Consulting Engineers Ltd

'optimising development potential'

LAND SOUTH OF BARTONS ROAD
HAVANT, HAMPSHIRE

Flood Risk Assessment &
Preliminary Surface Water Drainage Strategy

Project No. 14-018

December 2015

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Flood Risk Assessment &
Preliminary Surface Water Drainage Strategy

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Project No. 14-018

December 2015

DOCUMENT CONTROL SHEET

REV	ISSUE PURPOSE	AUTHOR	CHECKED	REVIEWED	APPROVED	DATE
-	Final	GAC	GG	GAC	GAC	Dec 2015
A	Revision to allow for Hybrid Infiltration & Overflow to Positive Outfall	GAC	GG	GAC	GAC	Feb 2016

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1.0 INTRODUCTION

1.1 Charles & Associates Consulting Engineers Ltd (C&A) have been appointed by Chidden Farms (CF) to prepare a Flood Risk Assessment (FRA) for the proposed development of land South of Bartons Road, Havant, within the Borough of Havant and County of Hampshire, hereafter referred to as 'the site'. The location is shown diagrammatically on **Figure 1**.

1.2 Further information provided by the Geotechnical Consultant has confirmed that the infiltration techniques proposed must be supplemented with a piped network to allow for overflow from the infiltration structures should they become overwhelmed.

1.3 As such following discussions with Southern Water, the incumbent water company, a further review of the existing public surface water sewer network has been undertaken. Together with the existing drainage on site, to reach a suitable overflow arrangement from the infiltration structures. This is identified within this revised report. Within Section 6.

Purpose

1.4 The site was promoted for residential development through the Havant Council Local Plan (Allocations), dated October 2014, and is currently allocated within it.

1.5 CF now wish to submit a planning application in line with the original strategic promotion. This application is to be outline in nature and include a scheme to satisfy policies HB1 and UE3b which provides for an allocation of up to 203 residential dwellings.

1.6 With this in mind this FRA has been prepared as a means of demonstrating that flooding and drainage issues would not constrain the development of the site. It also confirms that the site will conform to the recently published national standards for sustainable drainage (SuDS) and the local requirements set out by Hampshire County Council as the SuDs approval body (SAB).

1.7 It is noted that the application is outline in nature as such it is expected that a planning condition will be imposed on any approval that requires the principles of this FRA to be adhered to and proven at the more detailed design stage of the site evolution.

1.8 In terms of surface water drainage and potential for flooding, it examines the sites suitability in planning policy terms and physical characteristics to allow suggested solutions to deal with drainage in the developed state, thus ensuring the site is drained in a sustainable manner while not affecting the surrounding area.

1.9 The provisions of the National Planning Policy Framework (NPPF) have been considered in preparing the Flood Risk Assessment, together with The Flood & Water Management Act 2010 (TFWMA). In addition attention has also been paid to the Technical Guidance of the National Planning Practise Guidance (NPPG) In addition policies within the Core Strategy and LP(Allocations) have also been addressed.

1.10 Flood maps published by the Environment Agency and further information provided by the Agency and the Councils SFRA indicate that the site lies fully within Flood Zone 1, 'Low probability flood risk area', from for fluvial sources, as defined by Table 1 of NPPF. Correspondence from the EA is provided within **Appendix A** and shown diagrammatically on **Figure 4**.

Report Limitations

1.11 The findings, recommendations and conclusions of this report are based on information obtained from a variety of external sources which are understood to be reputable. However, C&A Consulting Engineers cannot guarantee the authenticity or reliability of any data and/or records provided by third parties.

2.0 SITE LOCATION & DETAILS

2.1 The site is located to the south east of the existing residential area of Denvilles, Bartons Road to the north and agricultural land to the east, as shown in **Figure 1**. The existing site is an open undeveloped field. The whole site within the red line boundary covers 6.8 hectares in area. Again this is shown diagrammatically in **Figure 2**.

