	SP	GW

Contents

Appendices

Executive Summary

Halcrow Group Limited (Halcrow), now operating under the business name of CH2M HILL has been appointed by Gallagher Estates Ltd to undertake a Flood Risk Assessment and Drainage Strategy study in respect of a residential development of a substantial area of land to the north of Redditch, located within Bromsgrove District.

This report results from a revision to the FRA & DS originally undertaken in 2010 following amendments to the extent of development currently proposed.

The original 2010 FRA & DS covered a total development area of approximately 197.5ha (across two sites) which included an area south of Weight's Lane that was subsequently separately progressed; this was subject to its own FRA & DS standalone report in March 2012; and the Weight's Lane site is currently in the latter stages of technical and planning permissions. This revised FRA & DS report covers a total of approximately 134.0ha across two sites, both of which are within Bromsgrove District; within the two sites, four developments are proposed with a total area of approximately 56.56ha.

As part of the site appraisal process it is necessary to demonstrate that the proposed development can be achieved with an acceptable risk of flooding. This report describes the results of the study. The report takes into account the recommendations of National Planning Policy Framework (NPPF) published by the Department for Communities and Local Government, March 2012 and the Technical Guidance to the National Planning Policy Framework published by the Department for Communities and Local Government, March 2012. These documents replace Policy Statement 25 - Development and Flood Risk (PPS 25) published by Communities and Local Government, December 2006.

It should be noted that the previous revision of this report (undertaken in 2010) pre-dated the NPPF and took into account the recommendations of Planning Policy Statement 25 - Development and Flood Risk (PPS 25) published by Communities and Local Government, December 2006. This revised FRA & DS report takes into account NPPF as detailed above.

The overall application sites lies predominately within NPPF flood zone 1 "low probability" which comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (< 0.1%). Land East of Birmingham Road is bordered to the east by Dagnell Brook with the River Arrow to the west passing through Land West of Birmingham Road. The largest and most easterly of the four sites has a proposed development envelope of approximately 22.27ha; the flood zone associated with Dagnell Brook extends into the overall site boundary of approximately 78ha, however the proposed development envelope itself would be located such that it is wholly within flood zone 1:

No other sources of flooding have been identified which affect the sites. SUDS will be implemented as part of the site proposals to reduce the impact of the surface water discharge and improve the quality of the water that will discharge into the River Arrow and Dagnell Brook. As such surface water flows leaving the site will be restricted to Greenfield runoff rates. Based on approximate site development areas, the following attenuation basins are proposed.

Foul discharge from the development can discharge into the existing foul drainage network

A Developer Enquiry has been submitted and returned and confirms it is not envisaged that further modelling will be necessary at this stage, however STW would like to know where the favourable connection points are anticipated to the network to inform and finalise the off-site improvement strategy.

The application site is deemed suitable for the proposed redevelopment.

1 Introduction

1.1 Terms of Reference

Halcrow Group Limited (Halcrow), now operating under the business name of CH2M HILL, has been appointed by Gallagher Estates Limited to undertake a Flood Risk Assessment and Drainage Strategy study for a substantial area of land to the north of Redditch, located within Bromsgrove District immediately north of its boundary with Redditch Borough.

The site is to be developed by Gallagher Estates with the overall intention to create a sustainable urban extension to the existing urban area. The two red lines, as shown on the drawings in Appendix A indicate the study areas and for the purpose of this report are referred to as Land East of Birmingham Road and Land West of Birmingham Road.

The current concept masterplan produced by Pegasus Urban Design (Pegasus) is shown on BIR.4226_01A, titled 'The Composite Development Strategy' in Appendix A. The Composite Development Strategy illustrates the four proposed development parcels, planted buffer zones around the residential development, a proposed bypass route and green corridors. Whilst the shape and form of the development parcels may alter as the masterplan progresses, they will be contained within the proposed red line boundaries and will be linked and integrated as far as possible through green infrastructure and promoted as one development on each site.

The purpose of this report is to provide a technical appraisal of the flood risk for the proposed development of the site and the proposed method of drainage. This includes a summary of the hydraulic river modelling works proposed in support of this FRA.

1.2 Planning Policy Framework Planning (NPPF)

The National Planning Policy Framework (NPPF) and the Technical Guidance to the National Planning Policy Framework (TGNPPF), published by the Department for Communities and Local Government, March 2012 supersedes the Planning Policy Statement 25 (PPS 25, under which the previous version of this SFRA report was considered) that was published by Communities and Local Government in December 2006.

The TGNPPF provides additional guidance to the Local Planning Authority (LPA). This guidance retains key elements of PPS25 and retention of this guidance is an interim measure pending a wider review of guidance to support planning policy.

The NPPF continues the implementation of the Sequential and the Exception test – a risk based approach to the location of development to avoid, where possible, flood risk to people and property and manage any residual risk, taking into account the impacts of climate change. The NPPF stresses the importance of steering new development towards areas with the lowest probability of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding.

The NPPF states that Local Plans should be supported by a Strategic Flood Risk Assessment (SFRA), which refines information regarding the probability of flooding, taking other sources of flooding and the impacts of climate change into account. SFRA's provide the footing for applying the sequential test, on the basis of flood zones.A SFRA was carried out by Royal Haskoning for the local planning authority by to inform the preparation of Local Development Documents (LDDs), having regard to catchment wide flooding issues which affect the area. Following the submission of the Draft Level 1 SFRA in September 2008, Royal Haskoning received three lists of changes required in the final report. These were received from the Environment Agency, Bromsgrove District Council and Redditch Borough Council. The final report was submitted in January 2009.

1.3 Consultation

Consultation with the Environment Agency (EA), the Local Authority (Bromsgrove District Council) and Severn Trent Water (STW) has formed a key part of the FRA and DS. Information from these parties has helped capture information on the risk of flooding from all sources, the condition of local assets, upon which appropriate recommendations for the site have been made and historic flooding.

The Environment Agency is a statutory consultee for all planning applications and will give comment and recommendations to the planning authority for any proposed developments affecting a watercourse.

1.4 Acknowledgments

Within this report, data from the British Geological Survey website has been 'Reproduced with the permission of the British Geological Survey © NERC. All rights Reserved' Reproduction of any BGS materials does not amount to an endorsement by NERC or any of its employees of any product or service and no such endorsement should be stated or implied.

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2 Existing Site Conditions

2.1 Site Location

The site under consideration for development comprises greenfield land located in a rural area to the north of the town of Redditch within Bromsgrove District Council. For the purpose of this report the proposed development areas are considered as Land East of Birmingham Road and Land West of Birmingham Road;

- **Land East of Birmingham Road** is located north of Dagnell End Road (B4101) and to the west of Dagnell Brook and known as Bordesley Park Farm.

- **Land West of Birmingham Road** is located east of the Birmingham to Redditch railway line, north of the A441 & Weights Lane, through which the River arrow flows.

Access to the sites can currently be gained from the A441 (both sites), Dagnell End Road (Land East of Birmingham Road) and Weight's lane (Land West of Birmingham Road).

The site are centred on Ordnance Survey Grid Reference (OSGR) SP 045 697

Land East of Birmingham Road and Land West of Birmingham Road are located within Bromsgrove District Council. It is proposed that the sites will be redeveloped for residential use likely to comprise approximately 56.56ha of development over the total site area of 134ha with associated recreation, parkland and public open space.

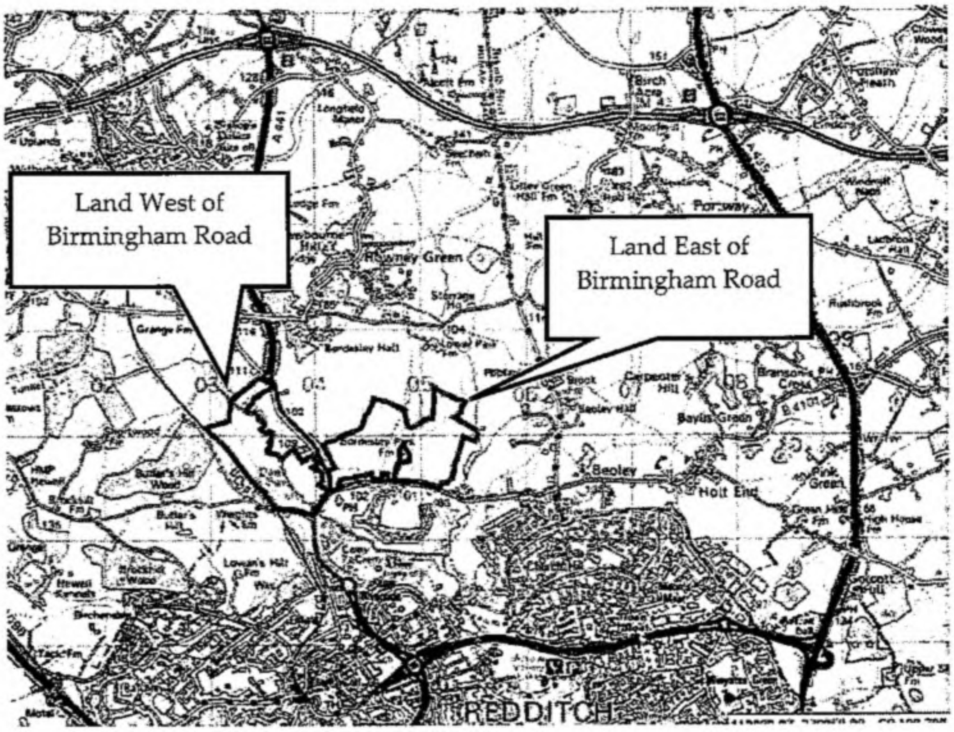


Figure 1 Site Location Map

2.2 Site Description

Both sites encompass approximately 134 hectares in total and for the purpose of this report are divided in two individual sites detailed as follows:

Land East of Birmingham Road – around Bordesley Park Farm, North of Dagnell End Road

Land East of Birmingham Road has an area of approximately 78.0 hectares and has a fall of approximately 35m across the site, contours range from about 90mAOD to 125mAOD. A ridge line runs approximately centrally from the north of the site (125mAOD), south towards Dagnell End Road (100mAOD) with about two thirds of the catchment running east towards Dagnell Brook and about one third towards the A441. It is currently in agricultural use, being mainly arable with some grassland. Immediately north of the site there are four man made impounded fishing lakes set a contour of approximately 110mAD. Towards the eastern boundary lies the Dagnell Brook flowing in a southerly direction until it merges with the River Arrow.

Land West of Birmingham Road - East of the Birmingham to Redditch Railway Line

Land West of Birmingham Road has an area of approximately 56.0 hectares and is situated in the valley of the River Arrow. Contours range from 106mAD on the western boundary and 100mAD on the eastern boundary with a valley contour of approximately 92.5mAD. The western boundary lies adjacent to the Birmingham to Redditch Railway Line. The River Arrow runs through this site from the north- west to the south east; in the north portion of the site the River is located along the east boundary; the River continues centrally through the southern portion of the site resulting in proposed developments either side of the River.

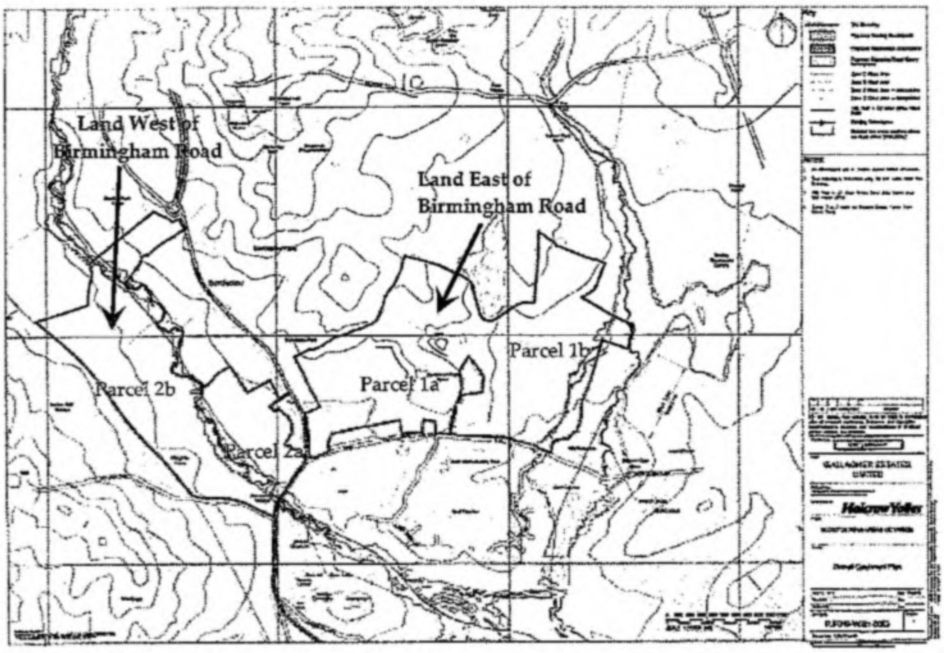


Figure 2 – Site Parcels

2.3 Existing Surface Water Features and Drainage

Drawing PJF019-W001-0005 and 0006 identifies surface water features that exist on and in the vicinity of the sites.

Land East of Birmingham Road

Immediately north of the site there are four man made impounded fishing lakes set a contour of approximately 110mAD. Towards the eastern boundary lies the Dagnell Brook flowing in a southerly direction until it merges with the River Arrow.

Land West of Birmingham Road

The River Arrow runs through this site from the north- west to the south east; in the north portion of the site the River is located along the east boundary; the River continues centrally through the southern portion of the site resulting in proposed developments either side of the River.

2.4 Existing Foul Water System

Severn Trent Water (STW) is the sewerage undertaker for the area. A developer enquiry has been submitted to STW, the enquiry and STW response is included in Appendix C. Sewer records show that there is a small network of foul and storm sewers along Birmingham Road and the residential housing area south of the site.

There is also a short length of foul sewer at the junction of Birmingham Road and Dagnell End Road. The existing foul drainage in the A441 Birmingham Road is near the head of the network that serves the properties either side of Birmingham Road for about 1km north of its junction with Dagnell End Road and a small number of properties about 0.4km east along Dagnell End Road. This foul sewer continues in a south east direction from Birmingham Road immediately north of the River Arrow as a 375mm sewer.

STW has been consulted and their response to the developer enquiry (refer to Appendix C) indicates that a head of a 450mm foul sewer is present about 300m south of Dagnell End Road between Hither Green Lane (serving an existing small residential development around the golf course) and Dagnell Brook; the head of the run chamber (SP05691201) is located in open (third party) ground and not within highway.

3 Ground Conditions

The EA mapping service 'My backyard' shows there to be no Groundwater Protection Zones (GwPZ) present within the vicinity of the site and therefore GwPZ do not pose a constraint to the development and potential drainage options.

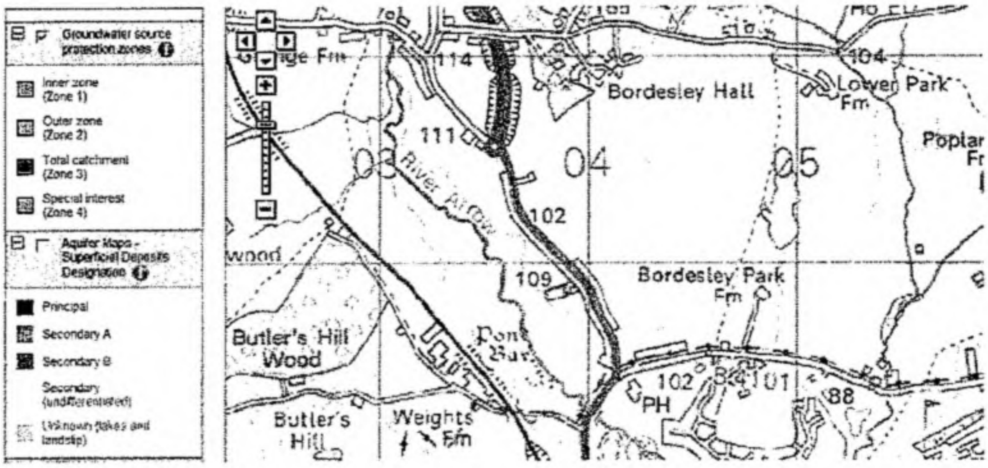


Figure 3: Groundwater Protection Zone Map (Source: www.environment-agency.gov.uk)

3.1 Aquifer Designation

The EA's mapping service shows there are no aquifer bands within the vicinity of the site.

