

MJA CONSULTING
CIVIL AND STRUCTURAL ENGINEERS

PROPOSED RESIDENTIAL DEVELOPMENT

BROOKS NURSEY
BARNHAM ROAD
BARNHAM
WEST SUSSEX

FLOOD RISK ASSESSMENT
&
DEVELOPMENT DRAINAGE STRATEGY

MJA Consulting
58-62 Ock Street
Abingdon
Oxon
OX14 5BZ

Tel: 01235 555173
Fax: 01235 523226
www.mjaconsulting.co.uk

Client:
David Wilson Homes

Where quality lives 
David Wilson Homes

Rev B (May 2013)
File Ref -13/0305/4482



DOCUMENT CONTROL RECORD

Document Issue:

Rev	Issue Status	Prepared by	Checked by
A	Draft for comment.	C.Pendle	K.Gebhart
B	Unit numbers changed, Site layout updated, Drainage strategy amended to suit.	C.Pendle	K.Gebhart



CONTENTS		Page
1	Introduction.....	1
2	Existing Site.....	2
3	Topographical and Geological Information.....	4
4	Flood Risk Assessment.....	7
5	Impact of Development on Flood Risk.....	9
6	Existing and Proposed Site Runoff.....	13
7	Surface Water Drainage Strategy.....	15
8	Foul Water Drainage Strategy.....	17
9	Summary & Conclusions.....	18

APPENDICES:

Appendix A - Site Layout

Appendix B - Topographical Survey

Appendix C - Southern Water Public Sewers

Appendix D - Foul & Surface Drainage Strategy Layout

Appendix E - Pre/Post Development Runoff Calculations

Appendix F - Site Investigation Borehole Logs & Infiltration Test

FIGURES:

Figure 1&2 - Site Location

Figure 3 - Development Site Boundary

Figure 4 - Extract from Environment Agency Flood Zone Map

REFERENCES:

Technical Guidance to the National Planning Policy Framework (2012)

Department for Communities and Local Government ISBN: 978-1-4098-3410-6

Environment Agency Flood Map Information © and database right www.environment-agency.gov.uk

Arun District Council SFRA – Capita Symonds (Feb 2008)

West Sussex SFRA - Capita Symonds (Jan 2010)

Wilson Bailey Geotechnical & Environmental – Ground Investigation Report – J10146 (Dec 2010)



1 Introduction

1.1 Scope

- 1.1.1 MJA Consulting have been commissioned by David Wilson Homes to undertake a Flood Risk Assessment and Drainage Strategy to determine the potential flood risks associated with the proposed development at land situated off Barnham Road, in the village of Barnham, West Sussex.
- 1.1.2 David Wilson Homes are proposing to develop the approximate 2.5ha site, involving the construction of 40 residential dwellings, with associated access roads, hardstanding parking areas and soft landscaping.
Refer to Appendix A for site layout.

1.2 Report Structure

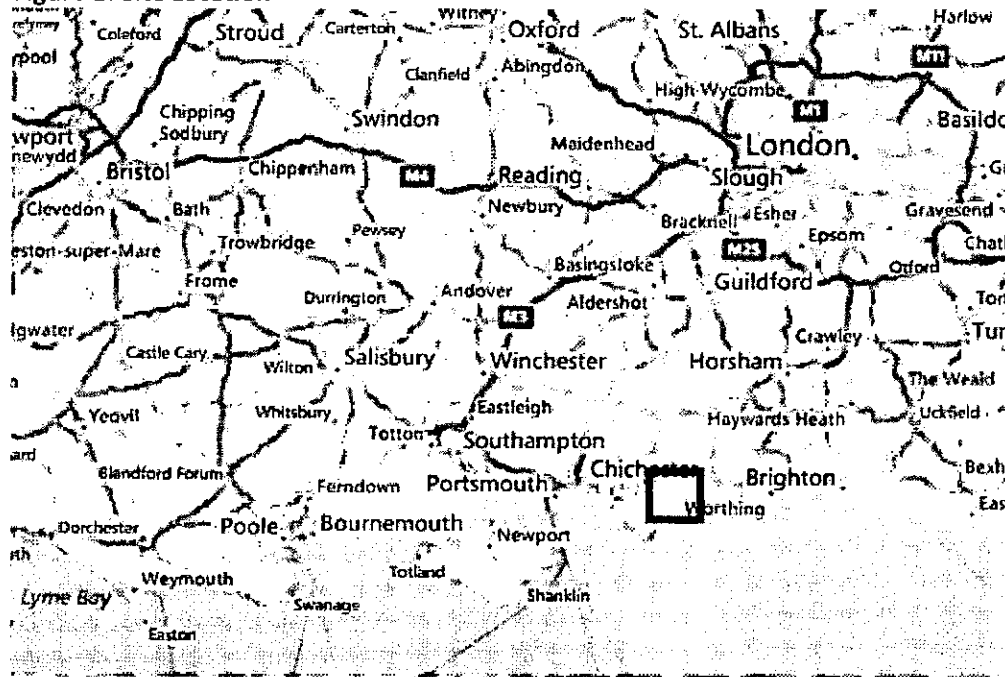
- 1.2.1 The National Planning Policy Framework - *Department for Communities and Local Government (2012)* is the current guidance on development and flood risk in England and Wales.
This guidance replaces but retains key elements of Planning Policy Statement 25: Development and Flood Risk.
The Flood Risk technical guidance for the National Planning Policy Framework requires a Flood Risk Assessment to be carried out to consider all potential forms of flooding including that from river, sea, estuarial, land drainage, groundwater, overland flow, surface water run-off, sewer systems, and artificial water bodies (lakes, reservoirs, canals etc).
A Flood Risk Assessment is required to consider the impact of all these potential forms of flooding on both the development site and off site parties and land.
- 1.2.2 This report will take the structure of a 'Flood Risk Assessment' in accordance with the Environment Agency's Flood Risk Assessment Guidance, the National Planning Policy Framework and CIRIA Report 624 'Development and Flood Risk – Guidance for the Construction Industry.
- 1.2.3 The purposes of this report are:
- To confirm that the proposed development will not be subject to flood risk.
 - To confirm that a satisfactory strategy for the disposal of surface and foul water from the proposed development is achievable.
 - To confirm that this development will not increase the risk of flooding to any offsite parties and land.

2 Existing Site

2.1 Site Location and Description

- 2.1.1 The proposed development is situated at land off Barnham Road in village of Barnham, approximately five miles north of Bognor Regis.
- 2.1.2 The approximate 2.5ha site consists of a rectangular parcel of land 240 m by 110m, occupied by rough overgrown land with a number of dilapidated brick and timber buildings and overgrown earthworks bunds and mounds.
- 2.1.3 In 1910 the site was occupied by glass-houses and buildings of "The Brooks Nursery", which was used for growing fruit until closure at this site and relocation of the business by about 1950.
Since that time the site is shown to have remained undeveloped with the glasshouses presumably having been demolished or removed and the brick built former nursery buildings left to fall into their current state of disrepair.
- 2.1.4 Access to the site is at the north eastern corner off the Barnham Road, which forms the north eastern boundary to the site together with a line of mature conifers. The north western site boundary is formed by a sparse hedgerow, beyond which are modern nursery glass houses and prepared areas of nursery bedding. The south western site boundary is formed by a relatively dense band of woodland within which is an elongate shaped pond, beyond which are open agricultural fields. The south eastern boundary to the site is formed by a mixture of hedges, close board fences and chain link fences which mark the extent of garden areas associated with adjoining houses fronting onto Elm Grove South and Barnham Road.