Topography & Existing Drainage

2.2 Topographic information has been obtained for the site. The land survey indicates a moderate to steep slope falling from north to the south east across the site. The approximate levels fall from 35m AOD to 18m AOD. Refer **Figure 3**.

2.3 A 375 mm diameter Southern Water surface water sewer crosses the site from north to south at the proposed access road before continuing south changing direction to the east ultimately discharging to a culvert within Eastleigh Road. This has been confirmed via Southern Water public sewer records, refer **Appendix E and Figure 3**. In addition a number of agricultural land drains cross the site to the east and west which discharge to the north/south southern water sewer. These drains are believed to be between 600 and 1000mm deep and currently drain the site in terms of greenfield runoff.

2.4 A small pond exists halfway down the eastern boundary which is heavily silted and overgrown with vegetation.

2.5 A full topographic survey has been undertaken which has confirmed the records accordingly. The presence of the public surface water suggests that the site can be drained via traditional piped networks, if necessary. However it is intended that the site follow SuDS methods of surface water control, as such the use of the existing public network will only come in to play should infiltration techniques not prove viable for geotechnical reasons.

2.6 Localised surface water flooding has been noted both visually on the site and within the EA's current mapping, refer **Figure 5**. This flooding follows the line of the public sewer in the main however small pockets of surface flooding occur to the south/south west as indicated on **Figure 5**.

2.7 It is thought that the combination of the land drainage entering the surface water sewer and the geology of the site creates this minor flooding phenomenon.

Geology

2.8 A review of the British Geological Society's records and intrusive borehole testing has confirmed that the superficial geology is River Terrace Deposits of Sand Silt & Clay of varying depths followed by head deposits of gravelly clay and finally a bedrock of clay silt and sand. Clearly the clay/silt has a low potential for infiltration. As such an intrusive investigation was carried out which confirmed that the site has gravely topsoil to 250mm followed by a layer of silty clay to gravely clay. Infiltration potential was reviewed and is supported by the infiltration test results within the geotechnical report. Infiltration rates were found to be good to poor as such selective infiltration is achievable. Refer **Appendix F** for extracts of Geotechnical Report and **Figures 6 & 7** for British Geological Society mapping.

2.9 As such there is potential to utilise some forms of infiltration techniques on the site at shallow levels below ground. The form of these SuDs techniques is explained later within this report. In summary they include a combination of traditional pipes and infiltration. With an ultimate over flow, should it be required, to the public sewer as per the existing condition.

Vulnerability classification

2.10 With reference to Table 2 of NPPF, the proposed residential dwellings would be considered as a 'More Vulnerable' use. By virtue of the site having a Flood Zone 1 classification and already allocated within the LP. The site is suitable for residential development and deemed to have passed the Sequential Test as set out in the NPPG guidance. This is supported by the Planning Authority's SFRA and LP.

Groundwater

2.11 Review of the Environment Agency's (EA) records has confirmed that the site is underlain by a Secondary 'A' Aquifer within the superficial gravel/clay, however, it is also designated unproductive due to the London Clay. Secondary Aquifers are designated by the EA 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"

2.12 Importantly EA records confirm that the site does not fall within a ground water protection zone area. Refer **Appendix A** for EA records on Ground Water and **Figures 8 to 10**. In addition no recorded groundwater flooding has been noted by the EA or Hampshire County Council (HCC), beyond that identified as surface water flooding as suggested within the EA mapping. Reproduced as **Figure 5** within this report.

2.13 In addition the intrusive geotechnical survey did not encounter ground water at the time of the testing in November 2013.

2.14 Historic observations by the land owner have however suggested that in times of extreme rainfall events such as those experienced in 2007, the ground became water logged by a mixture of waters backing up in the public sewer and land drains, together with ground waters becoming

trapped between the London Clay and Gravel/Clay layers eventually dissipating away.