According to the British Geological Survey (BGS) Maps, the bedrock geology underlying the site is made up of Mercia Mudstone (a silty clay marl). The superficial geology of the site has not been recorded.

The following boreholes are located within the boundary of sites:

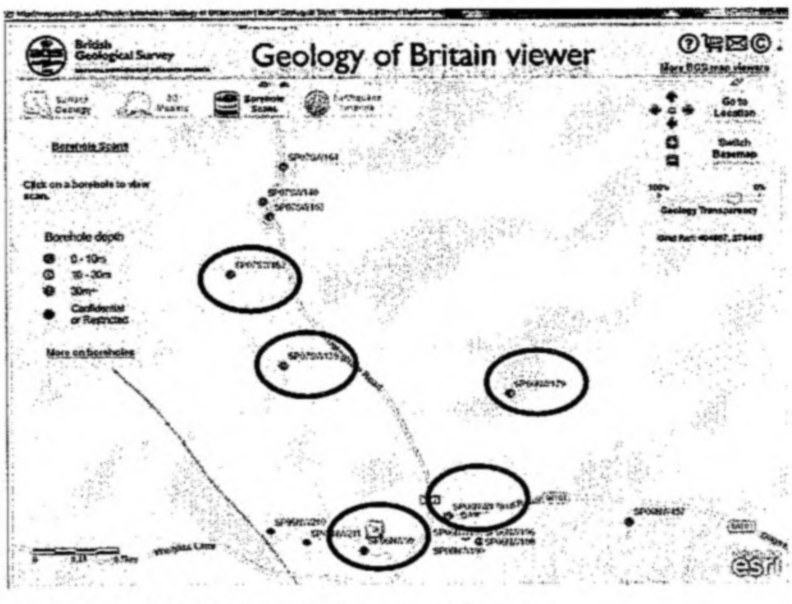


Figure 4: Borehole Locations (Source: www.bgs.ac.uk)

Land East of Birmingham Road

Borehole SP06 NW/178 is located in the south west corner of Land East of Birmingham Road, adjacent to the Birmingham Road and Dagnell End Road junction. Water entering the borehole slowly was found at 1.980m below ground level, fast at 3.195m below ground level and the water level in the borehole after 24 hours was -1.600m below ground level.

Borehole data for SP06 NW/179 confirms that no groundwater was found with a 2.435m of casing used.

Land West of Birmingham Road

Borehole data for *SP06 NW/99* confirms that water entering the borehole slowly was found at 1.520m below ground level and the water level after 24 hours was -1.60m below ground level.

Borehole data for *SP07SW139* confirms that water entering the borehole slowly was found at 4.415m below ground level and the water level after 24 hours was -3.10m below ground level.

No data for *SP07SW162* regarding water levels was documented for this borehole within the site boundary.

The borehole descriptions are summarised below in Table 1.

Borehole	Description
Land East of Birmingham Road - SP06 NW/178	Top soil at ground level. Yellow/grey clay with small stones between 0.3m and 0.605 deep. Brown grey, silty clay with large and small grit and stones, very stiff between 0.605m and 2.130m deep. Brown/grey, silty clay with large and small stones, very stiff between 2.130m and 2.435m deep. Brown/grey, gritty marl – hard and dry between 2.435m and 3.045m deep. Brown, silty marl, hard and dry between 3.045m and 5.330m deep.
Land East of Birmingham Road - SP06 NW/179	**Top soil** **Brown/grey, silty clay – medium between 0.3m and 0.760m deep.** **Brown, silty, clayey marl – stiff and dry between 0.760m and 1.520 deep.** **Brown/grey, silty, gritty marl – very stiff and dry between 1.520m and 2.280m deep.** **Brown/grey, gritty marl – hard and dry between 2.280m and 6.000m deep.**

Land West of Birmingham Road - SP06 NW/99	Top soil Brown sandy clay – medium to stiff between 0.152 and 1.980m deep. Layers of brown, silty clay and grey, silty clay with a few stones medium and wet between 1.980m and 2.280m deep. Grey silt with large and small stones – medium between 2.280m and 3.500m deep. Brown, gritty marl – dry and hard between 3.500m and 5.713m deep.
Land West of Birmingham Road - SP07SW139	Top soil Brown, sandy clay with large and small stones – hard and dry between 0.228m and 2.130m deep. Brown/grey, gritty marl – hard and dry. Changing to silty, gritty marl between 2.130m and 5.485m deep. Marl – very hard and lumpy – dry found at 5.485m deep.
Land West of Birmingham Road – SP07SW162	Top soil Firm dark brown silty fine sand clay with subrounded to rounded medium to coarse flint, quartrite and rock gravel (glacial flood gravel) found at 1.20m deep. Stiff red brown silty clay with occasional light green very silty pockets found at 1.40m deep, becoming stiff at 2.0m deep. Light green and very silty found at 3m deep.

Table 1: Groundwater Protection

3.2 Soakaway Testing

No intrusive site investigation has been carried out, however soakaway tests for the site are planned prior to development. The underlying geology and previous site visits suggest that it is unlikely that infiltration will be appropriate as the sole means of surface water disposal.

4 Development Description

4.1 Type of Development

Within the overall extent of the two sites, it is likely that four separate development areas will be proposed which are likely to consist of circa 1000 residential dwelling units (with appropriate schools and local community centre) across three of the development areas with the remaining development area potentially consisting of either employment or a mix of residential and employment.

Whilst the overall site extent boundaries straggle the River Arrow (in the case of Land West of Birmingham Road) and border Dagnell Brook (in the case of Land East of Birmingham Road), neither of the proposed individual developments would impinge on Flood protection zones.

Attenuation features will be incorporated into the proposals which again would be beyond the extent of Flood protection zones.

Two separate development parcels are proposed within Land West of Birmingham Road referred to as Development Parcel 2a (east of the River Arrow) and 2b (west of the River Arrow) having areas of approximately 7.81ha and 7.43ha respectively.

Similarly two separate development parcels are proposed within Land East of Birmingham Road, to the west referred to as Development Parcel 1a (an area of approximately 19.05ha), with Development Parcel 1b (an area of approximately 22.27ha) to the east.

The development proposal also includes for Bordesley Bypass linking into theA441 'Birmingham Road' and will serve Land West of Birmingham Road.

4.2 Vulnerability

The Technical Guidance to the National Planning Policy Framework Table 2 in TGNPPF (see Figure 5 below) has been used to assess the Flood Risk Vulnerability classification for the proposed use of the site. The classification "More Vulnerable" matches residential use and includes "Building used for; dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels". The classification "Less Vulnerable" matches employment use and includes "Building used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non-residential institutions not included in "more vulnerable"; and assembly and leisure".

Table 2: Flood risk vulnerability classification

Essential Infrastructure
- Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk.
- Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood.
- Wind turbines.

Highly vulnerable
- Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational during flooding.
- Emergency dispersal points.
- Basement dwellings.
- Caravans, mobile homes and park homes intended for permanent residential use[3].
- Installations requiring hazardous substances consent[4]. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as "essential infrastructure")[5].

More vulnerable
- Hospitals.
- Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels.
- Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels.
- Non–residential uses for health services, nurseries and educational establishments.
- Landfill and sites used for waste management facilities for hazardous waste[6].
- Sites used for holiday or short-let caravans and camping, *subject to a specific warning and evacuation plan*.[7]

Less vulnerable
- Police, ambulance and fire stations which are *not* required to be operational during flooding.
- Buildings used for shops, financial, professional and other services, restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non–residential institutions not included in "more vulnerable", and assembly and leisure.
- Land and buildings used for agriculture and forestry.
- Waste treatment (except landfill and hazardous waste facilities).
- Minerals working and processing (except for sand and gravel working).
- Water treatment works which do *not* need to remain operational during times of flood.
- Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place).

Water-compatible development
- Flood control infrastructure.
- Water transmission infrastructure and pumping stations.
- Sewage transmission infrastructure and pumping stations.
- Sand and gravel working.
- Docks, marinas and wharves.
- Navigation facilities.
- Ministry of Defence defence installations.
- Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.
- Water-based recreation (excluding sleeping accommodation).
- Lifeguard and coastguard stations.
- Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms.
- Essential ancillary sleeping or residential accommodation for staff required by uses in this category, *subject to a specific warning and evacuation plan*.

Notes to table 2:

a. This classification is based partly on Department for Environment, Food and Rural Affairs and Environment Agency research on *Flood Risks to People (FD2321/TR2)*[8] and also on the need of some uses to keep functioning during flooding.

b. Buildings that combine a mixture of uses should be placed into the higher of the relevant classes of flood risk sensitivity. Developments that allow uses to be distributed over the site may fall within several classes of flood risk sensitivity.

c. The impact of a flood on the particular uses identified within this flood risk vulnerability classification will vary within each vulnerability class. Therefore, the flood risk management infrastructure and other risk mitigation measures needed to ensure the development is safe may differ between uses within a particular vulnerability classification.

[3] For any proposal involving a change of use of land to a caravan, camping or chalet site, or to a mobile home site or park home site, the Sequential and Exception Tests should be applied.
[4] See Circular 04/00: *Planning controls for hazardous substances* (paragraph 18) at: www.communities.gov.uk/publications/planningandbuilding/circularplanningcontrols
[5] In considering any development proposal for such an installation, local planning authorities should have regard to planning policy on pollution in the National Planning Policy Framework.
[6] For definition, see *Planning for Sustainable Waste Management: Companion Guide to Planning Policy Statement 10* at: www.communities.gov.uk/publications/planningandbuilding/planningsustainable
[7] See footnote 3.

[8] See website for further details. www.defra.gov.uk/science/Project_Data/DocumentLibrary/FD2320_3364_TRP.pdf

6 7

Figure 5 – Extracts from Table 2 of TGNPPF

4.3 Local Development Policy

Bromsgrove District Council and Redditch Borough Council jointly consulted on cross boundary growth options in 2010. Since then changes to the planning system have meant that both Councils need to work together to find a solution to meet the growth needs of Redditch which cannot all be sustainably accommodated within the Borough.

The Localism Act, which received Royal Assent in November 2011 devolves greater powers to Councils and neighbourhoods and gives local communities more control over housing and planning in their areas. The Act provides the mechanism to remove the regional planning tier which has prevented any further Regional Spatial Strategies being progressed.

As part of this collaboration a joint Housing Growth Development Study document was produced in January 2013 highlighting potential areas for development.

4.4 Sequential Test

The sequential test should demonstrate that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed. It is up to the Local Planning Authority to approve the sequential test and confirm that there are no areas in Flood Zone 1 that would be more suitable for the development.

Whilst the overall site boundary extends to Flood Zones 2 & 3, the proposed developments areas consisting of approximately 22.27ha & 19.05ha are within the overall approximate 78.0ha area of Land East of Birmingham Road (and approximately 7.43ha & 7.81ha development areas within the overall approximate 56.0ha Land West of Birmingham Road boundary). As the areas susceptible to flooding within the overall site boundaries are very small and the proposed development areas are only 42% of the total site boundaries, it is proposed that sequential testing be carried out within each site itself which would confirm that all proposed Development will be located within Zone 1 as defined in Table 1 of TGNPPF (comprising land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year).

The development will therefore fall within the lowest area of flood risk and there are is no lower flood risk zone that the site could be allocated within thus passing the sequential test.

The highest vulnerability classification for the proposed uses on the development is More Vulnerable and in accordance with Table 3 – Flood Risk Vulnerability and Flood Zone Compatibility, the "Development is appropriate" (see Figure 6)

Table 3: Flood risk vulnerability and flood zone 'compatibility'

Flood risk vulnerability classification (see table 2)		Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Flood zone (see table 1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	×	Exception Test required	✓
	Zone 3b functional floodplain	Exception Test required	✓	×	×	×

Key: ✓ Development is appropriate.
× Development should not be permitted.

Notes to table 3:
This table does not show:
a. the application of the Sequential Test which guides development to Flood Zone 1 first, then Zone 2, and then Zone 3;
b. flood risk assessment requirements; or
c. the policy aims for each flood zone.

Figure 6 – Extract from Table 3 of TGNPPF

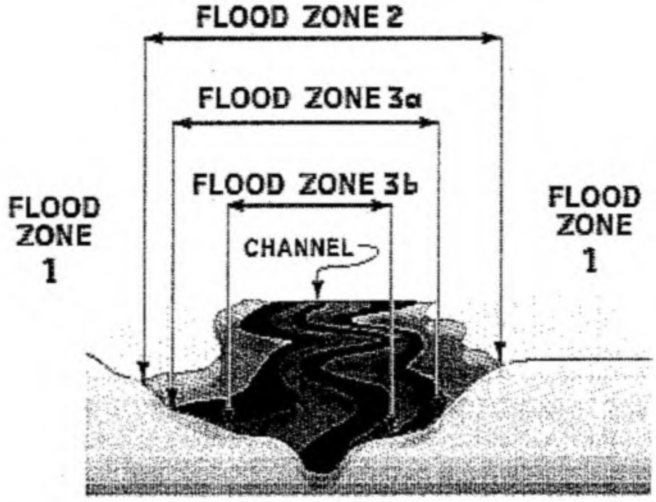


Figure 7 – Flood Zone Classification

5 Potential Sources of Flooding

5.1 Watercourses

The EA provides a web based Indicative Flood Mapping (IFM) service which shows the likelihood and magnitude of fluvial flooding within England and Wales. The latest publication of the IFM (shown in Figure 8) identifies that application sites lie predominately within NPPF flood zone 1 "low probability" which comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (< 0.1%).

Land East of Birmingham Road encompasses the Dagnell Brook to the east and Land West of Birmingham Road encompasses the River Arrow. Both watercourses are within flood zones 2 and 3. However, the proposed development would be located wholly within flood zone 1.

Land East of Birmingham Road is bordered to the east by Dagnell Brook with the River Arrow to the west passing through Land West of Birmingham Road. The largest and most easterly of the four development parcels has a proposed development envelope of approximately 22.27ha; the flood zone associated with Dagnell Brook extends into the overall site boundary of approximately 78ha, however the proposed development envelope itself would be located such that it is wholly within flood zone 1:

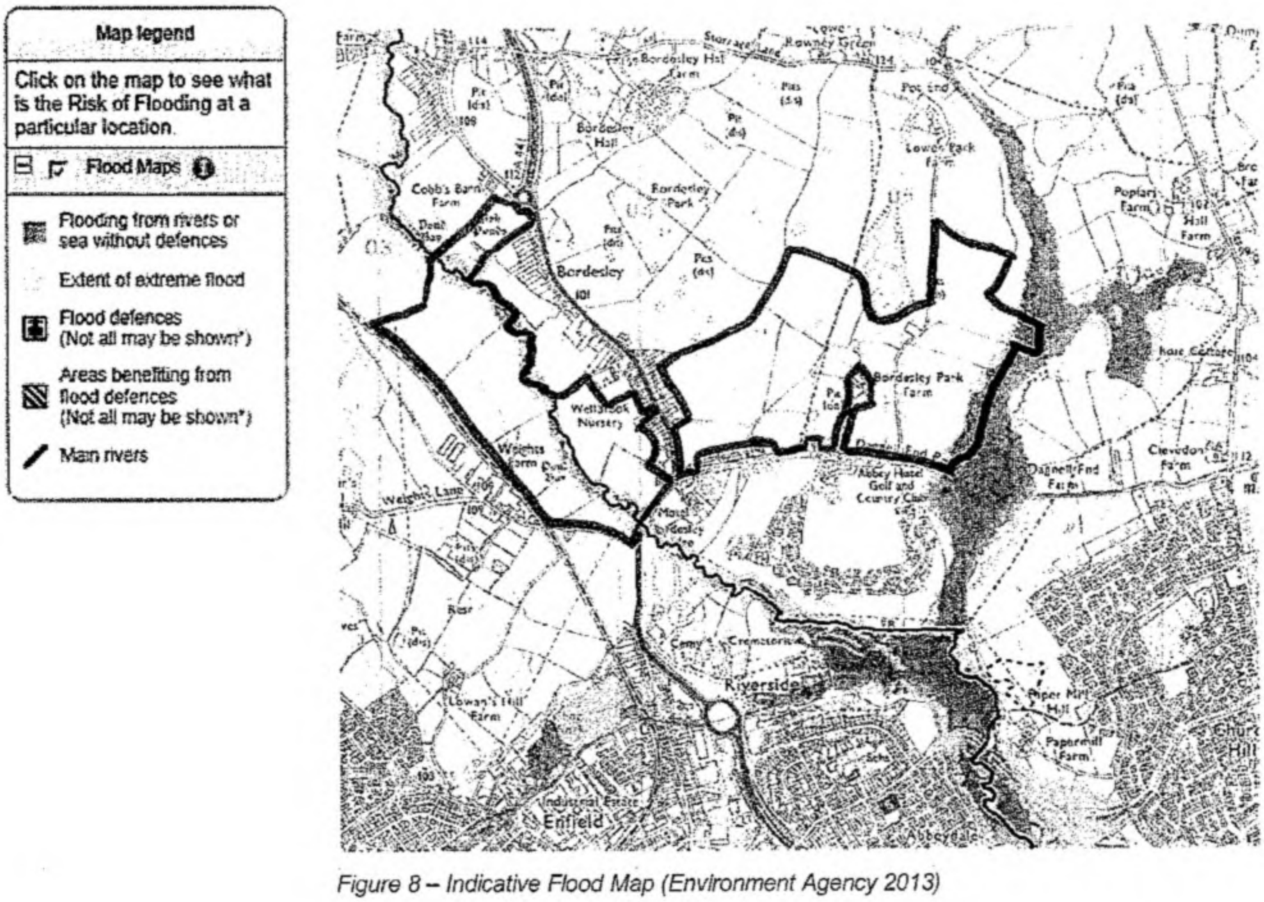


Figure 8 – Indicative Flood Map (Environment Agency 2013)

East of Bordesley Park Farm, North of Dagnell End Road – Land East of Birmingham Road.