Figure 1: Site Location



© 2012 Microsoft – Bing Maps

Figure 2: Site Location

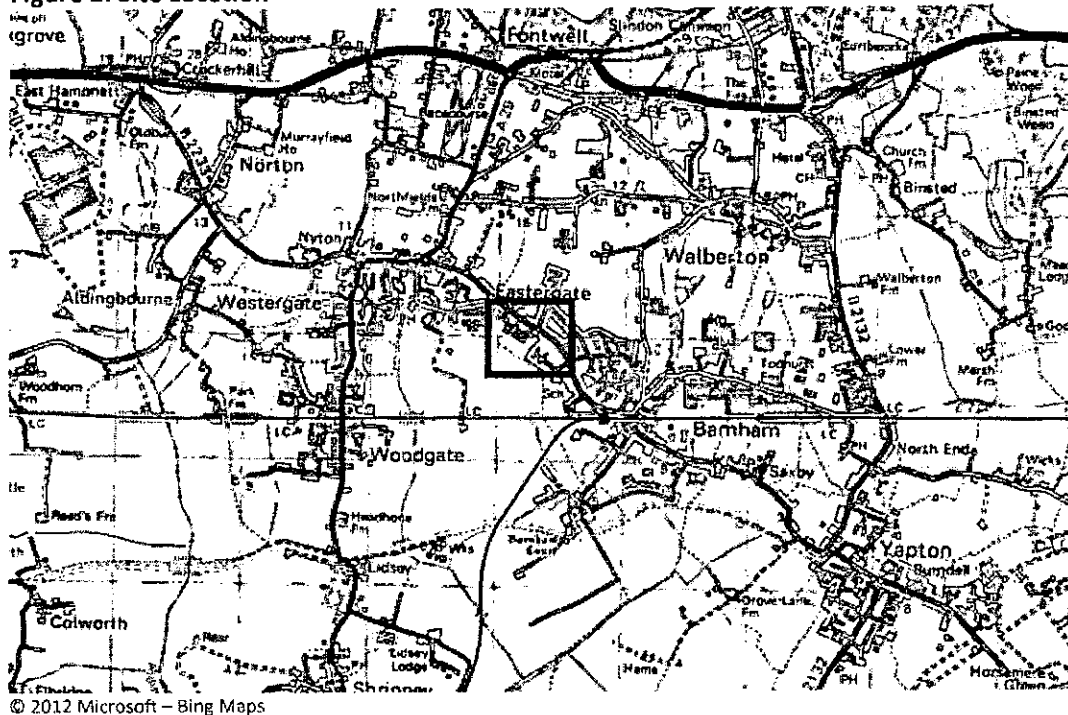
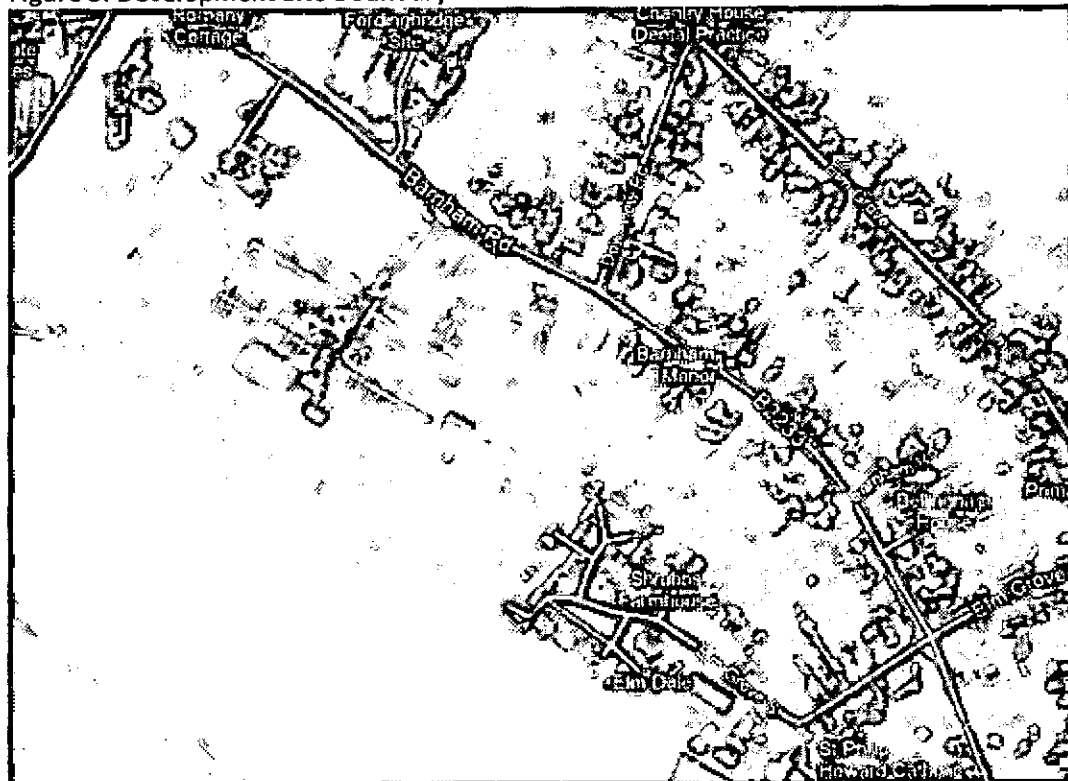


Figure 3: Development Site Boundary



3 Topographical and Geological Information

3.1 Topography

- 3.1.1 In general the topography of the site falls from 10.85mAOD in the north east to 9.50mAOD in the south west.

Refer to Appendix B for the existing Topographical Survey.

3.2 Geology

- 3.2.1 An intrusive geological ground investigation was carried out by Wilson Bailey in October 2010.

10No. boreholes were carried out, the results of which indicate the general site geology as:

Topsoil (Made Ground) (0.0-0.5m BGL)

Natural topsoil was encountered across the majority of the site comprising dark brown SANDY CLAY with abundant roots occasional fine gravel.

Localised made ground was encountered in a number of locations comprising reworked topsoil with brick, tile and slate fragments.

This is considered to be consistent with the long term historical use of the site as a plant nursery.

Aeolian Deposits (Brickearth) (0.5-1.9m BGL)

Aeolian Deposits were encountered across the site comprising generally low strength orange-brown SILTY SANDY CLAY with scattered fine flint GRAVEL.

Raised Beach Deposits (1.9-4.0m BGL)

These soils were found to comprise a white and off white SILTY SAND and GRAVEL with variable amounts of flint gravel, occasional cobbles and occasional pockets of pale brown SILTY CLAYEY SAND. In a number of the boreholes the predominantly chalk derived soils were found to be underlain by a pale yellowish brown silty locally clayey sand, which was proved to the maximum depth of investigation at 4.00 m, where encountered.

3.2.2 London Clay Formation

The clay soils of the London Clay Formation, which are anticipated to be present beneath the site where not been encountered during the investigation to a maximum depth of 4.00 m below ground level.

The Wilson Bailey report (2010) indicates that it is conceivable however that the generally loose pale yellowish orange-brown clayey silty sand soils encountered at the base of a number of the boreholes could be associated with one of the minor interstitial layers of silty sand within the basal stratigraphy of the London Clay.

3.2.3 Ground Contamination

The long term historical use of the site as a plant nursery would not be expected to present a significant concern with regards to soil contamination.

No visual or olfactory evidence of soil contamination was encountered during the site investigations with subsequent laboratory soil contamination testing not indicating the presence of elevated concentrations of a wide range of potential contaminants.

3.3 Hydrogeology

3.3.1 The Environment Agency's mapping website

(www.maps.environmentagency.gov.uk) has classified the site as not located within a groundwater source protection zone for groundwater abstractions.

3.3.2 The underlying superficial soils are classified by the Environment Agency as being 'Secondary A' Aquifer. These are defined as permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

3.3.3 The underlying bedrock is classified by the Environment Agency as being 'Unproductive'. These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

3.3.4 Groundwater

Groundwater inflows were encountered in a number of the exploratory boreholes at depths of between 1.50m and 2.40m BGL, with a number of the boreholes encountering soils that were noted as consistently damp below a depth of about 2.00 m below ground level.

Groundwater levels encountered across the site indicate a groundwater flow direction towards the south, where the water level in the pond/ditch suggests that the surface water and groundwater are in hydraulic continuity.

3.3.5 Soil Permeability

Soakage testing has not been carried out as part of the ground investigations.

The superficial clays are not expected to provide an effective infiltration medium, although the chalk derived granular Raised Beach Deposits could potentially offer a sufficient level of infiltration.

However the effective depth of any such soakaway devices will be significantly limited by the high groundwater levels encountered across the site.

Hence, the widespread use of conventional soakaways, infiltration basins and porous pavements to discharge water to ground would be considered impracticable.

3.4 Catchment Information

3.4.1 Watercourses

A pond/stream is located at the southern boundary of the site, believed to be fed by runoff from the upstream village to the east, this flows east to west leaving the site within an unnamed ditch.

This ditch forms a watercourse which ultimately joins a main watercourse 1km west of the site.

Another main watercourse is located 1km east of site flowing north to south through the centre of Barnham.

These ultimately combine to form a tributary of the 'Lidsey Rife' 2.5km south of the site which outfalls into the English Channel at Bognor Regis 5.5km south.