Local Policy Documents

2.15 This FRA has been prepared with due regard to the '*Strategic Flood Risk Assessment'* (SFRA) prepared by Atkins in 2007 for the Urban South Hampshire Partnership which formed part of Havant Borough Council's evidence base for their Core Strategy which was adopted in March 2011. The Adopted 'Core Strategy', sets out the policies and aims for the Borough until 2026.

2.16 This SFRA has been further supplemented by the '*Strategic Flood Risk Assessment Supplement - Incorporating Sequential and Exception Tests'* for the emerging Local Plan (Allocations) which also support the Borough's, then, emerging Local Plan (Allocations). This document also confirms the site is suitable for development.

2.17 It is intended to provide up to 175 dwellings and associated infrastructure on the site. The site is conducive to utilising a number of Sustainable Urban Drainage techniques.

2.18 As such it is envisaged that all hardstanding surface water flow will be stored and infiltrated back to the ground.

2.19 This ensures that policy and guidance, such as that required under the Local Plan (Allocations) Policy UE3b, Adopted Core Strategy Policies CS11, 15 and 21, National Planning Policies, the Flood & Surface Water Management Act 2010 and the recently released national SuDS Guidance, are all met and satisfied.

2.20 The site has been recognised by both the EA and the Local Planning Authority, through their evidence base, as being suitable for development and confirm that the site can be developed in terms of planning policy.

Sequential Test and Exception Test

2.21 NPPF & TFWMA requires that at all stages of planning a Sequential Test is completed with the aim of steering new development to areas at the lowest probability of flooding. The Sequential Test would normally be completed by the Local Planning Authority (LPA) to inform the preparation of the Local Development Framework (LDF).

2.22 NPPF indicates that where a Sequential Test has not been applied by the Local Authority, evidence will need to be gathered. The onus for provision of evidence demonstrating the successful application of the Sequential Test for the site falls to the developer or promoter of the site. It is noted that a Strategic Flood Risk Assessment has been prepared for the Core Strategy and has informed the evidence base, however this is not site specific. That said further evidence has been provided in the form of the Strategic Flood Risk Assessment Supplement - Incorporating Sequential and Exception Tests.

2.23 This evidence confirms the sites credentials for development via a positive result in the Sequential Test which assures its continued progress through the planning system in terms of flood risk.

2.24 With respect to the Exception Test. This test should only be applied as set out in NPPF Table 3 following application of the Sequential Test. In this case the Sequential Test Has been deemed to be passed by virtue of sections 2.22 & 2.23 above. It is therefore now necessary to show that both elements of the test, as set out in paragraph 102 of NPPF can be satisfied. That being:

- *it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared; and*

- *a site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.*
  Both elements of the test will have to be passed for development to be allocated or permitted.

2.25 As residential development has already been identified within the Council's evidence base as having passed the Sequential Test and is to be located within Flood Zone 1, the site is deemed to have also passed the required Exception Test

2.26 While a positive outcome, it must not be forgotten that in the development of the site it must be demonstrated that the development will be safe and will not increase the risk of flooding to other areas. This is dealt with in **Section 8** of this report.

3.0 DEFINITION OF THE FLOOD HAZARD

Sources of flooding:

3.1 NPPF identifies six potential sources of flooding that require investigation:

- Flooding from rivers or fluvial flooding;
- Flooding from the sea or tidal flooding;
- Flooding from land;
- Flooding from groundwater;
- Flooding from sewers; and
- Flooding from reservoirs, canals, and other artificial sources.

Flooding from rivers of fluvial flooding

3.2 There are no water courses or riparian ditches on, or adjacent to the site. A small pond exists to the eastern boundary half way down its north/south length, however this appears to be feed via the existing land drains.