Dagnell Brook flows along the eastern perimeter of the site as shown on Drawing No. PJF019-W001- 0005 in Appendix A. This is a tributary of the River Arrow and merges approximately 550m south. The source of the brook is located southwest of Weatheroak Hill, north of the M42 and east of Alvechurch. It is classified as an ordinary watercourse and is culverted beneath Dagnell End Road at NGR 405419, 269381, the culvert is approximately 1.1m deep by 3.6m wide of brick construction with a pass forward capacity of approximately 6.2m^3/sec, refer to Figures 9 and 10 below.

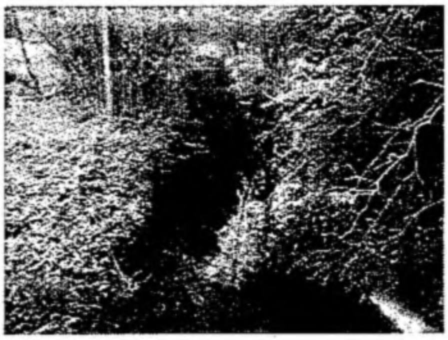


Figure 9- Dagnell Brook D/S of Bridge

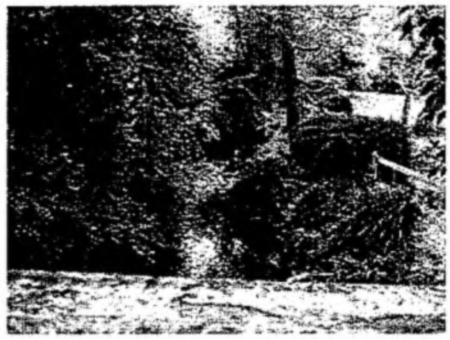


Figure 10 - Dagnell Brook U/S of Bridge

The IFM has been obtained from the EA and these have been correlated with data purchased from "Envirocheck". Both sets of data indicate a narrow flood plain on both banks which correlate well with the ground contour data. The exception to this is a section of channel where the floodplain is shown offset from the brook. This has been corrected by interrogation of levels on the western bank being transposed along the eastern bank.

There will be no development within this flood plain corridor and finish floor levels will be set 600mm above the indicative flood plain levels, therefore there will be no risk of flooding for events up to 1 in 1000yr.

East of the Birmingham to Redditch Railway Line - Land West of Birmingham Road

The River Arrow flows through the site. This is an enmained river and flows in a southerly direction, the source emanates from the Lickey Hills as an ordinary watercourse for approximately 6km prior to then being enmained. Hydraulic river modelling work using ISIS had been completed (2010) by Halcrow on behalf of the EA. The model extends approximately 3.5km upstream of the site and approximately 20.5km downstream. The hydraulic model contains one structure within the extents of the site which influence water levels locally; this is Bordesley Bridge, located beneath the A441 road as shown in Figure 11.

Figure 11 Bordesley Bridge A441

The EA's IFM for this stretch of the River Arrow have been updated following the (2010) completed hydraulic modelling results. The data used to produce the flood plain is that taken from Halcrow's model and in agreement with the EA. The modelling shows there to be a narrow floodplain as expected to be the case in this valley like ground profile.

There will be no development within this flood plain corridor and finish floor levels will be set 600mm above the 100yr plus Climate Change (CC), therefore there will be no risk of flooding for events up to 1 in 1000yr.

There are smaller tributaries flowing into the main watercourse. These generally follow the field boundaries and are obscured by vegetation, but will be accommodated within the development.

Modelled flows (m/sec) and Flood Levels (m AOD) for the River Arrow are tabulated in Table 2 and the extents are shown on Drawing PJF019-W001-0006. The data is a direct output from the ISIS model and used to represent an accurate flood plain.

Node Label	Location	River Levels (m AD) 100yr ST	100yr CC ST	200yr ST	1000yr ST	River Flows (m³/sec) 100yr FL	100yr CC FL	200yr FL	1000yr FL
RAR30040	U/S Site Boundary	96.59	96.69	96.74	97.37	28.49	34.15	38.22	67.6
RAR30040 D	U/S Site Boundary	96.59	96.69	96.74	97.18	28.49	34.15	38.22	67.6
RAR29046	Mid Site	92.4	92.55	92.64	93.13	32.31	*38.66*	*43.1*	*84.06*
RAR28245	U/S A441 Bridge	90.57	90.86	91	91.79	31.98	33.37	33.42	34.78
RAR28245 D	D/S A441 Bridge	89.93	90.14	90.28	90.92	31.98	33.37	33.42	34.78
RAR27249	D/S Site	86.88	86.94	86.98	87.26	23.53	26.54	28.45	46.63
RAR26646 U	U/S Dagnell Brook confluence	85.22	85.24	85.25	85.33	22.66	23.56	24.04	29.05
RAR26646 D	D/S Dagnell Brook confluence	84.98	85.07	85.14	85.41	20.1	20.15	20.14	20.06

Table 2 - River Arrow Flow (FL) and Stage (ST)

The Dagnell Brook has not been modelled; catchment areas have been taken from the FEH CD-ROM Version 1.0 1999 used in assessing flows for the River Arrow modelling analysis. The calculated flows are tabulated in Table 3. The capacity of the culvert beneath Dagnell End Road has been assessed at 6.2m³/sec, it is evident that this culvert is not the sole cause of the backing up of the brook, the indicative flood maps suggests flooding of the lower lying areas resulting from the merging levels of the river arrow.

	100yr (m3/sec)	100yr plus CC (m3/sec)	1000yr (m3/sec)
Dagnell Brook (confluence with River Arrow)	12.231	14.682	33.142

Table 3 - Dagnell Brook Flows

5.2 Groundwater

Analysis of the British Geological Maps and data obtained from "Envirocheck" confirm the site has a moderate to high susceptibility to groundwater flooding. The high levels being mainly associated with river/watercourse channels. The subsoil is mainly loamy clayey in nature with areas of impeded drainage limiting the downward water movement resulting in wet ground conditions more severe during winter months. Land drainage will be provided to ensure that there is no potential for flooding from groundwater standing at natural ground level

CIRIA report 156 'Infiltration Drainage- Manual of good practice" suggests a soil infiltration rate of less than 1×10^{-5} mm/hr for clayey soils. This low permeability suggests infiltration systems would not be appropriate for this site.

Reference to the Environment Agency website confirms that the site is not within any Groundwater Source Protection Zones.

5.3 Historical Flooding

The SFRA Level 1 consultation document (Appendix B, ID233) indicated historic flooding due to overland flows from the land between the A441 and B4101 Dagnell End Road (north-east sector). These combine with the River Arrow during times of spate and, due to the fact that the A441 is lower in part than the bridge over the River Arrow, the highway is regularly rendered impassable due to surface flooding.

5.4 Overland Flows

Land East of Birmingham Road generally falls southeast and towards Dagnell Brook. There is a small parcel of land that falls in a southerly direction and is associated with the River Arrow Catchment. The site is situated on the brow of a hill and as such has no direct potential for surface runoff from adjacent land. Due to the nature of the soil there is potential for overland flow within the site, this will be addressed within the development design.

Land West of Birmingham Road generally falls inwards towards the River Arrow forming a small valley, there is railway embankment forming the western boundary limiting the potential for overland flows from adjacent catchments. The north eastern boundary adjoins residential housing again limiting the potential for overland flows. Due to the nature of the soil there is potential for overland flow within the site, this will be addressed within the development design with overland flows routing directing any potential overland flows away from development and towards the attenuation areas and watercourses.

Highway drainage system exists in immediate road network, which prevents overland run-off from the carriageway reaching the site.

5.5 Sewers

Severn Trent Water is the sewerage undertaker for the area. Sewer Records show that there is a small network of foul and storm sewers along Birmingham Road and the residential housing area south of the site. There is also a short length of foul sewer at the junction of Birmingham Road and Dagnell End Road. There is limited data available regarding potential flooding from these sewers, however the sewer network adjacent to the site forms the head of the systems and as such unlikely to result in flooding.

The SFRA indicates one report of storm sewer flooding has been reported in proximity to this site, the exact location is unknown, although there is anecdotal evidence that pluvial flow from the land north of Dagnell End Road has resulted in localised flooding on that road.

5.6 Reservoirs, Canals & Other Artificial Sources

The Worcester and Birmingham Canal passes approximately 1.3km to the west of the site and poses no potential flood risk. There is only one other artificial source located centrally immediately north of Land East of Birmingham Road as illustrated in Figure 12. This consists of four man made fishing lakes constructed by levelling the existing ground to form a flat plateau. The current operating regime and condition is unknown at present. There are no other artificial sources in the vicinity.

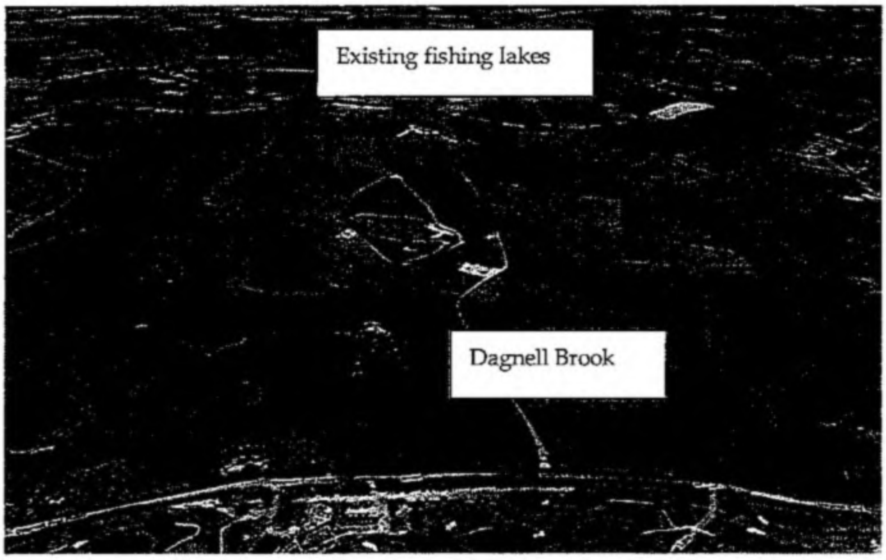


Figure 12 - Fishing Lakes

6 Climate Change

6.1 Climate Change Allowance

In accordance with Table 5 of TGNPPF the drainage design for the development will be carried out with an allowance for climate change dependent upon its design life. For a development with design life until between 2055 and 2085, an allowance for a 20% increase in rainfall intensity will be made. For a design life until between 2085 and 2115 the corresponding allowance is 30%. The impact of the watercourse through the site will also be assessed including an allowance for a 20% increase in peak river flows. The policy aims for Flood Zone 1, low probability flooding, are that "developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond, through the layout and form of the development, and the appropriate application of sustainable drainage techniques." This will be achieved for the application site by ensuring there is no risk of flooding for events up to and including the 1 in 100 year plus the appropriate allowance for climate change, being a 30% increase in rainfall intensity and a 20% increase in watercourse flows.

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%	+20%		
Offshore wind speed	+5%		+10%	
Extreme wave height	+5%		+10%	

Figure 13: Reproduction of Table 5 (TGNNPPF) – giving precautionary sensitivity ranges for taking climate change into account

7 Detailed Development Proposals

The development proposal consists of two sites immediately north of the Redditch Borough Council boundary within Bromsgrove District which would form a strategic sustainable urban extension for Redditch. The two adjacent sites are located on land north of Dagnell End Road and north-west of the A441 Birmingham Road.

- Land East of Birmingham Road – around Bordesley Park Farm, North of Dagnell End Road

This has an area of approximately 78.0 hectares within which two development parcels are proposed, both residential and having areas of approximately 19.05ha (Parcel 1a) and 22.27ha (Parcel 1b).

- Land West of Birmingham Road - East of the Birmingham to Redditch Railway Line

This has an area of approximately 56.0 hectares and is situated in the valley of the River Arrow; within which two development parcels are proposed, residential in the case of the site east of the River Arrow (Parcel 2a) and either employment or a mix of residential and employment for the development west of the River Arrow (Parcel 2b). These would have areas of approximately 7.81ha and 7.43ha respectively.

Within the overall extent of the two sites, the four development parcels would consist of circa 1000 residential dwelling units with Land West of Birmingham Road (west of the River Arrow) potentially being employment or a mix of employment and residential.

The development proposal also includes for Bordesley Bypass linking into theA441 'Birmingham Road' and will serve Land West of Birmingham Road.

8 Surface Water Drainage

This section outlines the proposed strategy for draining surface water runoff from the application site.

8.1 Drainage Design Guidance

In accordance with NPPF and TGNPPF, any new and re-development should apply and give priority to Sustainable Drainage Systems (SuDS), which are designed to control surface water runoff close to where it falls and mimic natural drainage as closely as possible. Therefore in accordance with planning policy the development will implement a site storm drainage system that provides sustainable drainage measures with due regard of the recommendations of NPPF, guidance contained within the local SFRA and the following industry standards:

- Draft SuDS National Standards;
- The SuDS Manual CIRIA C697;
- Defra/EA Flood & Coastal Erosion Risk Management R&D Programme – Preliminary Rainfall Runoff Management for Developments Rev E (2012);
- EA's pollution prevention guidelines (PPGs); and
- Sewers for Adoption 7th Edition.

When appraising suitable storm water discharge options for a development site, Part H of the Building Regulations 2002 provides the following hierarchy, listed in order of priority:

a) an adequate soakaway or some other adequate infiltration system; or where that is not reasonably practicable

b) a watercourse; or where that is not reasonably practicable

c) a sewer.

8.2 Surface Water Drainage

The surface water drainage system designed to serve the site will fully encompass sustainable drainage techniques to the approval of the Environment Agency. The design of a sustainable drainage system will take groundwater levels into account. It is proposed that surface water runoff will discharge to Dagnell Brook and the River Arrow at below greenfield rates. Land Drainage (Flood Defence) Consent will be sought from the Environment Agency for all proposed outfalls.

8.2.1 Surface Water Runoff Rates and Percentage Impermeability

Greenfield runoff rates are calculated to determine the level of acceptable rate of discharge from the site to the receiving watercourse and are likely to be used by the environmental regulator to set site-specific drainage constraints. The calculation of peak rates of runoff from greenfield areas is related to catchment size. The values derived should be regarded as indicative because prediction of runoff from any catchment will always be imprecise and estimation of runoff from part of a catchment (as most development sites are) will be even less accurate.

The Institute of Hydrology Report 124 Flood estimation for small catchments (Marshall & Bayliss, 1994) has been used to determine peak greenfield runoff rates for QBAR. Where developments are smaller than 50 ha, the analysis for determining greenfield discharge rate should use 50 ha in the formula but linearly interpolate the flow rate value based on the ratio of the size of the development to 50 ha.