The River Arun is located 5.5km east of the site and flows from the north to south out falling to the English Channel at Littlehampton.

3.4.2 Rivers

The River Arun is located 5.5km east of the site and flows from the north to south out falling to the sea at Littlehampton.

3.4.3 Water bodies

There are no reservoirs or canals or other artificial sources of flooding within a 1km radius of the development site.

4.3.4 History of Flooding

With reference to the West Sussex SFRA and the Arun District Council SFRA, the site has no reported history of flooding from all sources including tidal, fluvial, pluvial, groundwater and existing sewers.

3.5 Existing Site drainage characteristics

3.5.1 Although the site was formerly used as a nursery with a number of associated glasshouses and brick built buildings, these have been demolished or left to fall into their current state of disrepair.

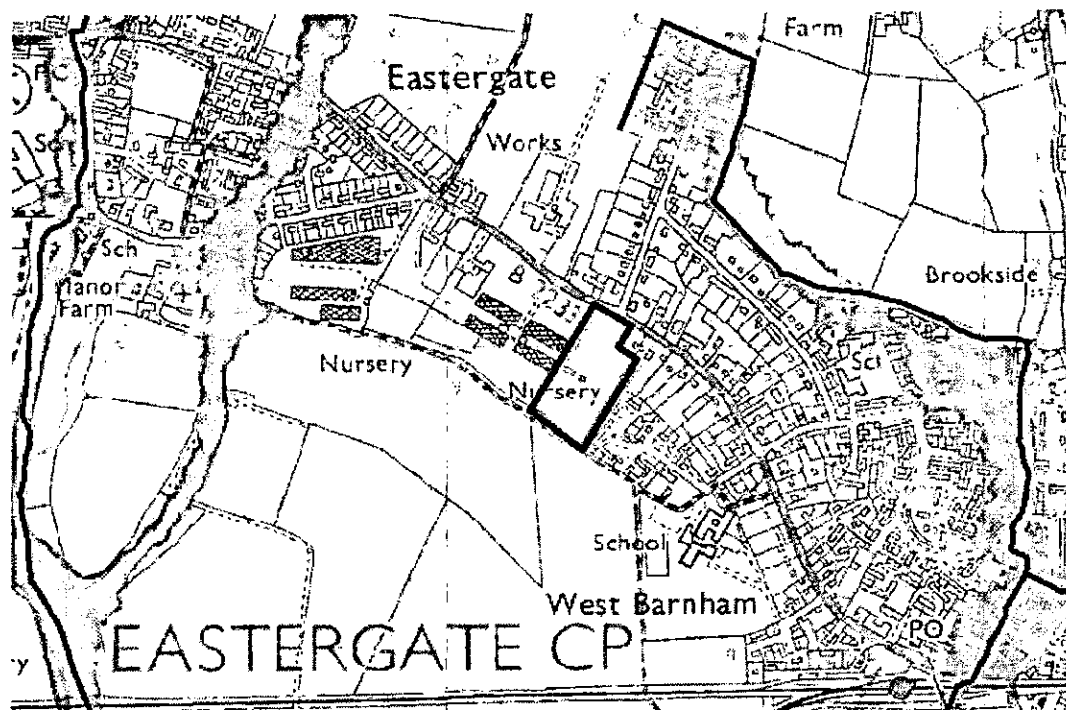
The site now functions as essentially un-developed land with 'Greenfield' runoff characteristics and as such rainfall that lands on this site primarily infiltrates into the underlying soils.

During intense storms on saturated soils, ponding and overland (pluvial) flow will occur following the topography of the site towards the south.

5 Flood Risk Assessment

5.1 Flood Zone Map

Figure 3: Extract from Environment Agency Flood Zone Map



© Environment Agency 2012

— Main Rivers

Dark blue shows the area that could be affected by flooding, either from rivers or the sea, if there were no flood defences. This area could be flooded:

- From the sea by a flood that has a 0.5 per cent (1 in 200) or greater chance of happening each year.
- From a river by a flood that has a 1 per cent (1 in 100) or greater chance of happening each year.

Light blue shows the additional extent of an extreme flood from rivers or the sea. These outlying areas are likely to be affected by a major flood, with up to a 0.1 per cent (1 in 1000) chance of occurring each year.

5.2 The Environment Agency's indicative Flood Map shows the site to be located within Flood Zone 1 (Lowest Risk).

This is land assessed as having a less than 1 in 1000 (<0.1%) annual probability of flooding from a river or stream in any year by the Environment Agency and is not within an area subject to either flooding or extreme flooding events.

- 5.3 The flood risk technical Guidance to the National Planning Policy Framework Table 2: Flood Risk Vulnerability classification, classifies residential developments as 'More Vulnerable'.

NPPF Table 2 of technical Guidance: Flood Risk Vulnerability classification

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 waste⁶.
- Sites used for holiday or short-let caravans and camping, *subject to a specific warning and evacuation plan.*⁷

- 5.4 Table 2 & 3 would indicate that 'more vulnerable' developments located within Flood Zone 1 are considered appropriate under the National Planning Policy Framework.

NPPF 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.

5.5 Sequential Test

- 5.5.1 The National Planning Policy Framework Guidance states that Planning Authorities should complete a risk based 'Sequential Test' at all stages of the planning process, to steer new development to areas with the lowest probability of flooding.
- 5.5.2 Under the requirements of the 'sequential test' and as the proposed development is already located within flood zone 1 (lowest risk), there are no more suitable, developable and deliverable alternative sites, better located from a flood risk perspective, which would accommodate the proposed development.

6 Impact of Development on Flood Risk

- 6.1 This section identifies sources of potential flood risk to the site.
The sources of flooding that could potentially affect the site include flooding from tidal, groundwater, rivers (fluvial), overland runoff (pluvial), artificial sources and flooding from overloaded existing and proposed sewer networks.
- 6.2 **History of Flooding**
With reference to the West Sussex SFRA and the Arun District Council SFRA, the development site has no reported history of flooding from all sources including tidal, fluvial, pluvial, groundwater and existing sewers.
- 6.3 **Tidal**
The Environment Agency has assessed the area of Barnham as not being at risk from tidal influenced flooding.
- 6.4 **Fluvial**
- 6.4.1 The shallow pond/ stream located at the southern boundary of the site has no reported history of flooding to this site or offsite land.
The upstream catchment to this pond is believed to be very small and does not conveyed large volumes of runoff.
The top water level within the pond was recorded at 8.26mAOD, with top of bank level at 9.25mAOD. From here the topography of the site continues to raise north through the site, with the proposed housing development having a 60m buffer from the existing ditch starting at a ground level of 10.00mAOD.
- 6.4.2 The watercourses situated 1km east and west of the site do not present a flood risk to this development and are assessed as having a less than 1 in 1000 (<0.1%) annual probability of flooding by the Environment Agency.
- 6.4.3 With reference to the West Sussex SFRA and the Arun District Council SFRA, historic fluvial flooding has occurred in the village of Barnham although this is limited to the centre of the village near to the main river.
The location of this event corresponds with the Environment Agency flood zoning map.
- 6.4.4 The River Arun located over 5.5km from the site does not present a flood risk to this development.
- 6.5 **Waterbodies**
There are no reservoirs or canals or other artificial sources of flooding within a 1km radius of the development area.

6.6 Groundwater

- 6.6.1 During the site investigation no evidence of groundwater flooding could be identified and no instances of flooding from emergent groundwater have been recorded at this site or within proximity to the development.
With reference to the West Sussex SFRA Groundwater Emergence Zone Map which takes into account geology and historic incidents of groundwater flooding, this site is located within a generic 'medium' risk zone.
- 6.6.2 The proposed plans for the site do not include basements and the height of proposed finished floor levels will be set a minimum of 150mm above surrounding ground level to protect properties from the effects of any emergent groundwater. Raised pavement levels will also provide safe and dry pedestrian access to and from the development in the event of groundwater emergence.
- 6.6.3 Ponding may occur on the permeable surface at various locations throughout the site during heavy rain events, this will however be minimal and will drain slowly through the sub strata.
In summary, the available sources of information generally indicate the likelihood of flooding on the proposed development site from groundwater reasonably low.
It should also be noted that the development proposals will not increase the risk of flooding to any off site parties or land.