3.3 There are historic records of flooding to water courses east and west of the site. However, these are some distance away. This is confirmed by the Environment Agency's flood maps, enclosed at **Appendix A** and **Figure 4.** It is also reinforced by a number of Planning Authority commissioned studies for the area. The most up to date of these being:

- The Strategic Flood Risk Assessment' (SFRA) prepared by Atkins in 2007 for the Urban South Hampshire Partnership;
- Strategic Flood Risk Assessment Supplement - Incorporating Sequential and Exception Tests for the, then, emerging Local Plan (Allocations) October 2013;

3.4 All of the documents identified above also confirm that the site falls within Flood Zone 1, therefore suitable for development.

Flooding from the Sea or tidal flooding

3.5 The site is remote from the coast and at an elevation of between 35 m AOD and 18 m AOD. As such no flooding from the sea or tidal flooding can occur.

Flooding from Land (Local Surface Water Flooding)

3.6 With reference to **Figure 3**, the site contours confirms that the catchment falls to the south/south east.

3.7 Land drains currently exist on the site and agricultural fields to the east which discharge to public sewer adjacent to the site to the east.

3.8 It is of note, from the EAs localised surface water flooding mapping that some low level localised flooding occurs on a similar line to that of the land drains and the public sewer.

3.9 Anecdotal evidence of flooding on the site has been raised, which would concur with the information shown on the EA mapping. The drainage strategy to be introduced as part of the development will intercept much of the existing localised flows within the site, directing them at controlled rates to appropriate points of discharge directly in to the ground via infiltration techniques.

3.10 The new SuDs regime from the development will also ensure this type of localised flooding will not occur due to the type of SuDs scheme proposed that will change the existing drainage patterns.

Flooding from sewers

3.11 There are surface water sewers on site, it is intended to connect into this existing public system. For overflow purposes only and this will be controlled to a maximum of Qbar. This would only occur if infiltration was overwhelmed at times of extreme repetitive storm events. There are also foul sewers that cross the site, all new foul pipe networks will be independent to any surface water drainage and will be offered for adoption to Southern Water.

3.12 The details of the Foul drainage strategy are covered under a separate report.

Flooding from groundwater

3.13 The site is underlain by a Secondary 'A' Aquifer. Secondary Aquifers are designated by the EA 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"

3.14 Importantly EA records confirm that the site does fall within a ground water protection zone area. That being inner zone 1c (subsurface activity only). Refer **Appendix A** for EA records on Ground Water. As the SuDs scheme will provide tertiary and secondary pollution control the risk of ground water contamination is minimal. In addition no recorded groundwater flooding has been noted by Hampshire County Council (HCC).

3.15 In addition the EA has confirmed that there has been no record of historic ground water flooding on the site. Refer **Appendix A & F**. It is our opinion therefore that ground water flooding is not a problem on the site.

3.16 As such, the risk of groundwater flooding is not considered significant and has not been considered further.

Flooding from reservoirs, canals and other artificial sources

3.17 Reference to the Streetmap website indicates there are no notable artificial sources in the vicinity of the site that could give rise to a flood risk. Flooding from reservoirs, canals and other artificial sources has therefore not been considered further.

4.0 PROBABILITY OF FLOODING

Flood Zone

4.1 Flood maps published by the EA and further information provided by the Agency/Planning Authority indicate that the site lies within 'Flood Zones 1, low probability flood risk area', for fluvial sources, as defined by Table 1 of NPPF. Correspondence from the Environment Agency is provided within **Appendix A** and shown diagrammatically on **Figure 4 & 5**.

Strategic Flood Risk Assessment

4.2 A 'Strategic Flood Risk Assessment' (SFRA) was been prepared by Atkins in 2007 for the Urban South Hampshire Partnership which formed part of Havant Borough Council's evidence.

4.3 This SFRA has been further supplemented by the 'Strategic Flood Risk Assessment Supplement - Incorporating Sequential and Exception Tests' for the emerging Local Plan (Allocations) which also support the Boroughs, then, emerging Local Plan (Allocations). This document also confirms the site is suitable for development.