The QBAR Value has been calculated at 4.85l/sec/ha. (Refer to Appendix B for details of the calculations).

The use of soakways is considered limited based on current ground conditions; however this will be investigated further during detailed design to determine any suitable areas. To ensure making space for water is considered at the earliest point in the master planning it has been assumed no infiltration is possible. This will ensure the maximum land required for the open attenuation is secured.

For the purpose of determining the amount of attenuation required the impermeable area of the proposed development has been assessed at 60% for residential areas and 80% for commercial areas, this will be subject to change during detail design and flows adjusted and agreed accordingly.

8.2.2 Attenuation Volumes

The required volume of storage has been calculated for the 1 in 100year design storm events with climate change (assessed at 30%). The maximum discharge has been set to QBAR at 4.85 l/sec/ha.

Micro Drainage WinDes (ver: 2013.1.1) programme has been used to determine the overall volume required. The programme runs a series of simulations for different storm durations for a 1 in 100 year (+30% climate change) return period rainfall event to determine the storm duration that requires the maximum volume of storage required.

Summary of outline attenuations requirements are tabulated in Table 4. The location of the proposed attenuation features and respective outfalls are shown on Drawing PJF019-W001- 0007 and 0008 in Appendix A.

Catchment Ref	Impermeable Area (ha)	Volume of attenuation (m^3)	Permitted discharge (l/sec)
Land East of B'ham Road Parcel 1B (East)	22.27 * 0.6= 13.36ha	8810m³	64.8
Land East of B'ham Road Parcel 1A (West)	19.05*0.6=11.43ha	7534 m³	55.4
Land West of B'ham Road Parcel 2A (East)	7.81*0.6=4.69ha	3065 m³	22.7
Land West of B'ham Road Parcel 2B (West)	7.43*0.8=5.94ha	3887 m³	28.8

Table 4 Outline Attenuation Requirements

The Bordesley Bypass is likely to require positive drainage. Attenuation will be in the form of either a linear ditch or attenuation feature or connected into the development drainage.

8.3 SuDS Management Train

A sustainable drainage system will be employed to minimise the impact of the development on the quantity and quality of surface water runoff and maximise amenity and biodiversity opportunities. Surface water drainage proposals will consist of a combination of techniques in order to achieve these objectives and to replicate, as closely as possible, the natural drainage of the site before development.

In seeking to implement SuDS techniques to deal with surface water runoff from the site the "Management Train" methodology as set out in CIRIA C697 will be adopted as part of the strategy for draining the site. The Management Train is made up of the following components:

a) **Prevention** – the use of good site design and housekeeping measures to prevent runoff and pollution (e.g. sweeping to remove surface dust & detritus from car parks), and rainwater reuse/harvesting. Prevention policies should generally be included within the site management plan.

b) **Source Control** – control of runoff at or very near to its source (e.g. soakaways, other infiltration methods, green roofs, pervious pavements).

c) **Site Control** – management of water in a local area or site (e.g. routing water from building roofs and car parks to a large soakaway, infiltration or detention basin).

d) **Regional Control** – management of runoff from a site or several sites, typically in a balancing pond or wetland.

Ground conditions at the site look likely to preclude the use of a soakaway system, so that attenuation facilities will be required to limit the discharge and remove pollutants before outfalling to the watercourse. The most suitable forms of SuDS for this site would be:

- Attenuation features/basins/wetlands and pervious surfaces with collector drains;
- Swales and/or filter strips with collector drains;
- Pre-treatment devices – incorporating suitable pollution control measures such as permeable paving, silt traps and petrol interceptors, in addition to the filtration provided by the aforementioned SuDS will further improve water quality before discharge to the watercourse;
- Bio retention units for highway drainage or pocket street gardens with collector drains.

8.3.1 Site Specific SuDS Proposals

The overall strategy for the development will be to outfall to the River Arrow and Dagnell Brook via four flow regulation facilities designed not to exceed the overall allowance. The following principle of SUDS will be considered for this development.

It is anticipated that the surface water sewers from the development will discharge in their entirety to attenuation features. The attenuation features will be constructed to balance surface water flows and restrict discharge from the site to Greenfield runoff rate.

The detailed design of the attenuation features will include variation in levels and areas which will fill at different rates, some of which may be permanently wet. These will have beneficial effects in terms of water quality on the receiving watercourse by providing the opportunity to treat the run-off emanating from the development.

The attenuation features as well as facilitating the required flow balancing for the whole site will also provide a minimum of 2 surface water treatment trains to provide water quality improvements as outlined in Tables 5 and 6 below. The attenuation features will also provide wider benefits such as bio-diversity and public amenity.

An access to the attenuation features for maintenance will be provided at the northern edge of the proposed development through the development proposals.

At detailed design stage the attenuation features will be designed in accordance with CIRIA SUDs manual to be approved by the adopting authority.

Stage	Description	Treatment Provided
Stage 1: Forebay Sacrificial Area	Surface Water discharging into attenuation features will flow into sacrificial area that can be de-silted on a regular basis.	Removal of solids due to enhanced settlement.
Stage 2: Vegetation and Reed Wetland	Surface Water discharging into attenuation features will flow over the top of vegetation within attenuation features and reed planting within the permanent water area of attenuation features.	Removal of solids due to enhanced settlement through reduced flow velocities, offers filtering and adsorption (see table 5 below)
Stage 3: Retention (within permanent attenuation features)	A permanent volume of water with vegetation provided below the invert level of the outlet to capture small events.	Dilution and retention of first flush of more heavily contaminated surface water discharge, settlement of suspended solids and water quality improvement.
Stage 4: Detention within attenuation features	Water detained within attenuation features by use of hydraulic control on outlet of attenuation features, discharging to watercourse at controlled rate.	Settlement of suspended solids and attenuation of surface water discharge to green field run off rates.

Table 5: Stages of proposed attenuation features

The proposed attenuation features will incorporate vegetation and a reed wetland area effective in the removal of suspended solids and associated heavy metals through the physical processes of settlement and filtration. The permanent attenuation feature within the attenuation feature ensures a sufficient residence time to allow adsorption and microbial degradation and biological uptake of metals and nutrients.

This type of attenuation feature is well suited to treat highway runoff as it is able to deal with the high suspended solid loads in highway runoff.

The principal constituents requiring treatment are solids, heavy metals, and a wide range of organic compounds, which include oils and grease.

The most important treatment processes in vegetative treatment systems are:

I. settlement and filtering of particulate constituents;
II. adsorption of heavy metals and organic compounds to vegetation and soils;
III. microbial degradation and assimilation of organic compounds;
IV. uptake of nutrients and metals by higher plants.

These processes, as applicable to the proposed stages of the proposed attenuation features are set out in Table 6 below.

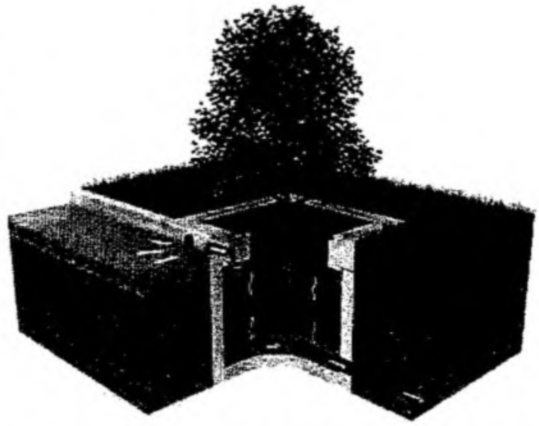
Runoff Constituent	Stage 1: Forebay Sacrificial Area	Stage 2: Vegetation and Reed Wetland	Stage 3: Retention (within permanent attenuation feature)	Stage 4: Detention within Attenuation Feature
Solids	Filtering Settlement	Filtering Settlement	Filtering Settlement	Settlement
Heavy Metals (particulate and soluble)	Filtering Settlement	Filtering Settlement Adsorption Plant uptake	Filtering Settlement Adsorption Plant uptake	Settlement Adsorption
Organic Compounds (particulate and volatile)	Filtering Settlement	Filtering Settlement Adsorption Biodegradable Volatilisation	Filtering Settlement Adsorption Biodegradation Volatilisation	Settlement Adsorption Biodegradable Volatilisation
Nutrients	Plant uptake	Plant uptake	Plant uptake	Plant uptake
Oil & Grease (particulate)	Filtering Settlement	Filtering Settlement Adsorption Biodegradation	Filtering Settlement Adsorption Biodegradation	Settlement Adsorption Biodegradation

Table 6: Treatment of Highway and Residential Surface Water Runoff: Principal Processes in proposed attenuation features

While the proposed attenuation features will provide water flow and quality improvements sufficient to comply with statutory requirements and national guidance, there may be opportunity to incorporate additional SuDs features within the development to provide improvements over and above those required. Where appropriate the following SuDS features may be utilised.

Pervious surfaces: Surfaces that allow inflow of rainwater into the underlying construction or soil, such as porous surfacing (e.g. gravel) or permeable hard surfacing (e.g. permeable block paving, porous tarmac and porous concrete). The source control (informal storage) can be created within the sub-base of these surfaces given careful selection of the stone fill or use of plastic box systems. They may also permit infiltration.

Bio-retention areas: Vegetated areas designed to collect and retain runoff, and permit settlement of suspended solids & biological removal of pollutants before discharge via a piped system or infiltration to the ground.



Pocket Street Infiltration: Where these units comprise a plan area of at least 2% of the impervious area connected, they have recently been shown to provide on average some 33% reduction in sewer inflow volumes. The attenuation is conservatively expected to store at least the first 12mm of runoff and only release it slowly, even during successive storm events.

8.3.2 SuDS Adoption & Maintenance

The future ownership and management of all elements of the SuDS system will need to be addressed at an early stage as the maintenance responsibility must be given to durable and accountable bodies having the resources to meet the long term needs of the system. The interim conclusion of the Pitt Review states that *'ensuring the developers make a full contribution to the costs of both building and maintaining'* such systems is vital to their long term effectiveness. The costs of maintaining SuDS devices will depend on the SuDS features used and this should be considered by the developer at an early stage.

STW are currently prepared to adopt only structures of the type they have historically maintained and which usually involve hard-engineered traditional drainage systems, not SuDS systems such as basins, ponds and attenuation features. Until this process changes there will be challenges with adoption and developers will have to engage with local authorities to establish the best long term maintenance plan. The Floods and Water Management Act (FWMA) 2010 gained royal ascent in April 2010. The Act will implement several key recommendations of Sir Michael Pitt's Review of the summer 2007 floods. Section 3 of the FWMA will possibly be introduced in spring 2014 and is intended to identify a process for unitary councils and local authorities to adopt sustainable urban drainage systems.

North Worcestershire Flood Management as the Lead Local Flood Authority (LLFA) is currently not a statutory consultee to the planning process for drainage matters. When Schedule 3 of the FWMA 2010 is implemented, North Worcestershire Flood Management is expected to become the SuDS Approval Body (SAB), as well as a statutory consultee to the planning process for matters that relate to surface water drainage. The existing Defra consultation has stated that the SAB role will apply initially to major developments, delivered through the planning process from the implementation date, with other thresholds for smaller developments being introduced, in time, on a phased basis. Schedule 3 of the FWMA 2010 is currently anticipated to be implemented in April 2014.

In the absence of National Standards and Guidance, developers and their consultants should base designs around current best practice in the form of CIRIA C697 and other leading local authority and water authority guidance available from Cambridge City, Anglian Water, and Oxfordshire County Council.

As the majority of SuDS are surface elements they should be incorporated into local landscape maintenance regimes. An advantage of this is that the site managers and landscape contractors will have a good knowledge of the site through regular maintenance operations such as grass cutting and litter removal. This should also ensure regular monitoring and a quick response to any maintenance needs.

CIRIA case studies of new developments have concluded that the most cost-effective SuDS measures are within the soft landscaped areas, as the long-term management and maintenance can be incorporated into landscape and wildlife management regimes. The need to keep SuDS simple was also raised as this ultimately reduced maintenance costs and increases the likelihood of future maintenance.

All foul and surface water sewers will be offered to STW for adoption under a Section 104 agreement.

8.3.3 Using Water Wisely

As part of the detailed design stage attempts should be made for the development to use water wisely due to the increasing pressure on water resources. It is recommended that source control systems are installed including porous paving.

9 Foul Drainage

A developer enquiry has been sent to Severn Trent Water who have returned existing sewer record plans (provided in Appendix C). This is copied below with potential connection points indicated. These proposed connection points are also shown on Drawing PJF019-W001- 0007 and 0008 in Appendix A.

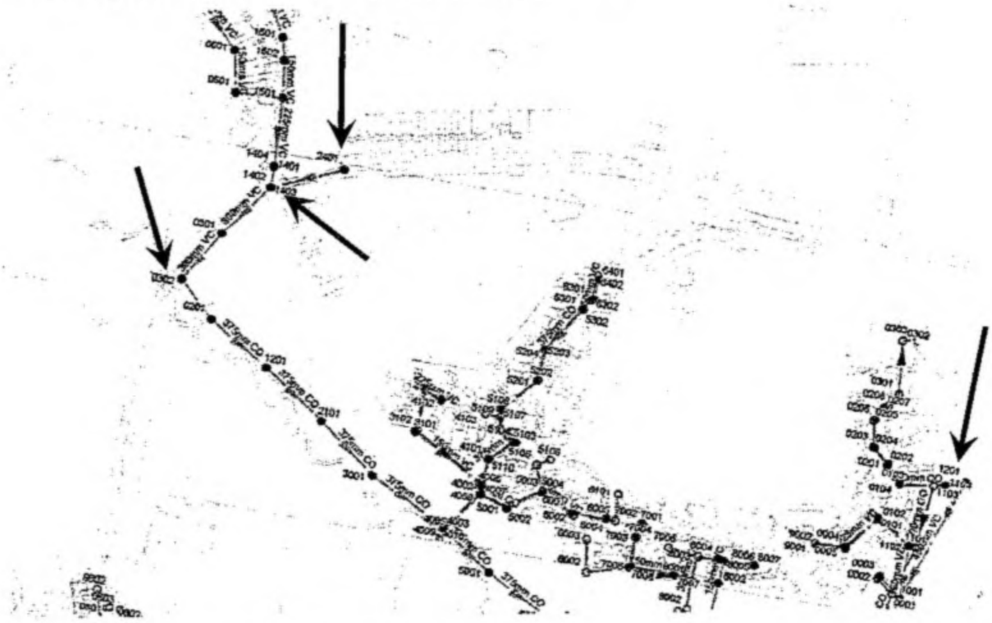


Figure 14: Potential Connection Points

Foul discharge from the development can discharge into the existing foul drainage network. STW have responded in the developer enquiry that it is not envisaged that further modelling will be necessary at this stage. However they are particularly interested in the phasing as this may require some local upsizing.

Foul water design discharge rates have been calculated using Sewers for Adoption 7th Edition guidelines and are based on 4000 l/house/day and 0.6 l/sec for other developable areas, this assumes no trade waste. Actual flows rates generated from the development will be much less and have been calculated using the following formulae for residential development (2.75head/unit x 160l/head/day plus 10% x a peak of 3 times). Preliminary estimates of the peak design foul water flows and actual flow rates are as follows:

Development Area	Sewers for Adoption Estimated Peak Design flow (litres/second)	Estimated Actual Flows
Housing (1000 units)	46	17
Employment (7.43 ha)	5	5
Total Discharge (l/sec)	51	22

Table 7: Sewers for Adoption Estimated Peak Design Flow and Actual Foul Water Flows

The sewers will be constructed in accordance with the relevant "Sewers for Adoption" and adopted by STW.

10 Conclusion

This report demonstrates that the proposed redevelopment can be achieved with an acceptable risk of flooding and takes into account the recommendations of National Planning Policy Framework Planning (NPPF) published by the Department for Communities and Local Government, March 2012 and the Technical Guidance to the National Planning Policy Framework published by the Department for Communities and Local Government, March 2012. These documents replace Policy Statement 25 - Development and Flood Risk (PPS 25) published by Communities and Local Government, December 2006.

The vast majority of the application site is classified as within NPPF flood zone 1 "low probability" which comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (< 0.1%). There is a small area identified by the EA's indicative maps shown as being located in flood zones 2 "medium probability" and 3 "high probability, however the proposal will ensure that all built development is located within the flood zone 1.