6.7 Existing Sewers

- 6.7.1 With reference to the West Sussex SFRA and the Arun District Council SFRA, sewer flooding has been recorded in the village of Barnham although this is limited to the north eastern residential area around Farmhurst Road/ Orchard Way.
The Environment Agency have confirmed that the main foul sewers in Barnham suffer from groundwater ingress and accept surface water during heavy storms leading to reduced capacity in the area.
- 6.7.2 No sewer flooding events have been recorded west of Barnham Road within the vicinity of the development site.
There are currently no foul or surface water sewers / infrastructure serving the existing site which could present a flood risk to the proposed development.

6.8 Proposed Site Drainage

6.8.1 A Flood Risk Assessment requires that an evaluation of all proposed artificial drainage systems and infrastructure within, or in close proximity to the site is carried out.

In the context of this development, the following systems are to be installed which need to be assessed in terms of potential flooding through the capacity of the systems being exceeded or the structural, hydraulic, mechanical or operational failure of the system occurring:

- Piped gravity foul and surface water sewers.
- SUDS systems for the collection, attenuation and discharge of surface water runoff within the site boundary.
- Foul water treatment works

6.8.2 All piped sewers will be designed to the Sewers for Adoption (7th edition) surface water network requirement of 'no surcharge of pipes up to the 1 in 1 year storm' and 'no flooding of manholes up to the 1 in 30 year storm event'.

Consideration will be also given to extreme rainfall events in terms of identifying potential points of surcharging and flood flow routes across the site.

6.8.3 All piped sewers will be constructed to the latest industry standard design criteria, ensuring robust structural integrity.

This will ensure that the proposed sewers on the development will not present a flood risk through ingress of groundwater or contamination risk through leakages to ground.

6.8.4 The surface water runoff generated on the site as a result of the development will be managed using appropriate SUDS techniques up to the 1 in 100 +30% storm event. This will ensure that the peak rate of surface water leaving the developed site is no greater than the existing site runoff rate, including the temporary condition during the construction of new buildings.

6.8.5 Proposed attenuation features such as above ground balancing ponds or below ground tanks will be sized and carefully designed to ensure they do not pose an increased flood risk to the development or off site parties and land.

6.8.6 The foul sewerage treatment works and associated reed beds will be designed and installed in accordance with best practice industry specifications.

As the entire site is located within Flood Zone 1 (lowest risk) the treatment works will not be located in an area susceptible to flooding.

6.9 Pluvial (Overland Flow)

- 6.9.1 Overland flow results from rainfall that is unable to infiltrate into the ground due to saturation, runs off hard impermeable surfaces or water surcharging from manholes during intense storm events above the sewer design capacity.
- 6.9.2 With reference to the West Sussex SFRA and the Arun District Council SFRA, a number of cases of surface water flooding have been recorded in the village of Barnham.
These instances are likely due to a number of factors including a high groundwater table in the area, inadequate drainage infrastructure and capacity to deal with storm water runoff leading to pluvial flooding.
- 6.9.3 No recorded incidents of surface water flooding have been recorded on the site or in the vicinity of the site that could have any effect on flooding risk to the development.
The proposed plans for the site do not include basements and the height of proposed finished floor levels will be set a minimum of 150mm above surrounding ground level to mitigate the effects of and groundwater ponding.
Raised pavement levels will also provide safe and dry pedestrian access to and from the development in the event of overland flow.
- 6.9.4 Provided the design and landscaping of the site consider overland flow routes and the proposed site drainage is adequately designed and constructed, the risk of flooding of buildings on site from overland flows will be mitigated.
This will ensure that this development does not impact on or pose any increased flood risk to the site or offsite parties and land.

7 Existing and Proposed Site Runoff

- 7.1 This section aims to calculate the estimated peak runoff rates and volumes of surface water leaving the site, for the pre and post development conditions. These discharge rates can then be used for the preliminary design of the surface water drainage strategy for the proposed development.

7.2 Catchment Areas

- 7.2.1 The existing and proposed permeable and impermeable areas are listed below:

	Permeable	Impermeable	Total
Existing Site Area	25,000 m ²	0 m ²	25,000 m ²
Proposed Site Area	16,500 m ²	8,500 m ²	25,000 m ²

- 7.2.2 This represents an overall increase of 8,500m² (0.85 ha) in impermeable area post development.

7.3 Existing Surface Water Runoff Rate

- 7.3.1 Greenfield runoff rates and volumes are calculated to determine the level of acceptable rate of discharge from the site to a receiving watercourse and are likely to be used by the environmental regulator to set site-specific drainage constraints.
- 7.3.2 An assessment of the estimated current Greenfield runoff rate has been carried out using the Institute of Hydrology Report 124 methodology using Micro Drainage software.
Refer to Appendix D for a summary of results.
- 7.3.3 IH124 mean annual flood flow rate equation:
 $QBAR_{Rural} = 0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$

Catchment: 2.5ha

1 in 1 year	7.7 l/sec
1 in 30 year	20.5 l/sec
1 in 100 year	28.9 l/sec
QBar	9.1 l/sec

- 7.3.4 The storm water runoff volume from a site should be limited to the Greenfield runoff volume wherever possible.

The volume criterion is calculated for the 100 year 6 hour storm event:
Volume = % Runoff x Total Rainfall x Area = 583m³

7.4 Proposed Development Surface Water Runoff Rate

7.4.1 The estimated peak runoff rate from the proposed site is based on 100% runoff from impermeable areas and 0% runoff from permeable areas, in accordance with CIRIA C697 The SUDS Manual & Preliminary rainfall runoff management for Developments (EA/DEFRA W5-074/A).

7.4.2 A suitable method for the estimation of peak flow is the *Rational method*:
 $Q = 2.78 CIA$.

Where:

Q = flow (l/s)

I = rainfall intensity (mm/hr), return period & equal to time of concentration

A = Impermeable area drained (ha)

C = runoff coefficient, assumed to be 1.0

These include an allowance of 30% for the potential effects on climate change.

1 in 1 year	48.5 l/sec
1 in 30 year	119.7 l/sec
1 in 100 year	155.9 l/sec

7.4.3 The volume criterion is calculated for the 100 year 6 hour storm event including a 30% increase in rainfall intensity for climate change:

$$V = \frac{2.78 CIA \times 21600(6\text{hr})}{1000} = 597\text{m}^3$$

7.4.4 It can be seen that as a result of this development and the increase in impermeable areas, the rate at which surface water could potentially runoff the site will be much quicker than in its Greenfield state.

The Environment Agency requires that the developed rate of runoff from a site should be no greater than the undeveloped rate of runoff for the same event.

The purpose of this is to slow down intense flashy flows from developed sites, retaining a natural flow regime in receiving watercourses and reducing the demands on existing drainage systems.

7.4.5 There is also an overall increase in runoff volume generated post development. The surface water runoff volume from a site should be limited to the greenfield runoff volume wherever possible.

Additional runoff due to development should be disposed of by way of infiltration, or if this is not feasible due to soil type, discharged from the site at flow rates below 2l/s/ha.

Where compliance to 100 year volumetric criterion cannot be met, the limiting discharge for the up to 100 year return period will be constrained to QBar (mean annual peak rate of runoff for the greenfield site).

8 Surface Water Drainage Strategy

- 8.1 The National Planning Policy Framework requires that new developments do not exacerbate flood risks elsewhere, which means there is a need to control drainage and runoff to ensure there are no increases in overland flow as a result of the development.
Sustainable Drainage Systems (SuDS) will be incorporated into the surface water drainage strategy to mitigate the additional runoff and reduce flood risk to downstream areas.
The philosophy of the SuDS will be to replicate as closely as possible the natural drainage regime from a site before development, reducing the impact on receiving watercourses and sewers.
- 8.2 The Building Regulations Document H (2002) details a hierarchy of potential methods of disposing of surface water from a site:
- An adequate soakaway or some other adequate infiltration system, or where that is not practicable,
 - A watercourse, or where that is not practicable,
 - A sewer
- 8.3 Following a review of the site geology and groundwater levels, the soils will not have a suitable permeability to enable sufficient infiltration and the effective depth of any such soakaway devices will be significantly limited by the high groundwater levels encountered across the site.
- 8.4 It is proposed that the surface water generated from this development will be stored and attenuated within a balancing pond sized to accommodate runoff from a 1 in 100 year +30% cc storm event.
This pond will attenuate flows to the existing Greenfield runoff rate discharging into the existing watercourse to the south of the site.
- 8.5 This method of disposal improves the quality of the storm water runoff, whilst maintaining the existing natural drainage regime, maintaining the predevelopment rates of runoff.
- 8.6 As this site has a potentially high groundwater table, the pond is to be fully lined with an impermeable liner to prevent the exchange of water between the pond and groundwater.
- 8.7 The piped system will be designed in accordance with the requirements of Sewers for Adoption 7th Edition (addendum).