Run-off

4.4 Were appropriate the existing rate of run-off from the site has been estimated using The SuDS Manual, CIRIA C697 (2007) in accordance with IH Report 124, flood estimation for small catchments (Marshall and Bayliss, 1994). The pro-rata method on the size of catchment detailed in Table 4.2 in The SuDS Manual, CIRIA C697 (2007) has been used for the 6.8 ha part of the overall site that is to be developed. The analysis has been completed using the Source Control module of WinDes using the following parameters:

AREA (AREA DRAINED)	6.8 ha	Recommended the **SuDs Manual. Pro-rate flows by area of the site**
SAAR (STANDARD AVERAGE ANNUAL RAINFALL)	771 mm	Obtained from WINDES
SOIL (PARAMETER REPRESENTING THE PERMEABILITY OF THE SUB SOLIDS)	0.4	This has been taken as a value to reflect the Impermeable London Clay underlying the site.
REGION (FSR REGION REPRESENTING REGIONAL GROWTH CURVE)	7	The site lies within region

4.5 The analysis provides an estimate for QBAR (the mean annual flood) of 25.9 ls^{-1} for a 6.8 ha site. The Q_{100} flow, the 1 in 100 year run-off from a 6.8 ha site, is 82.6ls.

4.5.1 As it is intended to infiltrate all development flows directly into the ground Qbar has been provided to confirm a failsafe mechanism. In the normal flood events, should abnormal repeated inundations occur that overwhelm the infiltration rates, runoff at Qbar will occur to the existing public sewer, which currently receives flows from the site at greenfield runoff rates, hence the new regime will be at a greatly reduced rate. Connection to the public sewer may be undertaken by requisition as agreed with Southern Water Plc, refer **Appendix E** This is provided in more detail within **Section 6.0**. inundations

4.6 It should also be noted that by providing the proposed SuDS system existing runoff toward the urban area to the south west will be reduced.

5 EFFECT OF CLIMATE CHANGE

Climate Change

5.5 Based on the most recent advice on climate change reported in NPPG, peak rainfall intensity, sea level, peak river flow, offshore wind speed and extreme wave heights are all expected to increase in the future. It is recommended that considerations for future climate change are included in Flood Risk Assessments for proposed developments.

5.6 Mapping within the SFRA and the EA data confirms that all dwellings will remain located in Flood Zone 1, after allowing for climate change and therefore will not be affected by the impact of climate change.

5.7 The site is likely to be subject to increases in rainfall intensity of 30% over the lifetime of the development that will place additional pressure on surface water drainage infrastructure. Therefore, the sustainable drainage system that will serve the proposed development has be designed to cater for the 1 in 100 year plus 30% rainfall event.

6 PRELIMINARY DEVELOPMENT PROPOSALS

Preliminary Development Layout

6.1 The development of the site will provide up to 175 residential dwellings and associated infrastructure as shown by the preliminary master plan at **Appendix B**.

6.2 The preliminary SuDs system for the development has been designed to HCC's *'Surface Water and Sustainable Drainage Guidance for Developer, Designers and Planners'.* It is expected that this guidance will be followed should the site gain outline planning permission, when full final details of the development are provided to release conditions.

6.3 It is intended to utilise infiltration techniques in the form of shallow porous paving, swales and infiltration trenches to recharge the ground water. With no offsite flows for up to 1 in 100 yr plus climate change storm events. Unless, following repeated storms events, the system is overwhelmed. Should this unlikely event occur a secondary adopted pipe system will be utilised to take flows to the existing 375mm dia sewer at Qbar or less rates of discharge. This system maybe requisitioned with Southern Water Ltd under the the Water Industry Act to allow for the reinforcement of the existing public system should it be appropriate. Refer **Appendix E** for correspondence.