The QBAR Value has been calculated at 4.85l/sec/ha

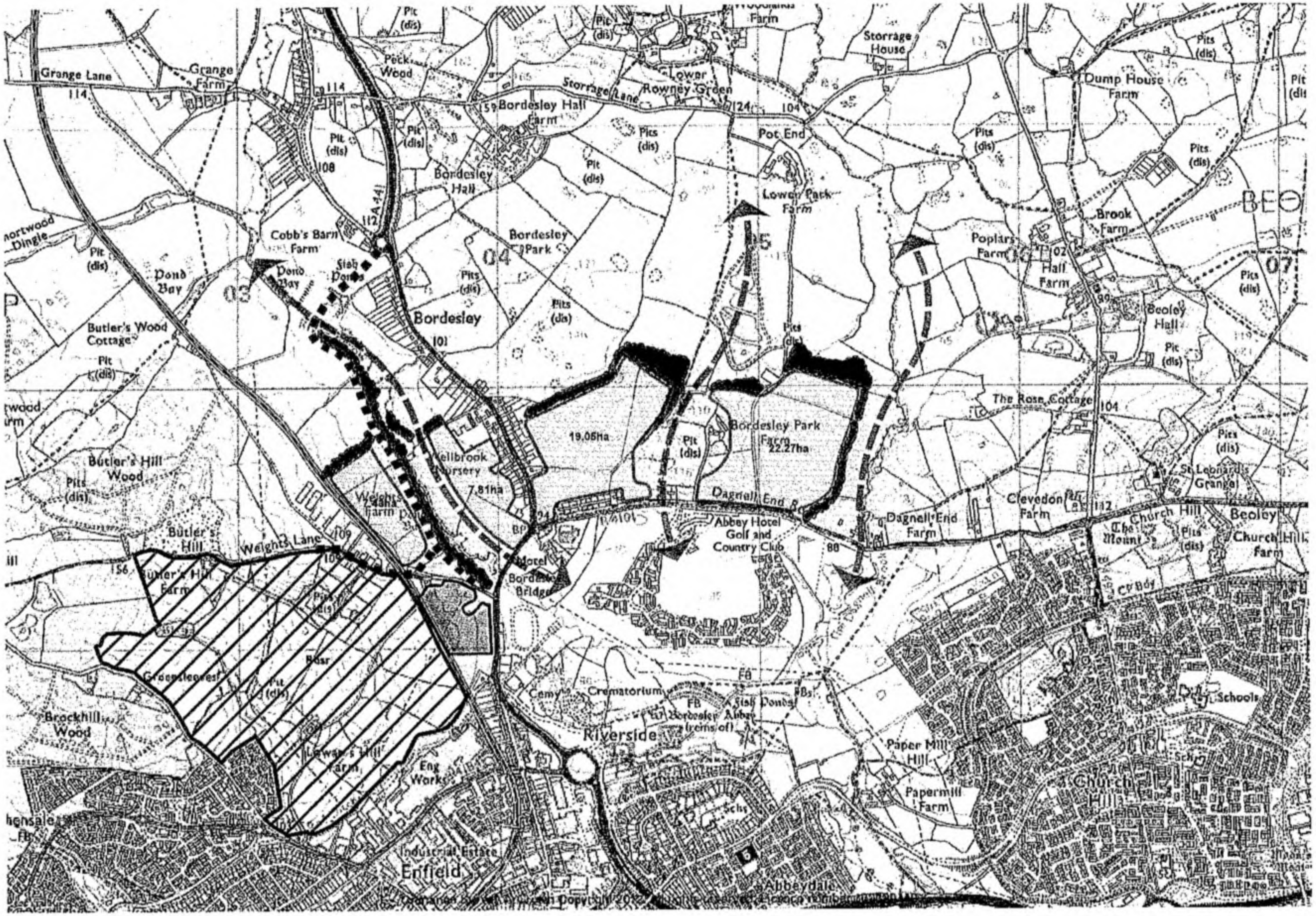
The required volume of storage for both sites has been calculated for the 1 in 100year design storm events with climate change (assessed at 30%).The run-off from the development is likely to be stored in four separate attenuation features which have been sized to accommodate the storage for the QBar discharge of 4.85l/sec/ha with an additional 30% to allow for climate change and will release water at a controlled rate to the River Arrow and Dagnell Brook. The required storage is 8810m^3 for Parcel 1B (East), 7534m^3 for Parcel 1A (West), 3065m^3 for Parcel 2A (East) and 3887m^3 for Parcel 2B (West).

SuDS will be employed to minimise the impact of the development on the quantity and quality of surface water runoff and maximise amenity and biodiversity opportunities. As well as facilitating the required flow balancing for the site, the attenuation features will also provide a minimum of 2 surface water treatment trains to provide water quality improvements. SuDS will be appropriately designed in accordance with the SuDS CIRIA C697 Manual.

Foul discharge from the development can discharge into the existing foul drainage network. STW have responded to the Developer Enquiry and do not envisage modelling will be necessary at this stage, however STW would like to know where the favourable connection points are anticipated to the network to inform and finalise the off-site improvement strategy.

Appendix A

Drawing



KEY

- By-pass and connection to adjoining land
- Approximate development envelope
- Area with resolution to grant consent
- Adjoining allocation
- Strategic planting belts
- 'Green corridor'

DRAFT

Bordesley, Redditch

Composite Development Strategy

Bir.4226_01A

Pegasus Landscape Design

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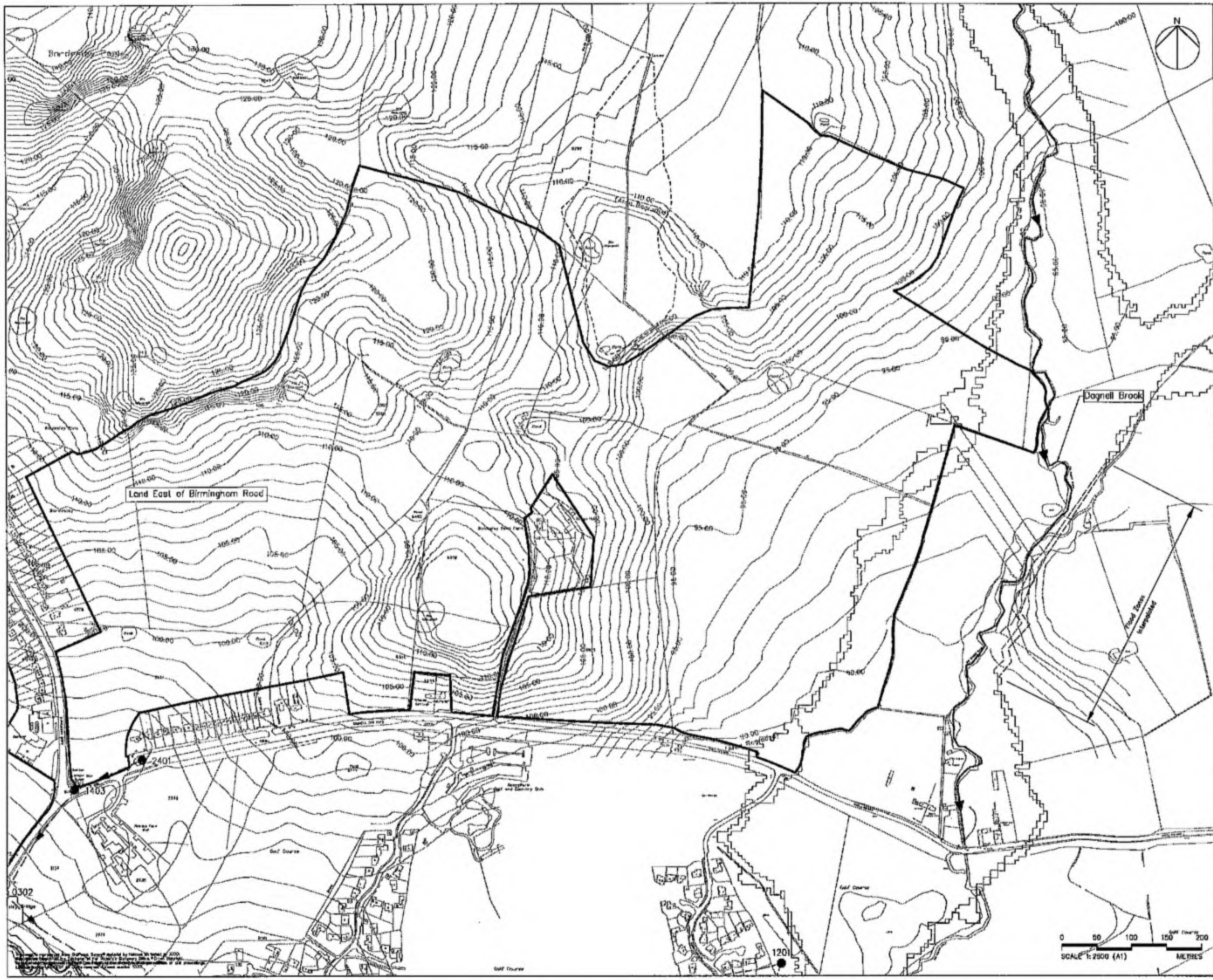


Key:

- Redline Application Boundary
- Existing Watercourse
- Existing FWS Network
- Zone 3 Flood Area } EA
- Zone 2 Flood Area } EA
- Modelled 100yr cc
- Existing fishing ponds

Notes:

1. All dimensions are in metres unless noted otherwise.
2. This Drawing is indicative only. Do not scale from this Drawing.
3. Zones 2 & 3 data for Dagnell Brook, taken from Enviro Data.

Rev	By	Chkd	Apprvd	Date	Description
B	[illegible]	[illegible]	SP	[illegible]	Red line boundary and text amended.
A	[illegible]	[illegible]	SP	[illegible]	OS background added. Boundary amended.

DO NOT SCALE. This drawing is to be read in conjunction with all relevant Architects, Engineers and Specialist Manufacturer's drawings and specifications. If in doubt please consult the Engineer.

Drawing Status: PRELIMINARY

Client: GALLAGHER ESTATES

Halcrow

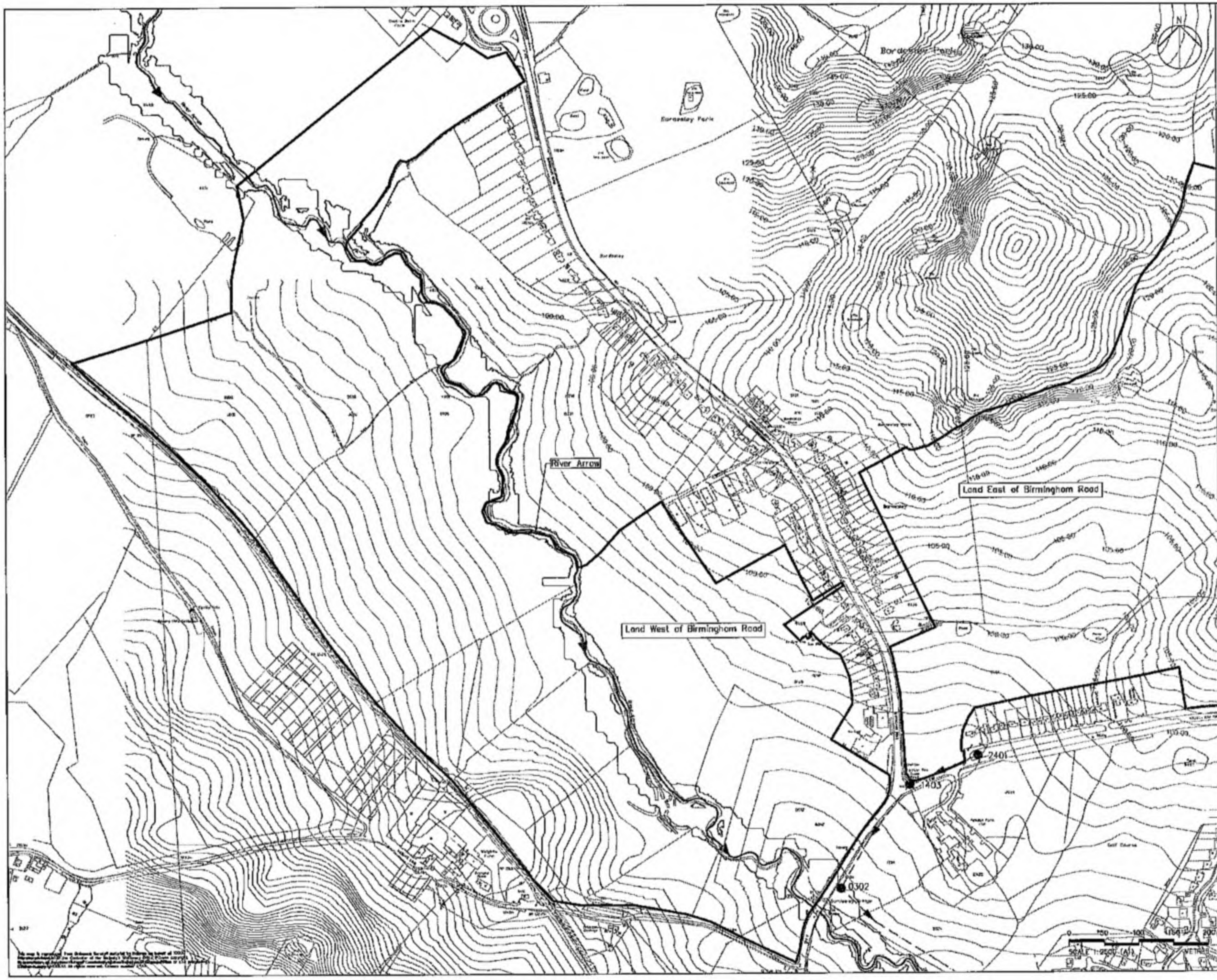
Project: REDDITCH TOWN URBAN EXTENSION

Drawing: EXISTING FEATURES LAND EAST OF BIRMINGHAM ROAD

Drawn by: SEH Date: 15/10/13
Checked by: DAW Date: 15/10/13
Approved by: - Date: -

Drawing No.: PJF019-W001-0005 Revision: B

Drawing Scale: 1:2500 at A1



Key:

- Application Redline Boundary
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- Modelled 100yr cc
- Existing fishing ponds

Notes:

1. All dimensions are in metres unless noted otherwise.
2. This Drawing is indicative only. Do not scale from this Drawing.
3. 100 year + CC River Arrow flood data taken from ISIS model 2010.

DO NOT SCALE. This drawing is to be read in conjunction with all relevant Architects, Engineers and Specialist Manufacturer's drawings and specifications. If in doubt please consult the Engineer.