8.8 Roof runoff will be collected by traditional roof guttering and downpipe systems into individual water butts before draining into a gravity storm sewer located within the main road.

Parking spaces and the main access roads will drain via macadam surfacing with trapped road gullies or linear channels located at kerb edges.

These gullies/channels will convey runoff to the gravity storm sewer located within the main road.

This system will be offered for adoption to Southern Water.

8.9 Pollution Mitigation

The trapped road gullies will offer a level of treatment the road runoff through silt and oil capture.

The balancing pond will offer a level of treatment through the settlement of silt and sediment particles.

8.10 Climate Change

The Flood Risk technical guidance for the National Planning Policy Framework requires that consideration is given to the effect of climate change on the flows generated by any new development. For piped surface water drainage and SUDS features, an increase in 30% is considered as a likely increase in rainfall intensity due to long term climate change, up to 2115.

NPPF Table 5: Recommended national precautionary sensitivity ranges for peak rainfall intensities:

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%	

9 Foul water drainage strategy

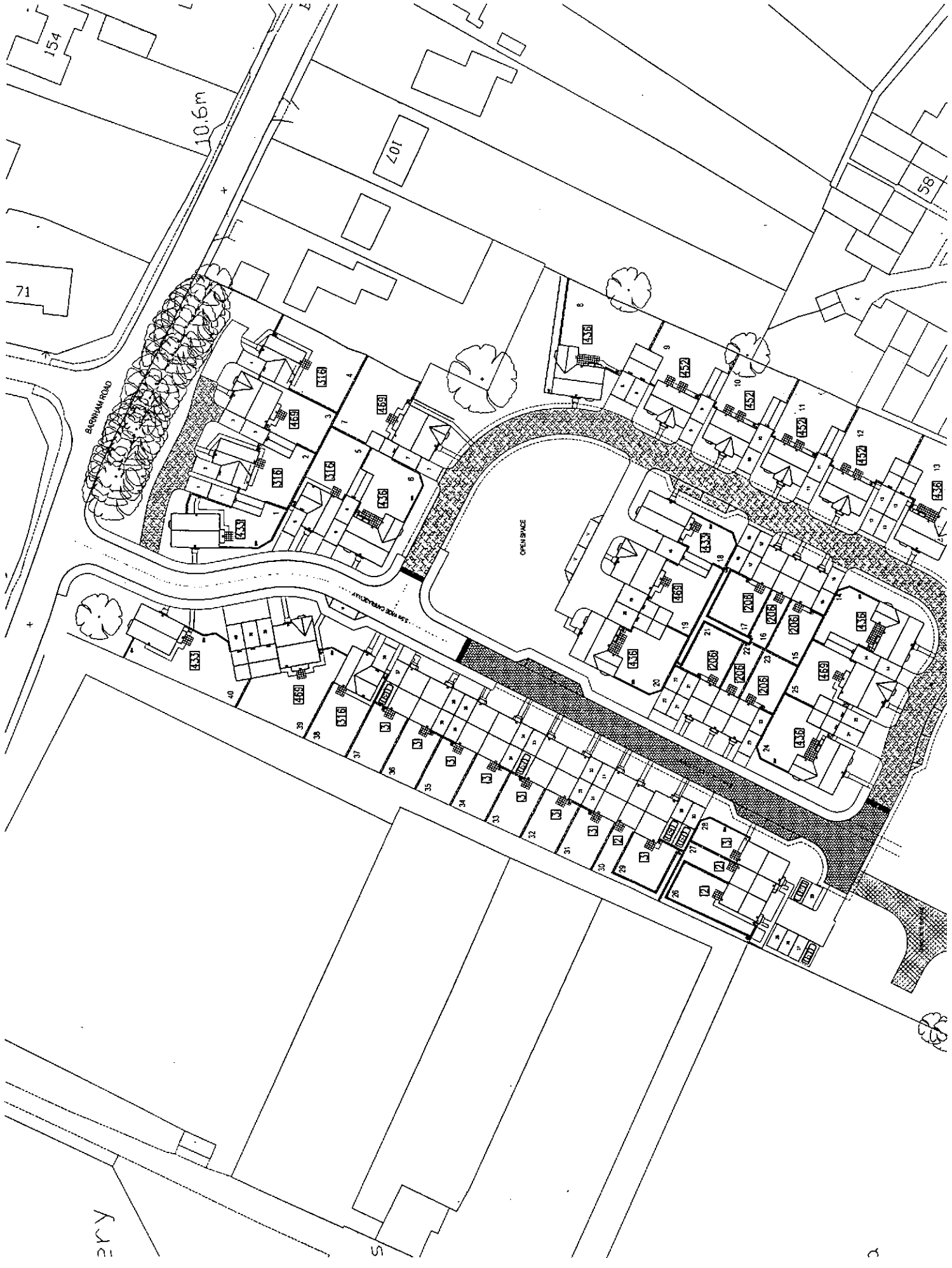
- 9.1 The Environment Agency have confirmed the main foul sewers in Barnham suffer from surface water ingress during heavy storms and when the ground water levels are high, leading to reduced capacity in the sewers.
- 9.2 The additional surface water ingress affects capacity and the effectiveness of the sewerage treatment works at Lidsey.
- 9.3 The Environment Agency have therefore imposed a moratorium on any additional foul flow into this sewerage treatment works until Southern Water deal with the inflow of surface water into the foul network.
- 9.4 Southern Water has indicated that the nearest manhole with capacity to accept the proposed foul flows from the developments is situated within Lidsey sewerage treatment works, 3.3km from the development site.
This would require the crossing of the branch railway line from Barnham to Bognor Regis.
The distance to the connection point and coupled with the crossing of the railway make this solution impractical.
- 9.5 A solution which has been approved by the Environment Agency is the utilisation of a small, below ground, foul sewerage treatment plant which will be constructed to an adoptable standard and offered to Southern Water.
- 9.6 This will be complimented through the use of reed beds which are shown to further enhance water quality and provide ecological benefit.
The filtered water will then drain into the balancing pond allowing UV rays to further purify the water before discharging into the adjacent watercourse.
- 9.7 The foul water discharge from each property will drain via gravity through the private house drainage before out falling to a sewer system within the development road network.
This sewer will drain via gravity to the sewerage treatment works located at the south of the site.
- 9.8 The predicted peak foul discharge rate into these works, based on the Sewers for Adoption 7th figure (4000 l/dwelling/day) for 40 units will be 1.85 l/s.

10 Summary & Conclusion

- 10.1 The Environment Agency's indicative Flood Map shows the proposed development site to be located within Flood Zone 1 (Lowest Risk).
This is land assessed as having a less than 1 in 1000 (<0.1%) annual probability of flooding from a river or stream in any year by the Environment Agency and is not within an area subject to either flooding or extreme flooding events.
- 10.2 Under the requirements of the 'sequential test' and as the proposed development is already located within flood zone 1 (lowest risk), there are no more suitable, developable and deliverable alternative sites, better located from a flood risk perspective, which would accommodate the proposed development
- 10.3 With reference to the West Sussex SFRA and the Arun District Council SFRA, no sources of flooding were identified on or within the vicinity of the site which could have an effect to this development.
- 10.4 This development represents an overall increase of 8,500m² (0.85 ha) in impermeable area post development.
- 10.5 Following a review of the site geology and groundwater levels, the soils will not have a suitable permeability to enable sufficient infiltration and the effective depth of any such soakaway devices will be significantly limited by the high groundwater levels encountered across the site.
- 10.6 It is proposed that the surface water generated from this development will be stored and attenuated within a balancing pond sized to accommodate runoff from a 1 in 100 year +30% cc storm event.
This pond will attenuate flows to the existing Greenfield runoff rate discharging into the existing watercourse to the south of the site.
- 10.7 This method of disposal improves the quality of the storm water runoff, whilst maintaining the existing natural drainage regime, maintaining the predevelopment rates of runoff.
- 10.8 As this site has a potentially high groundwater table, the pond is to be fully lined with an impermeable liner to prevent the exchange of water between the pond and groundwater.
- 10.9 The Environment Agency have therefore imposed a moratorium on any additional foul flow into this sewerage treatment works until Southern Water deal with the inflow of surface water into the foul network
- 10.10 A solution which has been approved by the Environment Agency is the utilisation of a small, below ground, foul sewerage treatment plant which will be constructed to an adoptable standard and offered to Southern Water.