6.4 As stated above the existing land drains already connect to the public sewer at various locations. These drains currently discharge to the public sewer at uncontrolled greenfield runoff rates. These will be disconnected should the development proceed and only Qbar allowed to enter the public system. As Qbar is less than the current greenfield runoff 25.9l/s the existing public sewer will be able to operate at a more efficient rate. In addition this would only occur in the unlikely event that the infiltration process was over whelmed.

6.5 Should Southern Water require the existing system to be upgraded this can be achieved via the use of infrastructure charges which are levied on the developer for local reinforcement. It is important to note that there will be no increase, actually a decrease, in flows to the receiving water course to the south. As such no variation to the consent to discharge will be required with the Environment Agency.

6.6 Storm events above the 1 in 100 yr plus climate change events will be provided for via overland flow paths to the agricultural field to the south east. These overland flow paths will be via the proposed roads and open space areas and are shown diagrammatically on **Figure 11.**

6.7 Drawings and calculations are provided in **Appendix C & D** respectively these confirm the following:

- All flows will be cleansed either, via the use of the porous paving and swales. In addition pipe networks will utilize trapped gullies and oil/petrol interceptors, if appropriate before discharging to infiltration structures;
- All development flows will be controlled at or near source via infiltration techniques;
- Where infiltration results from testing have proven to be poor tanked attenuation will be utilised beneath porous paving that will discharge to a pipe network which will in turn discharge to a infiltration structure;
- 1 in 100 year plus climate change of 30% will be controlled via further attenuation either in porous paving within private car parking/driveway areas or within suitably landscaped swales and local grassed depressions within the open space areas of between 200 and 300 mm deep;
- While the swales will act as surface water conveyance conduits, as well as storage, for all storm events the infiltration structures

below these will only hold water at the 1 in 100 year plus climate change storm event;

- Housing finished Floor Levels will be set 150mm above existing ground to provide an additional factor of safety;
- It is not intended to utilise these existing Southern Water pipes crossing the site for development flow.

7 MANAGEMENT MEASURES

Flood Risk Management Measures

7.1 NPPG & the Practice Guide require that the safety of people and the proposed development be considered against each source of flooding identified in Section 3.

7.2 The residential development is to be located within Flood Zone 1 and therefore, even with the potential for climate change, properties will not be at risk of fluvial flooding.

7.3 A preliminary drainage strategy incorporating sustainable urban drainage (SuDs) has been provided to manage the increase in run-off from the site over the lifetime of the development such that it will not place properties at risk of surface water flooding.

7.4 The SuDs system will also be maintained by a suitably qualified Management Company for the lifetime of the development. such that it will not place properties either on the site or elsewhere at an increased risk of surface water flooding. This complies with NPPF guidance and HCC's SuDS guidance/policies.

7.5 The flood risk to the proposed development and surrounding area, as a consequence of the development is therefore considered to be low and no specific flood risk management measures will be required.

8 OFF SITE IMPACTS

Flood Risk elsewhere

8.1 As the proposed development is located entirely within a Flood Zone 1 designation, it will not have any adverse impact on the flood risk to others by virtue of obstruction to flood flows or the reduction of flood plain storage.

Surface Water Management

8.2 NPPG, Paragraph F6 states:-

"Surface water arising from a developed site should, as far as is practicable, be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development, while reducing the flood risk to the site itself and elsewhere, taking climate change into account."

8.3 The development plans, with the indicative surface water drainage solutions provided, confirms that the site can be drained in a sustainable manner. The drainage proposals are presented within **Section 6** above.

8.4 To reduce the run-off from the developed site to that of the undeveloped site or better, infiltration techniques using sustainable drainage measures have been fully utilised.

9.0 RESIDUAL RISKS

Residual flood risk

9.1 As the site's residential properties will be built in Flood Zone 1 they will not be at significant risk of flooding, even with allowance for climate change.