PRELIMINARY

GALLAGHER ESTATES

Halcrow

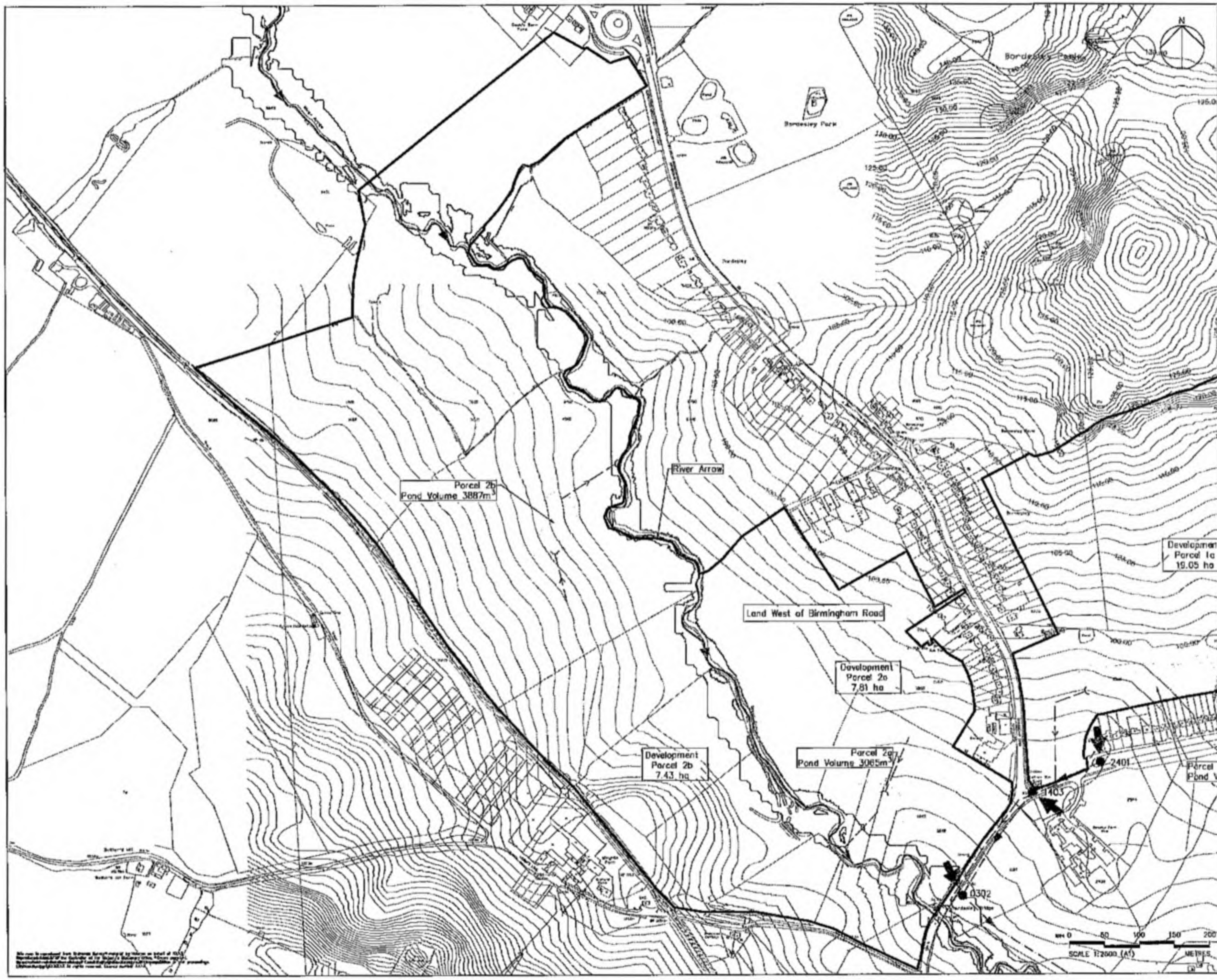
Project: REDDITCH TOWN URBAN EXTENSION

Drawing: EXISTING FEATURES
LAND WEST OF BRIMINGHAM ROAD

Drawn by: SEH Date: 15/10/13
Checked by: DAW Date: 15/10/13
Approved by: - Date: -

Drawing No: PJF019-W001-0006 Revision: B


Land East of Birmingham Road
Development Parcel 1a 19.05 ha
Development Parcel 1b 22.27 ha
Parcel 1a Pond Volume 7534m³
Parcel 1b Pond Volume 8810m³
Dagnell Brook
2401
2403
0302
120
SCALE 1:2500 (A1)
METRES
Legend:
Site Boundary
Indicative SWS Network
Existing Watercourse
Existing FWS Network
Zone 3 Flood Area
Zone 2 Flood Area
Proposed FW Connection Point
Notes:
1. All dimensions are in metres unless noted otherwise.
2. This Drawing is indicative only. Do not scale from this Drawing.
3. Zones 2 & 3 data for Dagnell Brook, taken from Enviro Data.
DO NOT SCALE. This drawing is to be read in conjunction with all relevant Architects, Engineers and Specialist Manufacturer's drawings and specifications. If in doubt please consult the Engineer.
PRELIMINARY
GALLAGHER
ESTATES
Halcrow
REDDITCH TOWN URBAN EXTENSION
PROPOSED FWS/SWS, CATCHMENT AREAS & ATTENUATION PONDS LAND EAST OF BIRMINGHAM ROAD
Checked by: GAW
PJF019-W001-0007
B



Legend:

- Redline Application Boundary
- Indicative SWS Network
- Existing Watercourse
- Existing FWS Network
- Zone 3 Flood Area
- Zone 2 Flood Area
- Proposed FW Connection Point

Notes:

1. All dimensions are in metres unless noted otherwise.
2. This drawing is indicative only. Do not scale from this drawing.
3. 100 year + CC River Arrow flood data taken from ISIS model 2010.

Rev	By	Chkd	Apprvd	Date	Description
B					Red line boundary and text amended.
A					OS background added. Boundary amended.

DO NOT SCALE. This drawing is to be read in conjunction with all relevant Architects, Engineers and Specialist Manufacturer's drawings and specifications. If in doubt please consult the Engineer.

Drawing Status: PRELIMINARY

Client: GALLAGHER ESTATES

Halcrow

Project: REDDITCH TOWN URBAN EXTENSION

Drawing: PROPOSED FWS/SWS, CATCHMENT AREAS & ATTENUATION PONDS LAND WEST OF BIRMINGHAM ROAD

Drawn by: SEH Date: 15/10/13
Checked by: DAW Date: 15/10/13
Approved by: - Date: -

Drawing No. PJF019-W001-0008 Revision B

Drawing Scale: 1:2500 at A1

Appendix B

Calculations

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	97.364	0.364	46.2	3203.5	O K
30 min Summer	97.474	0.474	50.4	4171.8	O K
60 min Summer	97.586	0.586	50.4	5159.2	O K
120 min Summer	97.695	0.695	54.1	6115.3	O K
180 min Summer	97.753	0.753	56.3	6623.3	O K
240 min Summer	97.789	0.789	57.6	6939.3	O K
360 min Summer	97.832	0.832	59.2	7325.0	O K
480 min Summer	97.858	0.858	60.1	7550.0	O K
600 min Summer	97.872	0.872	60.6	7675.2	O K
720 min Summer	97.879	0.879	60.8	7736.0	O K
960 min Summer	97.880	0.880	60.9	7744.3	O K
1440 min Summer	97.874	0.874	60.6	7693.1	O K
2160 min Summer	97.856	0.856	60.0	7532.7	O K
2880 min Summer	97.830	0.830	59.1	7307.1	O K
4320 min Summer	97.771	0.771	57.0	6788.1	O K
5760 min Summer	97.711	0.711	54.7	6260.8	O K
7200 min Summer	97.655	0.655	52.5	5768.3	O K
8640 min Summer	97.603	0.603	50.4	5308.9	O K
10080 min Summer	97.554	0.554	50.4	4873.8	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	129.286	27
30 min Summer	84.561	41
60 min Summer	52.662	70
120 min Summer	31.683	130
180 min Summer	23.225	188
240 min Summer	18.524	248
360 min Summer	13.425	366
480 min Summer	10.684	484
600 min Summer	8.943	602
720 min Summer	7.730	722
960 min Summer	6.137	898
1440 min Summer	4.427	1120
2160 min Summer	3.188	1512
2880 min Summer	2.523	1916
4320 min Summer	1.812	2732
5760 min Summer	1.432	3528
7200 min Summer	1.192	4328
8640 min Summer	1.026	5104
10080 min Summer	0.903	5856

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	97.408	0.408	49.5	3588.9	O K
30 min Winter	97.532	0.532	50.4	4679.5	O K
60 min Winter	97.658	0.658	52.6	5786.8	O K
120 min Winter	97.780	0.780	57.3	6862.8	O K
180 min Winter	97.845	0.845	59.6	7439.2	O K
240 min Winter	97.886	0.886	61.1	7800.0	O K
360 min Winter	97.937	0.937	62.8	8247.5	O K
480 min Winter	97.968	0.968	63.8	8516.2	O K
600 min Winter	97.986	0.986	64.4	8675.2	O K
720 min Winter	97.996	0.996	64.7	8763.8	O K
960 min Winter	98.001	1.001	64.9	8810.1	O K
1440 min Winter	97.985	0.985	64.4	8666.0	O K
2160 min Winter	97.956	0.956	63.4	8409.1	O K
2880 min Winter	97.915	0.915	62.0	8053.1	O K
4320 min Winter	97.825	0.825	58.9	7260.7	O K
5760 min Winter	97.737	0.737	55.7	6489.2	O K
7200 min Winter	97.657	0.657	52.6	5777.5	O K
8640 min Winter	97.581	0.581	50.4	5116.7	O K
10080 min Winter	97.504	0.504	50.4	4437.2	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	129.286	26
30 min Winter	84.561	41
60 min Winter	52.662	70
120 min Winter	31.683	128
180 min Winter	23.225	186
240 min Winter	18.524	244
360 min Winter	13.425	360
480 min Winter	10.684	474
600 min Winter	8.943	588
720 min Winter	7.730	700
960 min Winter	6.137	920
1440 min Winter	4.427	1172
2160 min Winter	3.188	1624
2880 min Winter	2.523	2080
4320 min Winter	1.812	2948
5760 min Winter	1.432	3808
7200 min Winter	1.192	4616
8640 min Winter	1.026	5448
10080 min Winter	0.903	6160

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.409	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 13.360

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	4.460	4-8	4.450	8-12	4.450

Model Details

Storage is Online Cover Level (m) 100.000

Tank or Pond Structure

Invert Level (m) 97.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	8800.0	1.000	8800.0

Hydro-Brake® Outflow Control

Design Head (m) 1.000 Hydro-Brake® Type Md7 Invert Level (m) 97.000
Design Flow (l/s) 64.8 Diameter (mm) 310

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.8	1.200	71.0	3.000	112.3	7.000	171.6
0.200	22.1	1.400	76.7	3.500	121.3	7.500	177.6
0.300	38.4	1.600	82.0	4.000	129.7	8.000	183.4
0.400	49.1	1.800	87.0	4.500	137.6	8.500	189.1
0.500	48.4	2.000	91.7	5.000	145.0	9.000	194.6
0.600	50.3	2.200	96.2	5.500	152.1	9.500	199.9
0.800	58.0	2.400	100.5	6.000	158.9		
1.000	64.9	2.600	104.6	6.500	165.4		

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m^3)	Status
15 min Summer	97.365	0.365	39.9	2739.7	O K
30 min Summer	97.476	0.476	41.2	3570.7	O K
60 min Summer	97.589	0.589	42.4	4414.4	O K
120 min Summer	97.698	0.698	46.1	5231.4	O K
180 min Summer	97.755	0.755	48.0	5665.5	O K
240 min Summer	97.791	0.791	49.1	5935.2	O K
360 min Summer	97.835	0.835	50.5	6264.1	O K
480 min Summer	97.861	0.861	51.2	6455.7	O K
600 min Summer	97.875	0.875	51.6	6562.0	O K
720 min Summer	97.882	0.882	51.8	6613.2	O K
960 min Summer	97.882	0.882	51.9	6618.3	O K
1440 min Summer	97.876	0.876	51.7	6569.6	O K
2160 min Summer	97.857	0.857	51.1	6426.9	O K
2880 min Summer	97.831	0.831	50.3	6230.3	O K
4320 min Summer	97.771	0.771	48.5	5781.9	O K
5760 min Summer	97.711	0.711	46.5	5330.1	O K
7200 min Summer	97.655	0.655	44.7	4911.3	O K
8640 min Summer	97.603	0.603	42.9	4525.5	O K
10080 min Summer	97.556	0.556	41.2	4171.5	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	129.286	27
30 min Summer	84.561	41
60 min Summer	52.662	70
120 min Summer	31.683	130
180 min Summer	23.225	188
240 min Summer	18.524	248
360 min Summer	13.425	366
480 min Summer	10.684	484
600 min Summer	8.943	604
720 min Summer	7.730	722
960 min Summer	6.137	900
1440 min Summer	4.427	1122
2160 min Summer	3.188	1516
2880 min Summer	2.523	1928
4320 min Summer	1.812	2732
5760 min Summer	1.432	3536
7200 min Summer	1.192	4328
8640 min Summer	1.026	5104
10080 min Summer	0.903	5856

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m^3)	Status
15 min Winter	97.409	0.409	41.2	3070.0	O K
30 min Winter	97.534	0.534	41.2	4004.2	O K
60 min Winter	97.660	0.660	44.9	4950.8	O K
120 min Winter	97.783	0.783	48.8	5870.8	O K
180 min Winter	97.848	0.848	50.8	6363.6	O K
240 min Winter	97.890	0.890	52.1	6672.0	O K
360 min Winter	97.941	0.941	53.5	7054.2	O K
480 min Winter	97.971	0.971	54.4	7283.7	O K
600 min Winter	97.989	0.989	54.9	7419.1	O K
720 min Winter	97.999	0.999	55.2	7494.5	O K
960 min Winter	98.004	1.004	55.3	7533.5	O K
1440 min Winter	97.988	0.988	54.9	7407.0	O K
2160 min Winter	97.958	0.958	54.0	7184.5	O K
2880 min Winter	97.917	0.917	52.9	6878.6	O K
4320 min Winter	97.827	0.827	50.2	6200.6	O K
5760 min Winter	97.739	0.739	47.5	5544.2	O K
7200 min Winter	97.659	0.659	44.8	4943.4	O K
8640 min Winter	97.587	0.587	42.3	4398.9	O K
10080 min Winter	97.518	0.518	41.2	3884.4	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	129.286	26
30 min Winter	84.561	41
60 min Winter	52.662	70
120 min Winter	31.683	128
180 min Winter	23.225	186
240 min Winter	18.524	244
360 min Winter	13.425	360
480 min Winter	10.684	474
600 min Winter	8.943	588
720 min Winter	7.730	700
960 min Winter	6.137	920
1440 min Winter	4.427	1174
2160 min Winter	3.188	1624
2880 min Winter	2.523	2080
4320 min Winter	1.812	2948
5760 min Winter	1.432	3808
7200 min Winter	1.192	4616
8640 min Winter	1.026	5448
10080 min Winter	0.903	6248

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.409	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 11.430

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	3.810	4-8	3.810	8-12	3.810

Model Details

Storage is Online Cover Level (m) 100.000

Tank or Pond Structure

Invert Level (m) 97.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	7500.0	1.000	7500.0

Hydro-Brake® Outflow Control

Design Head (m) 1.000 Hydro-Brake® Type Md7 Invert Level (m) 97.000
Design Flow (l/s) 55.4 Diameter (mm) 286

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.4	1.200	60.5	3.000	95.6	7.000	146.1
0.200	20.4	1.400	65.3	3.500	103.3	7.500	151.2
0.300	34.2	1.600	69.8	4.000	110.4	8.000	156.1
0.400	41.2	1.800	74.1	4.500	117.1	8.500	160.9
0.500	39.5	2.000	78.1	5.000	123.4	9.000	165.6
0.600	42.8	2.200	81.9	5.500	129.5	9.500	170.2
0.800	49.4	2.400	85.5	6.000	135.2		
1.000	55.2	2.600	89.0	6.500	140.7		

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m^3)	Status
15 min Summer	97.375	0.375	13.8	1124.2	O K
30 min Summer	97.488	0.488	15.8	1465.1	O K
60 min Summer	97.603	0.603	17.6	1809.8	O K
120 min Summer	97.714	0.714	19.1	2142.5	O K
180 min Summer	97.773	0.773	19.9	2318.3	O K
240 min Summer	97.809	0.809	20.3	2426.7	O K
360 min Summer	97.852	0.852	20.9	2557.3	O K
480 min Summer	97.877	0.877	21.2	2631.7	O K
600 min Summer	97.890	0.890	21.3	2671.4	O K
720 min Summer	97.896	0.896	21.4	2688.8	O K
960 min Summer	97.895	0.895	21.4	2684.4	O K
1440 min Summer	97.885	0.885	21.3	2653.9	O K
2160 min Summer	97.861	0.861	21.0	2582.3	O K
2880 min Summer	97.831	0.831	20.6	2492.2	O K
4320 min Summer	97.766	0.766	19.8	2297.8	O K
5760 min Summer	97.703	0.703	19.0	2110.0	O K
7200 min Summer	97.647	0.647	18.2	1939.9	O K
8640 min Summer	97.596	0.596	17.4	1786.7	O K
10080 min Summer	97.550	0.550	16.8	1649.3	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	129.286	27
30 min Summer	84.561	41
60 min Summer	52.662	70
120 min Summer	31.683	130
180 min Summer	23.225	188
240 min Summer	18.524	248
360 min Summer	13.425	366
480 min Summer	10.684	484
600 min Summer	8.943	602
720 min Summer	7.730	722
960 min Summer	6.137	896
1440 min Summer	4.427	1120
2160 min Summer	3.188	1516
2880 min Summer	2.523	1928
4320 min Summer	1.812	2732
5760 min Summer	1.432	3568
7200 min Summer	1.192	4328
8640 min Summer	1.026	5112
10080 min Summer	0.903	5864