- 10.11 This will be complimented through the use of reed beds which are shown to further enhance water quality and provide ecological benefit.
The filtered water will then drain into the balancing pond allowing UV rays to further purify the water before discharging into the adjacent watercourse.
- 10.12 The foul water discharge from each property will drain via gravity through the private house drainage before out falling to a sewer system within the development road network.
This sewer will drain via gravity to the sewerage treatment works located at the south of the site.
- 10.13 This report concludes to demonstrate the following:
- The proposed development will not be subject to flood risk, result in a loss of flood plain storage or impede flood flow routes.
 - That a satisfactory strategy for the disposal of surface and foul water from the proposed development is achievable.
 - This development will not increase the risk of flooding to any offsite parties and land or increase resident population within a flood plain

APPENDIX A
SITE LAYOUT



APPENDIX B
TOPOGRAPHICAL SURVEY

450mN

400mN

350mN

300mN

250mN

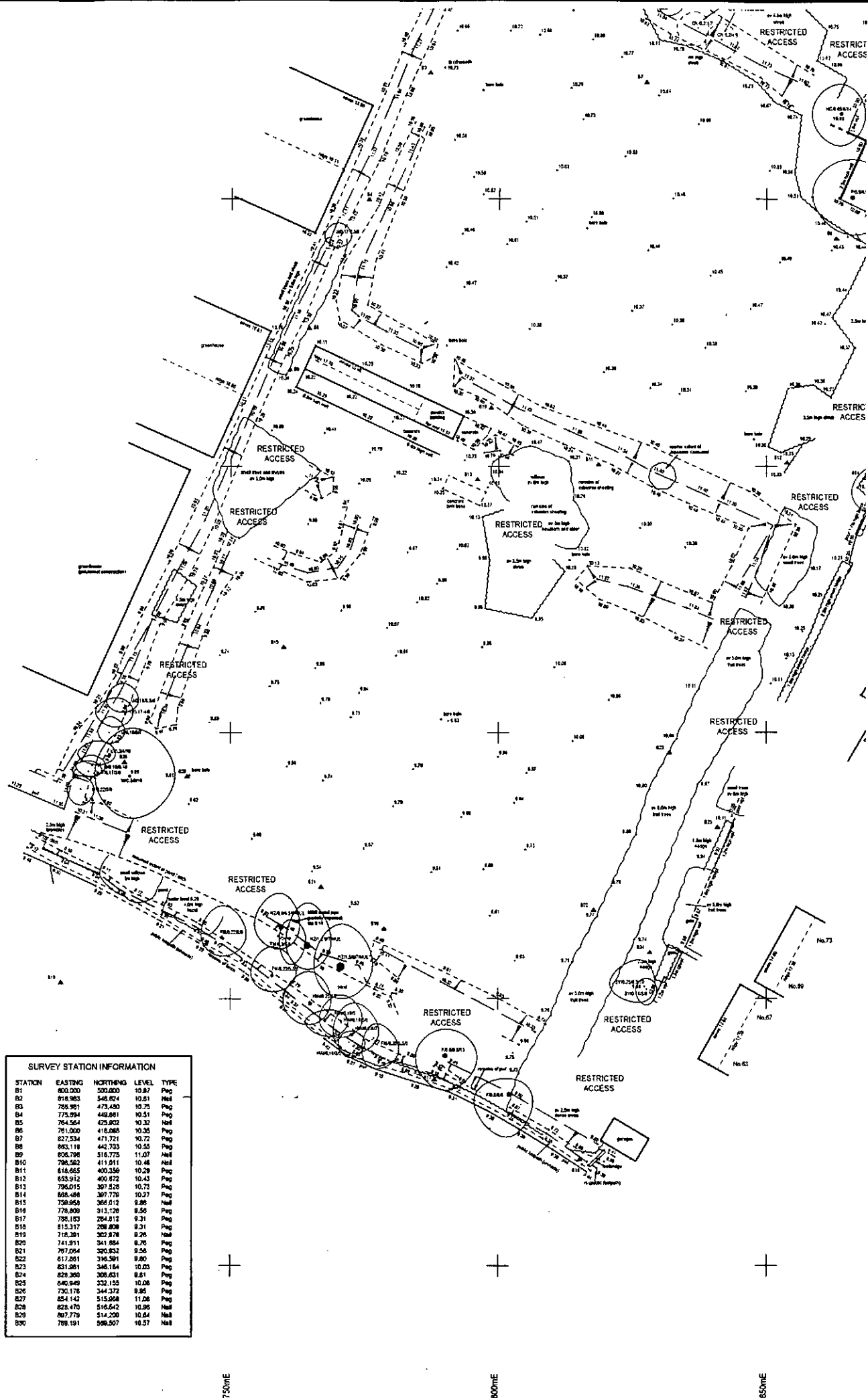
700mE

750mE

800mE

850mE

STATION	EASTING	NORTHING	LEVEL	TYPE
B1	800.000	500.000	10.87	Peg
B2	818.983	548.824	10.51	Nail
B3	798.981	473.430	10.75	Peg
B4	775.994	448.881	10.51	Peg
B5	764.564	425.802	10.32	Nail
B6	761.000	416.685	10.35	Peg
B7	827.534	471.721	10.72	Peg
B8	883.118	442.703	10.55	Peg
B9	806.798	516.775	11.07	Nail
B10	798.582	411.011	10.46	Nail
B11	818.665	400.359	10.29	Peg
B12	853.912	406.872	10.43	Peg
B13	796.015	397.528	10.73	Peg
B14	868.498	387.770	10.27	Peg
B15	759.958	366.512	9.95	Nail
B16	778.809	313.126	9.56	Peg
B17	738.183	284.812	9.31	Peg
B18	815.317	288.808	9.31	Peg
B19	718.381	302.878	9.26	Nail
B20	741.811	341.884	8.76	Peg
B21	787.084	326.832	9.56	Peg
B22	817.851	316.581	9.80	Peg
B23	831.981	346.184	10.03	Peg
B24	828.380	308.631	8.81	Peg
B25	846.849	332.155	10.08	Peg
B26	750.178	344.372	9.85	Peg
B27	854.142	515.968	11.08	Peg
B28	828.470	516.642	10.95	Nail
B29	887.779	514.200	10.64	Nail
B30	788.191	598.507	10.57	Nail



APPENDIX C
EXISTING PUBLIC FOUL & SURFACE SEWERS

SOUTHERN WATER



The positions of pipes shown on this plan are believed to be correct, but Southern Water Services Ltd accept no responsibility in the event of inaccuracy. The actual positions should be determined on site.

Based upon Ordnance Survey Digital Data with the permission of the controller of H.M.S.O. Crown Copyright Reserved Licence No. WU 295530