9.2 Extreme rainfall events are generally predictable, but by their nature predictions are based on probability and thus subject to uncertainty. Therefore an unquantifiable residual risk remains that events exceeding those predicted may occur, notably surcharging or blockage of sewers or gullies.

9.3 If the drainage system is overwhelmed, either by a storm event with a magnitude greater than that designed for or due to a blockage, the finished site levels will be designed to ensure that there is no risk of floodwaters ponding to a significant depth. In addition the overland flow path for any such exceedance storm event will be designed to take overland flow to open space areas such as the village green.

Management

9.4 The public drainage systems serving the proposed development will be managed either by the highways adopting authorities such as Hampshire County Council or Southern Water Ltd. For any additional SuDs element of the scheme, Hampshire County Council, as required under the FWMA as the lead Local Flood Authority, will approve the scheme in detail however a management Company will be employed to maintain the SuDs element of the system. As discussed above.

10.0 CONCLUSIONS & RECOMMENDATIONS

Background

10.1 This report has been commissioned to assess the risk to, and the impact of, a proposed development of the land south of Bartons Road. It is proposed to provide up to 175 residential dwellings on the site. The proposed residential development is considered as a 'More Vulnerable' when utilising Table 2 of NPPG.

10.2 The entire site lies Zone 1 'Low Probability' flood area as defined by Table 1 of NPPG. In assessing the flood risk, the impacts of climate change have been considered for the lifetime of the proposed development and considered acceptable.

Sequential and Exception tests

10.3 The Sequential and Exception tests have been applied and deemed to have been passed.

Ground Water Protection

10.4 The site is underlain by London Clay and is over a secondary non-productive aquifer but not within a ground water protection zone. As such the risk of ground water flooding is negligible.

Flood Risk Management

10.5 As the proposed residential development will lie within Flood Zone 1, the risk of flooding from all sources is assessed to be low and the safety of people is considered acceptable in all foreseeable flooding events. No specific flood management measures beyond that of maintenance are considered to be necessary.

Offsite Impacts

10.6 The Outline Drainage Strategy set out in this assessment identifies an option for the management of surface water run-off using sustainable drainage techniques. The proposed development will not increase the flood risk elsewhere. In fact, due to the implementation of the SuDs scheme proposed, downstream existing flooding, if any, will be minimised.

Residual Risks

10.7 A residual risk remains that an event exceeding the design parameters used for the drainage system may occur, or part of the drainage system may fail due to a blockage. However, in these circumstances, the general topography of the site would convey floodwaters away from the development. Toward open fields to the south east.

10.8 In addition the employment of a management company for the life of the development to maintain the surface water management train will ensure the scheme will operate at its maximum efficiency at all times.

Recommendations

10.9 Due to the positive outcome of this Flood Risk Assessment we see no reason why the site should not continue through the planning process and be approved for residential development in terms of flood risk.

REFERENCES

- Department for Communities and Local Government, 2012 National Planning Policy Framework.

- Department for Communities and Local Government, 2014 National Planning Practise Guidance.

- Environment Agency, Nov 2012 ver 1. Ground Water Protection : Principles and Practice (GP3)

- The SuDS Manual, CIRIA C697 (2007)

- IH Report 124, Flood estimation for small catchments (Marshall and Bayliss, 1994).

- Urban South Hampshire Partnership Strategic Flood Risk Assessment 2007.

- Strategic Flood Risk Assessment Supplement - Incorporating Sequential and Exception Tests for the emerging Local Plan (Allocations) October 2013;