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m^3)	Status
15 min Winter	97.420	0.420	14.6	1259.9	O K
30 min Winter	97.547	0.547	16.7	1642.4	O K
60 min Winter	97.677	0.677	18.6	2029.7	O K
120 min Winter	97.802	0.802	20.2	2405.3	O K
180 min Winter	97.869	0.869	21.1	2605.6	O K
240 min Winter	97.910	0.910	21.6	2730.2	O K
360 min Winter	97.961	0.961	22.2	2883.5	O K
480 min Winter	97.991	0.991	22.5	2974.2	O K
600 min Winter	98.009	1.009	22.7	3026.5	O K
720 min Winter	98.018	1.018	22.8	3054.4	O K
960 min Winter	98.022	1.022	22.8	3064.8	O K
1440 min Winter	98.002	1.002	22.6	3004.7	O K
2160 min Winter	97.968	0.968	22.2	2903.3	O K
2880 min Winter	97.924	0.924	21.7	2771.0	O K
4320 min Winter	97.829	0.829	20.6	2486.8	O K
5760 min Winter	97.740	0.740	19.4	2219.3	O K
7200 min Winter	97.660	0.660	18.4	1980.5	O K
8640 min Winter	97.590	0.590	17.4	1770.8	O K
10080 min Winter	97.529	0.529	16.4	1586.4	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	129.286	26
30 min Winter	84.561	41
60 min Winter	52.662	70
120 min Winter	31.683	128
180 min Winter	23.225	186
240 min Winter	18.524	244
360 min Winter	13.425	360
480 min Winter	10.684	474
600 min Winter	8.943	588
720 min Winter	7.730	700
960 min Winter	6.137	918
1440 min Winter	4.427	1172
2160 min Winter	3.188	1624
2880 min Winter	2.523	2080
4320 min Winter	1.812	2948
5760 min Winter	1.432	3808
7200 min Winter	1.192	4616
8640 min Winter	1.026	5448
10080 min Winter	0.903	6248

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.409	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 4.690

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	1.570	4-8	1.560	8-12	1.560

Model Details

Storage is Online Cover Level (m) 100.000

Tank or Pond Structure

Invert Level (m) 97.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	3000.0	1.000	3000.0

Hydro-Brake® Outflow Control

Design Head (m) 1.000 Hydro-Brake® Type Md7 Invert Level (m) 97.000
Design Flow (l/s) 22.7 Diameter (mm) 183

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.6	1.200	24.8	3.000	39.1	7.000	59.8
0.200	11.6	1.400	26.7	3.500	42.3	7.500	61.9
0.300	12.9	1.600	28.6	4.000	45.2	8.000	63.9
0.400	14.3	1.800	30.3	4.500	47.9	8.500	65.9
0.500	16.0	2.000	32.0	5.000	50.5	9.000	67.8
0.600	17.5	2.200	33.5	5.500	53.0	9.500	69.7
0.800	20.2	2.400	35.0	6.000	55.4		
1.000	22.6	2.600	36.4	6.500	57.6		

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	97.375	0.375	18.1	1423.9	O K
30 min Summer	97.488	0.488	20.0	1855.7	O K
60 min Summer	97.603	0.603	22.2	2292.5	O K
120 min Summer	97.714	0.714	24.2	2714.6	O K
180 min Summer	97.773	0.773	25.2	2937.7	O K
240 min Summer	97.809	0.809	25.8	3075.4	O K
360 min Summer	97.853	0.853	26.5	3241.8	O K
480 min Summer	97.878	0.878	26.8	3337.0	O K
600 min Summer	97.892	0.892	27.0	3388.0	O K
720 min Summer	97.898	0.898	27.1	3410.8	O K
960 min Summer	97.897	0.897	27.1	3406.8	O K
1440 min Summer	97.887	0.887	27.0	3370.8	O K
2160 min Summer	97.864	0.864	26.6	3283.4	O K
2880 min Summer	97.835	0.835	26.2	3171.2	O K
4320 min Summer	97.770	0.770	25.1	2927.0	O K
5760 min Summer	97.708	0.708	24.1	2688.8	O K
7200 min Summer	97.651	0.651	23.1	2472.4	O K
8640 min Summer	97.599	0.599	22.2	2276.6	O K
10080 min Summer	97.553	0.553	21.3	2100.9	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	129.286	27
30 min Summer	84.561	41
60 min Summer	52.662	70
120 min Summer	31.683	130
180 min Summer	23.225	188
240 min Summer	18.524	248
360 min Summer	13.425	366
480 min Summer	10.684	484
600 min Summer	8.943	602
720 min Summer	7.730	722
960 min Summer	6.137	896
1440 min Summer	4.427	1120
2160 min Summer	3.188	1512
2880 min Summer	2.523	1928
4320 min Summer	1.812	2732
5760 min Summer	1.432	3568
7200 min Summer	1.192	4328
8640 min Summer	1.026	5112
10080 min Summer	0.903	5864

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	97.420	0.420	18.6	1595.7	O K
30 min Winter	97.547	0.547	21.2	2080.3	O K
60 min Winter	97.677	0.677	23.6	2571.1	O K
120 min Winter	97.802	0.802	25.6	3047.1	O K
180 min Winter	97.869	0.869	26.7	3301.2	O K
240 min Winter	97.910	0.910	27.3	3459.5	O K
360 min Winter	97.962	0.962	28.1	3654.2	O K
480 min Winter	97.992	0.992	28.5	3769.8	O K
600 min Winter	98.010	1.010	28.8	3836.7	O K
720 min Winter	98.019	1.019	28.9	3872.5	O K
960 min Winter	98.023	1.023	29.0	3886.7	O K
1440 min Winter	98.003	1.003	28.7	3812.5	O K
2160 min Winter	97.970	0.970	28.2	3686.2	O K
2880 min Winter	97.926	0.926	27.6	3519.8	O K
4320 min Winter	97.832	0.832	26.1	3160.6	O K
5760 min Winter	97.742	0.742	24.7	2820.7	O K
7200 min Winter	97.662	0.662	23.3	2516.0	O K
8640 min Winter	97.591	0.591	22.0	2247.5	O K
10080 min Winter	97.529	0.529	20.8	2010.5	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	129.286	26
30 min Winter	84.561	41
60 min Winter	52.662	70
120 min Winter	31.683	128
180 min Winter	23.225	186
240 min Winter	18.524	244
360 min Winter	13.425	360
480 min Winter	10.684	474
600 min Winter	8.943	588
720 min Winter	7.730	700
960 min Winter	6.137	918
1440 min Winter	4.427	1170
2160 min Winter	3.188	1624
2880 min Winter	2.523	2080
4320 min Winter	1.812	2948
5760 min Winter	1.432	3808
7200 min Winter	1.192	4616
8640 min Winter	1.026	5448
10080 min Winter	0.903	6248

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.409	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 5.940

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	1.980	4-8	1.980	8-12	1.980

Model Details

Storage is Online Cover Level (m) 100.000

Tank or Pond Structure

Invert Level (m) 97.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	3800.0	1.000	3800.0

Hydro-Brake® Outflow Control

Design Head (m) 1.000 Hydro-Brake® Type Md7 Invert Level (m) 97.000
Design Flow (l/s) 28.8 Diameter (mm) 206

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.0	1.200	31.4	3.000	49.6	7.000	75.8
0.200	13.9	1.400	33.9	3.500	53.6	7.500	78.4
0.300	18.1	1.600	36.2	4.000	57.3	8.000	81.0
0.400	18.1	1.800	38.4	4.500	60.8	8.500	83.5
0.500	20.3	2.000	40.5	5.000	64.0	9.000	85.9
0.600	22.2	2.200	42.5	5.500	67.2	9.500	88.3
0.800	25.6	2.400	44.4	6.000	70.2		
1.000	28.6	2.600	46.2	6.500	73.0		

Greenfield Runoff

Using IOH124 rural runoff for small catchments

$QBAR_{rural} = 0.00108AREA^{0.89}\ SAAR^{1.17}\ SOIL^{2.17}$

Where:

AREA	Rural area
SAAR	Standard Average Annual Rainfall obtained from FEH (mm)
SOIL	Soil factor depending on soil class (see below)

WRAP CLASS	FACTOR
1	0.15
2	0.30
3	0.40
4	0.45
5	0.50

Site name	Catchment B/C (Site)	
Site OS NGR	Bordesley Park	
Development size	7.43 ha	(Hectares) Typically excluding public open space not modified by the proposed development
	50	If the development is under 50 ha, use 50 ha when applying the formula and subsequently factor the resulting value by the ratio of the site are to 50ha (i.e. if the site is 10ha, divide the answer by 5).
SAAR	762	Standard Average Annual Rainfall (mm)
Hydrological Region (FSSR)	4	For determining the flood growth curve
WRAP classification	4	Refer to Wallingford Procedure Winter Rainfall Acceptance Potential map
SOIL (Runoff factor)	0.45	see table above

For developments **under** 50 ha

$QBAR_{rural} = 0.00108AREA^{0.89}\ SAAR^{1.17}\ SOIL^{2.17}$

$QBAR_{rural} =$ 36.048 l/s — Use this results when the development site is under 50ha

4.852 l/s/ha

For developments **over** 50 ha

$QBAR_{rural} =$ 44.459 l/s — Use this result if the development site is over 50ha

5.984 l/s/ha

Greenfield Runoff

Using IOH124 rural runoff for small catchments

$QBAR_{rural} = 0.00108AREA^{0.89}\ SAAR^{1.17}\ SOIL^{2.17}$

Where:

AREA	Rural area
SAAR	Standard Average Annual Rainfall obtained from FEH (mm)
SOIL	Soil factor depending on soil class (see below)

WRAP CLASS	FACTOR
1	0.15
2	0.30
3	0.40
4	0.45
5	0.50

Site name	Catchment B/C (Site)	
Site OS NGR	Bordesley Park	
Development size	22.27 ha 50	(Hectares) Typically excluding public open space not modified by the proposed development If the development is under 50 ha, use 50 ha when applying the formula and subsequently factor the resulting value by the ratio of the site are to 50ha (i.e. if the site is 10ha, divide the answer by 5).
SAAR	762	Standard Average Annual Rainfall (mm)
Hydrological Region (FSSR)	4	For determining the flood growth curve
WRAP classification	4	Refer to Wallingford Procedure Winter Rainfall Acceptance Potential map
SOIL (Runoff factor)	0.45	see table above

For developments under 50 ha

$QBAR_{rural} = 0.00108AREA^{0.89}\ SAAR^{1.17}\ SOIL^{2.17}$

$QBAR_{rural} =$ 108.048 l/s
4.852 l/s/ha

Use this results when the development site is under 50ha

For developments over 50 ha

$QBAR_{rural} =$ 118.101 l/s
5.303 l/s/ha

Use this result if the development site is over 50ha

Appendix C

STW Correspondence

SEVERN
TRENT
WATER

Severn Trent Water

Severn Trent Water Ltd
Regis Road
Wolverhampton
WV6 8RU

Tel: 01902 793871
Fax: 01902 793971

www.stwater.co.uk
net.dev.west@severntrent.co.uk

Contact: Dave Hadley

Your ref:
Our ref: WT33818/SAP8123125

Halcrow Group Ltd
Red Hill House
227 London Road
Worcester
WR5 2JG
FAO Ian Parmenter

05 September 2013

[redacted]

Proposed Residential Development at Bordesley Park Farm off Dagnell End Road, Redditch, Worcestershire B98 9BH

I refer to your 'Development Enquiry Request' in respect of the above sites. Please find enclosed the sewer records that are included in the fee together with the Supplementary Guidance Notes which refer to surface water disposal from development sites.

We have previous information concerning these areas and our Strategies team have confirmed that documentation forwarded to the Council will be sent to me shortly. We are particularly interested in the phasing of the yellow areas as this may require some local upsizing so I would appreciate confirmation of build start dates in these areas as soon as possible.

Foul Water Drainage

It is not envisaged that further modelling will be necessary at this stage but we would like to know where favourable connection points are anticipated to the network whilst I am waiting for documentation from my Strategy colleagues. We can then use this information to finalise the off site improvement strategy.

Surface Water Drainage

From previous information it is assumed that surface water can be discharged to soakaways and/or local watercourses in the area. Discharge rates would need to be agreed with the Environment Agency and Local Planning Authority.

SEVERN TRENT WATER

Severn Trent Water

Please see the guidance notes attached with this letter for further information on surface water disposal.

New Connections

For any new connections (including the re-use of existing connections) to the public sewerage system, the developer will need to submit Section 106 application forms. Our New Connections department are responsible for handling all such enquiries and applications. To contact them for an application form and associated guidance notes please call 0800 7076600 or download from www.stwater.co.uk.

Please quote WT33818/SAP8123125 in any future correspondence (including e-mails) with STW Limited. Please note that 'Development Enquiry' responses are only valid for 6 months from the date of this letter.

Yours sincerely

[redacted]

SUPPLEMENTARY GUIDANCE NOTES

In 2006 the Government issued national advice in the form of "Planning Policy Statement 25: Development and Flood Risk" that seeks to reduce the impact of development on surface water runoff. This advice is generally followed by Local Authorities through both the Building Regulations (Approved Document H) and the imposition of appropriate planning conditions. Severn Trent welcomes this advice and supports such planning conditions that impose flow restrictions. It is considered that in accordance with current guidance disposal of storm runoff from the development should be dealt with as follows:

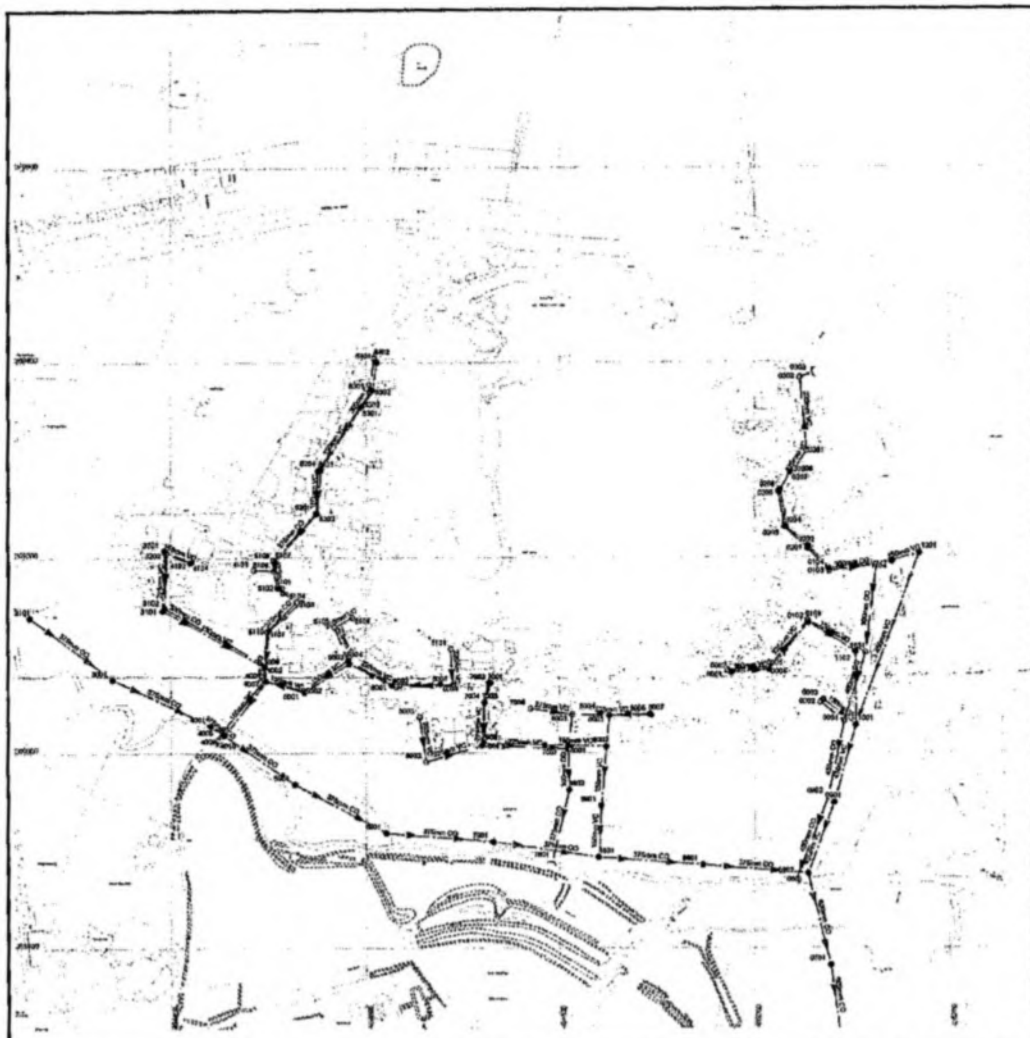
1. By soakage into the site's subsoil, subject to suitable ground soakage capacity and any contamination present. If ground soakage proves inadequate, evidence should be submitted to Severn Trent Water. The evidence should be either percolation test results or a statement from the SI consultant (extract from report or a supplementary letter) stating that soakaways would be ineffective. **A connection to public sewerage (existing or adoptable) would then be considered reasonable with flows as:**

2. Brown field development site: If storm runoff from the existing development is connected to the public sewerage system, then peak storm flows from the proposed development up to that generated from the previous connected impermeable area may be connected to the network subject to the details of the existing storm connection arrangements being submitted to Severn Trent Water. Existing flows should be assessed as the lower of $Q=2.78x50xA_{imp}$ l/s (A_{imp} ha), based on a 2 year storm return period, and the unsurcharged capacity of the outfall pipe(s).