O.S. REF: SU9504NW

Scale: 1:2786

Sewer Plot

WARNING: BAC pipes are constructed of Bonded Asbestos Cement

WARNING: Unknown (UNK) materials may include Bonded Asbestos Cement



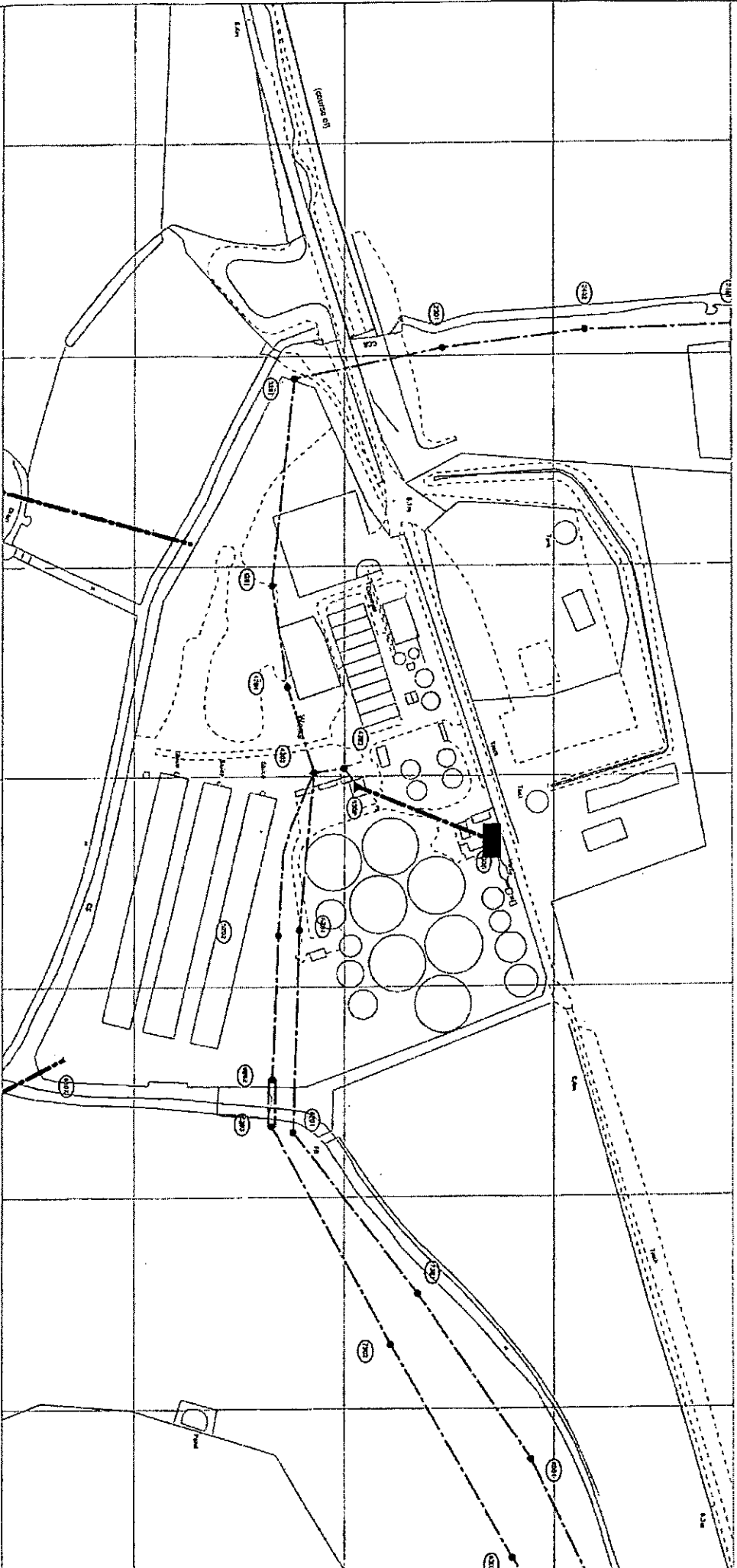
Printed By: chandro

Date: 21-3-2011

Southern Water MapGuide Browser

Requested By:

SOUTHERN WATER



The positions of pipes shown on this plan are believed to be correct, but Southern Water Services Ltd accept no responsibility in the event of inaccuracy. The actual positions should be determined on site.

Based upon Ordnance Survey Digital Data with the permission of the controller of HM.S.O. Crown Copyright Reserved License No. WU 298330

O.S. REF: SU8403SE

Scale: 1:2500

Screen Print

WARNING: BAC pipes are constructed of Bonded Asbestos Cement

WARNING: Unknown (UNK) materials may include Bonded Asbestos Cement



Printed By: saloni

Date: 5-4-2011

Southern Water MapGuide Browser

Requested By:

APPENDIX D
DEVELOPMENT FOUL AND SURFACE
DRAINAGE STRATEGY

NOTIONAL DIRECTION OF FLOW
AS INDICATED BY ADJACENT
LAND OWNER

DITCH TO BE RE-GRADED
BETWEEN POINTS A-B A
DISTANCE OF APPROXIMATELY
550m

EXTENT OF FLOODING TAKEN
FROM ENVIRONMENT AGENCY
FLOOD MAPS



REV. No.	DATE	DESCRIPTION	INITIALS
A	21.05.13	Overall drainage strategy updated to latest planning layout	KTG

Client	Space to live
Project	David Wilson Homes Brook Street Barnham
Title	Overall Drainage strategy

Scale	1:2000000	Drawn	KTG	Rev	A
Checked		Drawn	KTG		

MJA CONSULTING	CIVIL AND STRUCTURAL ENGINEERS
59-62 Oak Street, Alnwick	
Oron, ON14 8BZ	
Tel: 01235 655173	
Fax: 01235 623226	

APPENDIX E
GREENFIELD/BROWNFIELD
RUNOFF CALCULATIONS

Michael A Jennings Associates		Page 1
58-62 Ock Street Abingdon Oxon OX14 5BZ	Barnham Road Greenfield Runoff	
Date 30.11.12 File	Designed by C.Pendle Checked by	
Micro Drainage Source Control W.12.6.1		
<u>ICP SUDS Mean Annual Flood</u> Input Return Period (years) 1 Soil 0.400 Area (ha) 2.500 Urban 0.000 SAAR (mm) 739 Region Number Region 7 Results l/s QBAR Rural 9.1 QBAR Urban 9.1 Q1 year 7.7 Q1 year 7.7 Q30 years 20.5 Q100 years 28.9		
©1982-2011 Micro Drainage Ltd		

Michael A Jennings Associates		Page 1																										
58-62 Ock Street Abingdon Oxon OX14 5BZ	Barnham Road Greenfield Volume																											
Date 30.11.12 File	Designed by C.Pendle Checked by																											
Micro Drainage		Source Control W.12.6.1																										
<u>Greenfield Runoff Volume</u> FSR Data <table> <tr> <td>Return Period (years)</td> <td>100</td> </tr> <tr> <td>Storm Duration (mins)</td> <td>360</td> </tr> <tr> <td>Region</td> <td>England and Wales</td> </tr> <tr> <td>M5-60 (mm)</td> <td>19.000</td> </tr> <tr> <td>Ratio R</td> <td>0.350</td> </tr> <tr> <td>Areal Reduction Factor</td> <td>1.00</td> </tr> <tr> <td>Area (ha)</td> <td>2.500</td> </tr> <tr> <td>SAAR (mm)</td> <td>730</td> </tr> <tr> <td>CWI</td> <td>108.871</td> </tr> <tr> <td>Urban</td> <td>0.000</td> </tr> <tr> <td>SPR</td> <td>37.000</td> </tr> </table> Results <table> <tr> <td>Percentage Runoff (%)</td> <td>37.01</td> </tr> <tr> <td>Greenfield Runoff Volume (m³)</td> <td>583.182</td> </tr> </table>			Return Period (years)	100	Storm Duration (mins)	360	Region	England and Wales	M5-60 (mm)	19.000	Ratio R	0.350	Areal Reduction Factor	1.00	Area (ha)	2.500	SAAR (mm)	730	CWI	108.871	Urban	0.000	SPR	37.000	Percentage Runoff (%)	37.01	Greenfield Runoff Volume (m³)	583.182
Return Period (years)	100																											
Storm Duration (mins)	360																											
Region	England and Wales																											
M5-60 (mm)	19.000																											
Ratio R	0.350																											
Areal Reduction Factor	1.00																											
Area (ha)	2.500																											
SAAR (mm)	730																											
CWI	108.871																											
Urban	0.000																											
SPR	37.000																											
Percentage Runoff (%)	37.01																											
Greenfield Runoff Volume (m³)	583.182																											
©1982-2011 Micro Drainage Ltd																												

	Project	Job No.	Date	Page No.	Rev.
	BAENHAM ROAD POST DEVELOPMENT	Member/Location	30-11-12	Engineer CP	Checked

POST DEVELOPMENT RUNOFF

Q.P.	D(min)	Ave I (mm/hr)	+ 30% CLIMATE CHANGE
1	30	17.6	22.8
30	30	43.3	56.3
100	30	56.4	73.3
100	360	10.0	13.0

RATIONAL METHOD - $Q = 2.78 \cdot C \cdot I \cdot A$

WHERE: C - RUNOFF COEFFICIENT - 0.9
 I - RAINFALL INTENSITY / TIME OF CONCENTRATION (30)
 A - IMPERMEABLE AREA (ha) - 0.85
 Q - PEAK FLOW RATE (l/s)

$$1 \text{ year} - Q = 2.78 \times 0.9 \times 22.8 \times 0.85 = \underline{48.5 \text{ l/s}}$$

$$30 \text{ year} - Q = 2.78 \times 0.9 \times 56.3 \times 0.85 = \underline{119.7 \text{ l/s}}$$

$$100 \text{ year} - Q = 2.78 \times 0.9 \times 73.3 \times 0.85 = \underline{155.9 \text{ l/s}}$$

POST DEVELOPMENT VOLUME

100 YEAR OVR EVENT:

$$V = (2.78 \times 0.9 \times 13 \times 0.85 \times 0.001) \times 21600 = \underline{597 \text{ m}^3}$$

APPENDIX F
SITE INVESTIGATION BOREHOLE LOGS
& INFILTRATION TEST

Project Name Barnham Nursery Site	Project No. J10146	Co-ords: -	Hole Type WLS
Location: Barnham Road, Barnham, West Sussex	Level: 11.00 m AOD	Scale 1:50	Logged By DPB
Client: BDW Southampton	Dates: 08/10/2010		

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	D		0.30	10.70		MADE GROUND (brown sand and gravel)	
		0.50	D					Medium strength orange-brown silty sandy CLAY with scattered fine flint gravel	
		1.00	SPT	N=8 (1,1/ 2,2,2,2)	1.40	9.60		Loose pale yellowish brown very silty clayey fine SAND with occasional fine flint and chalk gravel	1
		1.50	D						
		2.00	SPT	N=4 (2,2/ 1,1,1,1)					2
		2.50	D						
		3.00	SPT	N=8 (3,2/ 2,2,2,2)					3
					4.00	7.00		End of Borehole at 4.00 m	4
									5
									6
									7
									8
									9

Remarks: Groundwater encountered as a seepage at 2.00m below ground level.
 Groundwater monitoring standpipe installed with a response zone from 1.00m to 4.00m below ground level





Project Name

Barnham Nursery Site

Project No.

J10146

Co-ords: -

Hole Type

WLS

Location: Barnham Road, Barnham, West Sussex

Level: 10.75 m AOD

Scale

1:50

Client: BDW Southampton

Dates: 08/10/2010

Logged By

DPB

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	D		0.30	10.45		TOPSOIL (dark brown silty sandy clay with abundant roots and rootlets)	
					0.50	10.25		Medium strength dark orange-brown silty sandy CLAY	
		0.80	D		0.60	10.15		TOPSOIL (pale brown silty sand with occasional rootlets) - probable infilled rabbit burrow	
		1.20	D					Medium strength dark orange-brown silty sandy CLAY with scattered fine flint gravel and occasional roots and rootlets	1
		1.50	D		1.40	9.35		Off white silty sandy GRAVEL of reworked chalk with abundant flint fragments, pockets of low strength pale brown and pale grey silty clay and pockets of pale brown slightly clayey silty fine sand	2
	▽	2.50	D						
					3.00	7.75		End of Borehole at 3.00 m	3
									4
									5
									6
									7
									8
									9
		Type	Results						

Remarks: Groundwater encountered as a seepage at 2.40m.

Project Name Barnham Nursery Site	Project No. J10146	Co-ords: -	Hole Type WLS
Location: Barnham Road, Barnham, West Sussex	Level: 10.30 m AOD	Scale 1:50	Logged By DPB
Client: BDW Southampton	Dates: 08/10/2010		

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	D		0.30	10.00		MADE GROUND (dark brown sandy clayey sand with abundant roots, rootlets, brick fragments, tile fragments and slate)	
		0.50	D					Medium strength orange-brown silty sandy CLAY with scattered fine chalk and flint gravel and occasional roots and rootlets	1
		1.00	D						
		1.50	D		1.60	8.70		White and off-white silty sandy GRAVEL of chalk with abundant flint gravel and occasional pockets of brown silty sand	2
		2.00	D						
					3.00	7.30		End of Borehole at 3.00 m	3
									4
									5
									6
									7
									8
									9

Remarks: Groundwater was not encountered, although soils noted as damp below 1.80m

Project Name

Barnham Nursery Site

Project No.

J10146

Co-ords: -

Hole Type

WLS

Location: Barnham Road, Barnham, West Sussex

Level: 10.50 m AOD

Scale

1:50

Client: BDW Southampton

Dates: 08/10/2010

Logged By

DPB

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.40	D					TOPSOIL (dark brown silty sand with occasional roots and rootlets)	
		0.60	D		0.50	10.00		Low strength brown, orange-brown and dark orange-brown slightly silty sandy CLAY with scattered fine chalk gravel	1
		1.00	SPT	N=8 (2,2/ 2,2,2,2)					
		1.00	D						
		1.50	D						
		2.00	SPT	N=4 (1,2/ 1,1,1,1)	1.90	8.60		Off white very sandy silty GRAVEL of chalk with occasional flint gravel	2
		2.00	D						
		2.50	D		2.40	8.10		Dark yellowish orange-brown silty slightly clayey fine SAND	
		3.00	SPT	N=10 (1,1/ 2,2,3,3)					3
					4.00	6.50		End of Borehole at 4.00 m	4
									5
									6
									7
									8
									9

Remarks: Groundwater was encountered as a seepage at 1.50m



Project Name Barnham Nursery Site	Project No. J10146	Co-ords: -	Hole Type WLS
Location: Barnham Road, Barnham, West Sussex	Level: 10.40 m AOD	Scale 1:50	Logged By DPB
Client: BDW Southampton	Dates: 08/10/2010		

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.50	D		0.60	9.80		TOPSOIL (dark brown sandy clay with abundant roots and rootlets)	
		1.00	D		1.30	9.10		Low strength locally medium strength dark orange-brown silty sandy CLAY with scattered fine chalk gravel	1
		1.80	D		2.00	8.40		Off white and pale brown sandy SILT with abundant flint gravel and fragments of low density chalk	2
		2.20	D		2.50	7.90		White, silty sandy GRAVEL of chalk with occasional flints	2
		2.80	D					Pale orange-brown and brown silty slightly clayey fine SAND	3
		3.50	D		4.00	6.40		End of Borehole at 4.00 m	4
									5
									6
									7
									8
									9

Remarks: Groundwater encountered at 2.00m.
 Groundwater monitoring standpipe installed with a response zone from 1.00m to 4.00m



WILSON BAILEY

GEOTECHNICAL & ENVIRONMENTAL

Wilson Bailey Partnership Limited
Tel: 01985 248397
www.wilson-bailey.co.uk

Borehole No

BH7

Sheet 1 of 1

Project Name

Barnham Nursery Site

Project No.

J10146

Co-ords: -

Hole Type

WLS

Location: Barnham Road, Barnham, West Sussex

Level: 9.90 m AOD

Scale

1:50

Client: BDW Southampton

Dates: 08/10/2010

Logged By

DPB

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
	✓	0.20	D		0.30	9.60		MADE GROUND (brown sandy clay with brick and clinker fragments)	
		0.50	D					Low strength brown and dark orange-brown silty sandy CLAY	
		0.80	D						1
		1.50	D		1.90	8.00		Orange-brown silty slightly sandy flint GRAVEL	2
		2.50	D		2.20	7.70		White and yellowish off-white silty sandy chalk GRAVEL with occasional flint gravel	
					3.00	6.90		End of Borehole at 3.00 m	3
									4
									5
									6
									7
									8
									9

Remarks: Groundwater encountered at 1.00m





Wilson Bailey Partnership Limited
Tel: 01985 248397
www.wilson-bailey.co.uk

BH8

Sheet 1 of 1

Project Name
Barnham Nursery Site

Project No.
J10146

Co-ords: -

Hole Type
WLS

Location: Barnham Road, Barnham, West Sussex

Level: 10.10 m AOD

Scale
1:50

Client: BDW Southampton

Dates: 08/10/2010

Logged By
DPB

A vertical scale with major tick marks labeled 1 through 9. Between each major tick mark, there are four smaller, unlabeled tick marks, dividing each unit into five equal intervals.

Remarks: Groundwater encountered at 1.70m



Project Name

Barnham Nursery Site

Project No.

J10146

Co-ords: -

Hole Type

WLS

Location: Barnham Road, Barnham, West Sussex

Level: 10.00 m AOD

 Scale
1:50

Client: BDW Southampton

Dates: 08/10/2010

 Logged By
DPB

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.40	D		0.50	9.50		TOPSOIL (dark brown sandy clay with roots and rootlets)	
		1.00	D		1.50	8.50		Low strength pale brown silty sandy CLAY with roots and rootlets	1
	▽	2.00	D		3.00	7.00		Low strength off white and pale brown silty sandy CLAY with abundant chalk and flint gravel	2
								End of Borehole at 3.00 m	3
									4
									5
									6
									7
									8
									9

Remarks: Groundwater encountered at 2.00m.





Client	Barratt David Wilson Southampton
---------------	----------------------------------