   In addition to this restriction, for Brownfield developments, the Company would also suggest a reduction in surface water flow to the public sewerage systems of 20%. It should be noted that the Company would like to see any flow attenuation based on a 30 year critical duration storm design in accordance with 'Sewers for Adoption' current edition.

   For existing storm connections to the public foul sewerage system, any new storm connection to the public storm sewerage system (if available) should be limited to 2 to 5 litres/sec/ha depending on scale of development, to be agreed (option A) OR a peak flow to be determined by the Company from its developer-funded hydraulic modelling of the public storm sewerage system (option B). The developer may choose either option.

3. Green field development site: If the site is a green field development i.e. not involving any demolition of buildings or paved areas connected to the public sewerage system, then the storm runoff from the proposed development may be connected to the public sewerage system subject to peak storm flows (30 year storm return period) being limited to a green field runoff of 5 litres/sec/ha (subject to a minimum of 5 litres/sec for Adoptable systems), applied to the gross area of the site, subject to sufficient capacity in the network.



Sewer Node | Sewer Pipe Data

Sewer Node | Sewer Pipe Data

Abandoned Sewer	Cable, Earthing	Blind Shaft	Sewer Chemical Injection Point
Private Combined Gravity Sewer	Cable Junction	Combined Use Manhole	Sewer Junction
Private Foul Gravity Sewer	Cable, Optical Fibre/Instrumentation	Flushing Chamber	Sewerage Air Valve
Private Surface Water Gravity Sewer	Cable, Low Voltage	Foul Use Manhole	Sewerage Hatch Box Point
Public Combined Gravity Sewer	Cable, High Voltage	Grease Trap	Sewerage Isolation Valve
Public Foul Gravity Sewer	Cable, Other	Head Node	Soakaway
Public Surface Water Gravity Sewer	Housing, Building	Hydrobrake	Surface Water Manhole
Trunk Combined Gravity Sewer	Housing, Kiosk	Lamphole	Vent Column
Trunk Foul Use Gravity Sewer	Disposal Site	Outfall	Waste Water Storage
Trunk Surface Water Gravity Sewer	Sewage Treatment Works	Overflow	Culverted Watercourse
Combined Use Pressurised Sewer	Housing, Other	Penstock	Pre-1937 Properties
Foul Use Pressurised Sewer	Pipe Support Structure	Petrol Interceptor	
Surface Water Pressurised Sewer	Sewage Pumping Facility		
Highway Drain	Sewer Facility Connection Inlet / Outlet		
Combined Lateral Drain (S0)			
Foul Lateral Drain (SS)			
Surface Water Lateral Drain (SS)			

MATERIALS

CATEGORIES

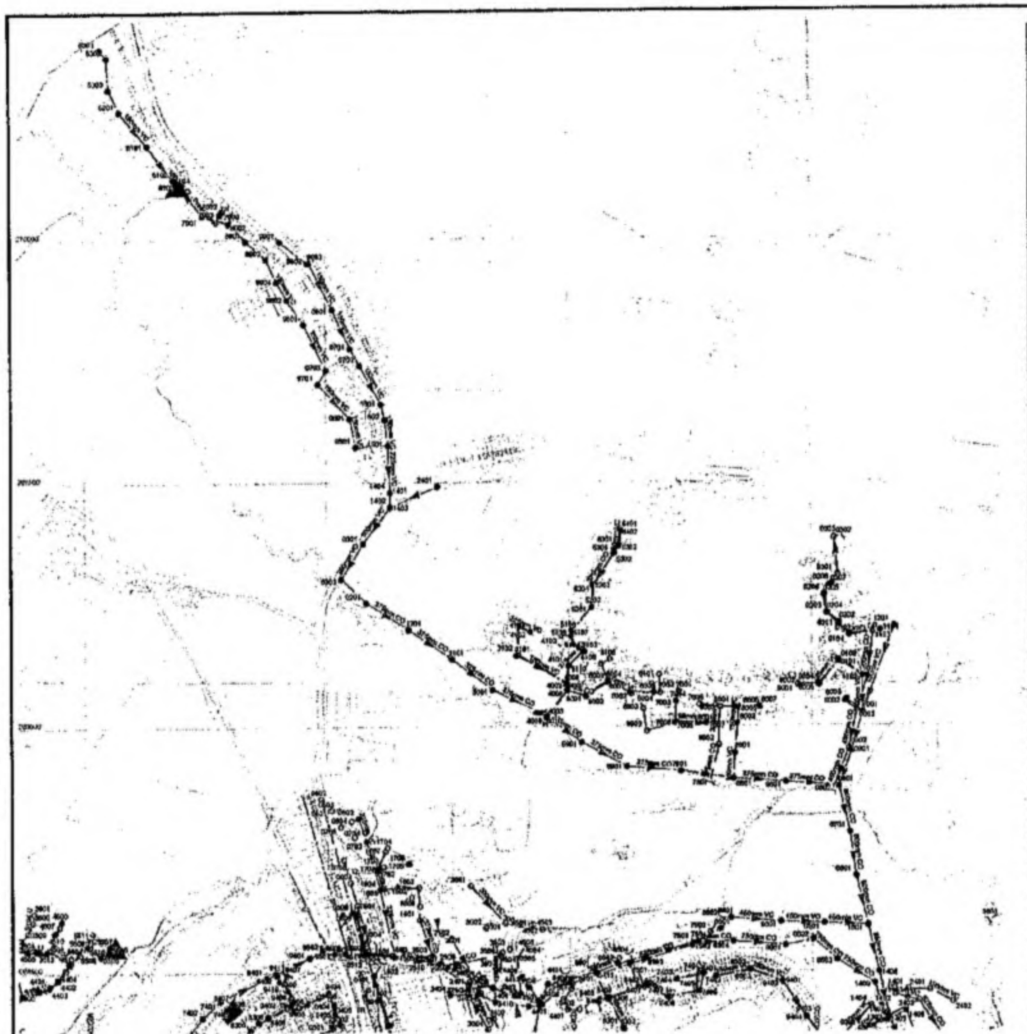
TABULAR KEY

SHAPE

PURPOSE

SEWER RECORD (TABULAR)

OS Map scale:	1:2500		
Date of Issue:	05.09.13	X:	454750
Sheet No.	1 of 1	Y:	280237



Sewer Node | **Sewer Pipe Data**

- Abandoned Sewer
- Private Combined Gravity Sewer
- Private Foul Gravity Sewer
- Private Surface Water Gravity Sewer
- Public Combined Gravity Sewer
- Public Foul Gravity Sewer
- Public Surface Water Gravity Sewer
- Trunk Combined Gravity Sewer
- Trunk Foul Use Gravity Sewer
- Trunk Surface Water Gravity Sewer
- Combined Use Pressurised Sewer
- Foul Use Pressurised Sewer
- Surface Water Pressurised Sewer
- Highway Drain
- Combined Lateral Drain (S8)
- Foul Lateral Drain (S8)
- Surface Water Lateral Drain (S8)
- Cable, Earthing
- Cable Junction
- Cable, Optical Fibre/Instrumentation
- Cable, Low Voltage
- Cable, High Voltage
- Cable, Other
- Housing, Building
- Housing, Kiosk
- Disposal Site
- Sewage Treatment Works
- Housing, Other
- Pipe Support Structure
- Sewage Pumping Facility
- Sewer Facility Connection Inlet / Outlet
- Wind Shaft
- Combined Use Manhole
- Flushing Chamber
- Foul Use Manhole
- Grease Trap
- Head Node
- Hydrobrake
- Lamphole
- Outfall
- Overflow
- Penstock
- Petrol Interceptor
- Sewer Chemical Injection Point
- Sewer Junction
- Sewerage Air Valve
- Sewerage Hatch Box Point
- Sewerage Isolation Valve
- Soakaway
- Surface Water Manhole
- Vent Column
- Waste Water Storage
- Culverted Watercourse
- Pre-1937 Properties

MATERIALS

AC - ASBESTOS CEMENT
BR - BRICK
CC - CONCRETE BOX CULVERT
CI - CAST IRON
CO - CONCRETE
CSB - CONCRETE SEGMENTS (BOLTED)
CSU - CONCRETE SEGMENTS (UNBOLTED)
DI - DUCTILE IRON
GRC - GLASS REINFORCED CONCRETE
MAC - MASONRY IN REGULAR COURSES
MAR - MASONRY RANDOMLY COURSED
PE - POLYETHYLENE
PF - PITCH FIBRE
PP - POLYPROPYLENE
PSC - PLASTIC/STEEL COMPOSITE
PVC - POLYVINYL CHLORIDE
RPM - REINFORCED PLASTIC MATRIX
SI - SPUN (GREY) IRON
XXX - OTHER

CATEGORIES

W - WEIR
C - CASCADE
SE - SIDE ENTRY
FV - FLAP VALVE
BD - BACK DROP
S - SIPHON
HD - HIGHWAY DRAIN

SHAPE

C - CIRCULAR
E - EGG SHAPED
O - OTHER
R - RECTANGLE
S - SQUARE
T - TRAPEZOIDAL
U - UNKNOWN

TABULAR KEY

A. Sewer pipe data refers to downstream sewer pipe.

PURPOSE

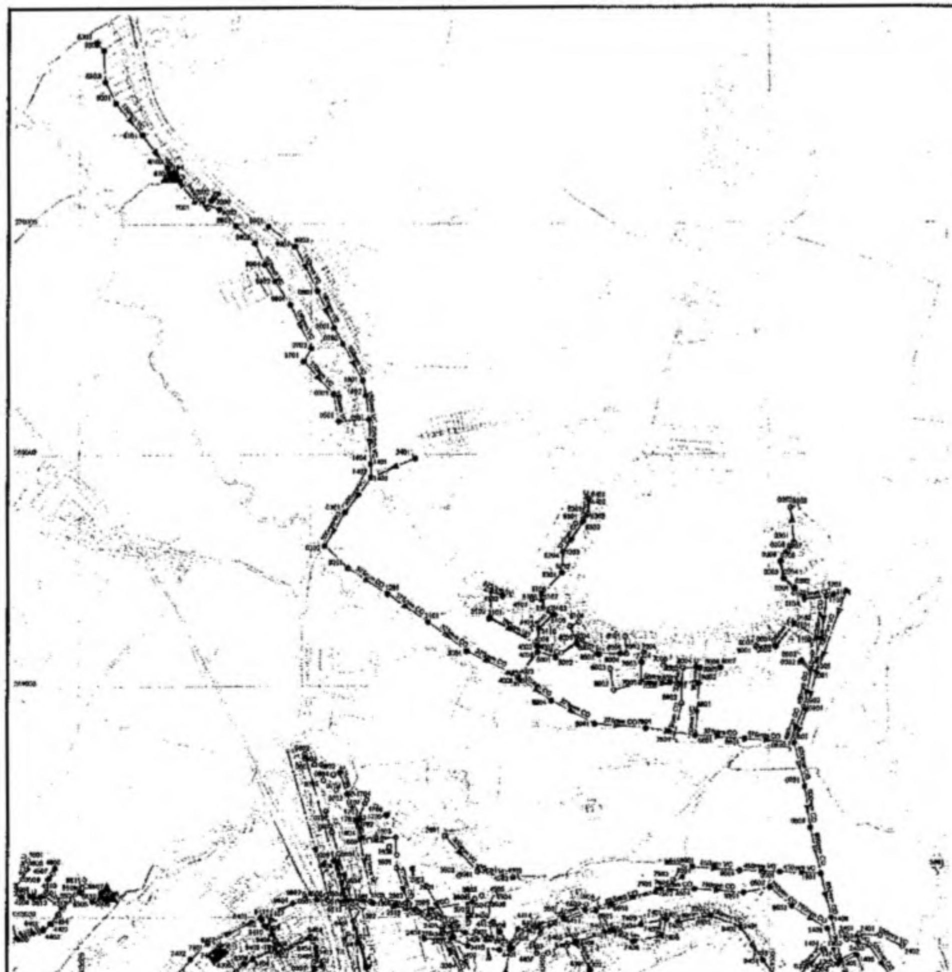
C - COMBINED
E - FINAL EFFLUENT
F - FOUL
L - SLUDGE
S - SURFACE WATER

Severn Trent Water Limited
Asset Data Management
PO Box 5344
Coventry
CV3 9FT

SEWER RECORD (TABULAR)

OS Map scale: 1:5000
Date of Issue: 05.09.13
Sheet No. 1 of 2

This map is centred upon O / S Grid reference:
x: 404375
y: 299416



	Abandoned Sewer
	Private Combined Gravity Sewer
	Private Foul Gravity Sewer
	Private Surface Water Gravity Sewer
	Public Combined Gravity Sewer
	Public Foul Gravity Sewer
	Public Surface Water Gravity Sewer
	Trunk Combined Gravity Sewer
	Trunk Foul Use Gravity Sewer
	Trunk Surface Water Gravity Sewer
	Combined Use Pressurised Sewer
	Foul Use Pressurised Sewer
	Surface Water Pressurised Sewer
	Highway Drain
	Combined Lateral Drain (SS)
	Foul Lateral Drain (SS)
	Surface Water Lateral Drain (SS)
	Cable, Earthing
	Cable Junction
	Cable, Optical Fibre/Instrumentation
	Cable, Low Voltage
	Cable, High Voltage
	Cable, Other
H	Housing, Building
K	Housing, Kiosk
	Disposal Site
STW	Sewage Treatment Works
	Housing, Other
	Pipe Support Structure
▲	Sewage Pumping Facility
⊠	Sewer Facility Connection Inlet / Outlet
	Blind Shaft
	Combined Use Manhole
	Flushing Chamber
	Foul Use Manhole
	Grease Trap
	Head Node
	Hydrobrake
	Lamphole
	Outfall
	Overflow
	Penstock
	Petrol Interceptor
	Sewer Chemical Injection Point
	Sewer Junction
	Sewerage Air Valve
	Sewerage Hatch Box Point
	Sewerage Isolation Valve
	Soakaway
	Surface Water Manhole
	Vent Column
	Waste Water Storage
	Culverted Watercourse
	Pre-1937 Properties

MATERIALS

CATEGORIES

TABULAR KEY

SHAPE

PURPOSE

SEWER RECORD (TABULAR)

OS Map scale: 1:6000

05.09.13

Sheet No. 1 of 2

This map is centred upon:
O/S Grid reference:

x: 404375

y: 289416

27th September 2013

Dear Mr Grist,

Further to our conversation I write to confirm Diamond Bus would potentially be interested in running a bus service to your proposed development in Redditch.

Costs for a bus every 15 minutes to your development would range from range from £180,000 to £220,000 per year. For £180,000 Diamond could run 1 bus every 15 minutes to the entrance of the site and back to Redditch Town Centre. Costs would increase based on size and specification of vehicle, route extension to serve the whole site, number of vehicles needed to provide a 15 minute service if the route were to be extended etc.

As discussed it is difficult to specify costs when the development is at such an early stage. Please view these costs as indicative only.

I look forward to hearing the outcome of your planning application.

Yours Sincerely

[redacted]

Diamond Bus Company, Hallbridge Way, Tipton Road, Tividale, West Midlands, B69 3HW.
Tel: 0121 557 7337 Fax: 0121 520 4999 www.diamondbuses.com