- Havant Borough Council Core Strategy

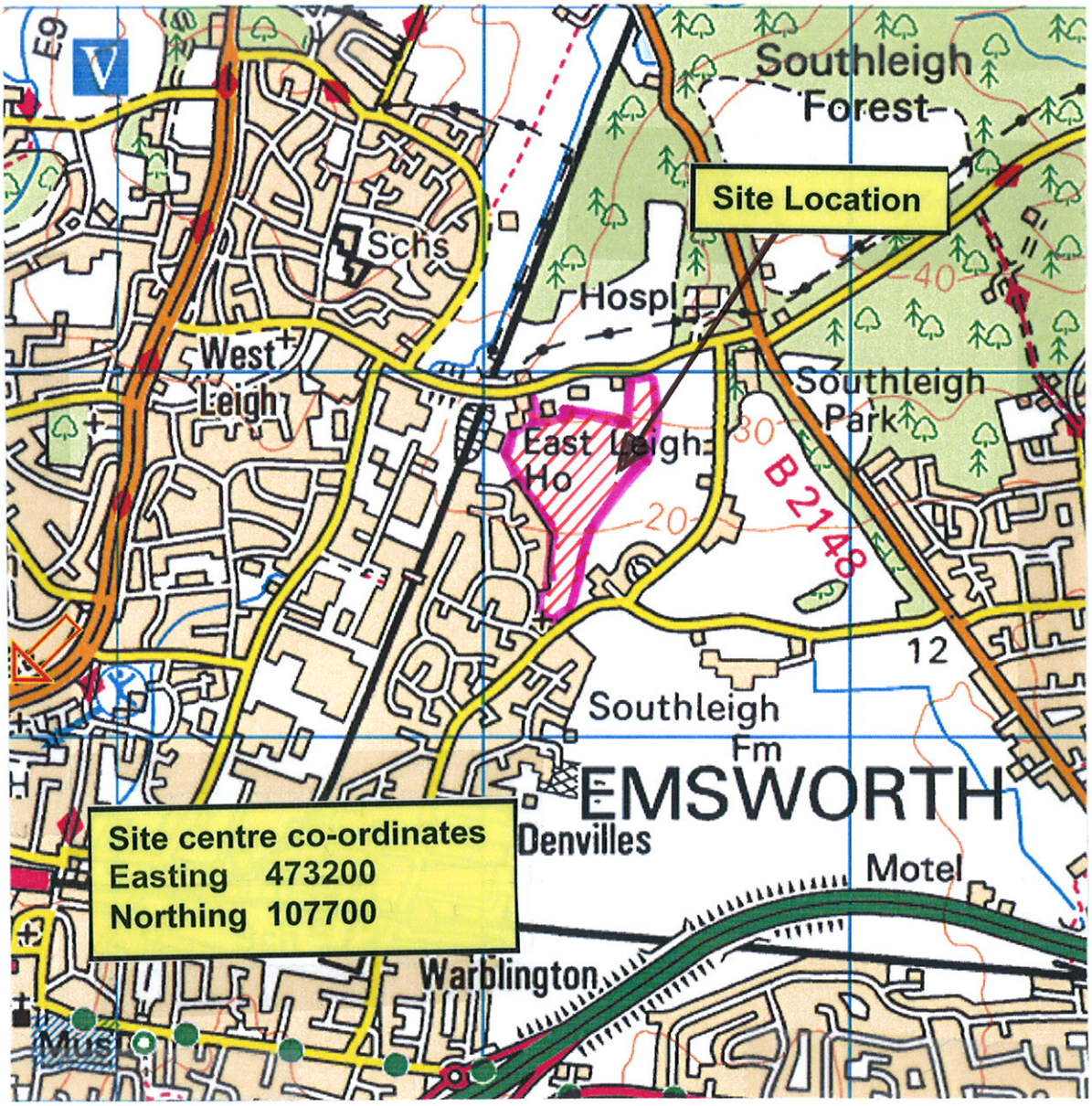
- Havant Borough Councils Local Plan (Allocations)

- HCC Surface Water and Sustainable Drainage Guidance for Developers, Designers and Planners

- British Geological Survey, Geology of Britain viewer: http://maps.bgs.ac.uk/geologyviewer_google/googleviewer.html

- Streetmap http://www.streetmap.co.uk

FIGURES



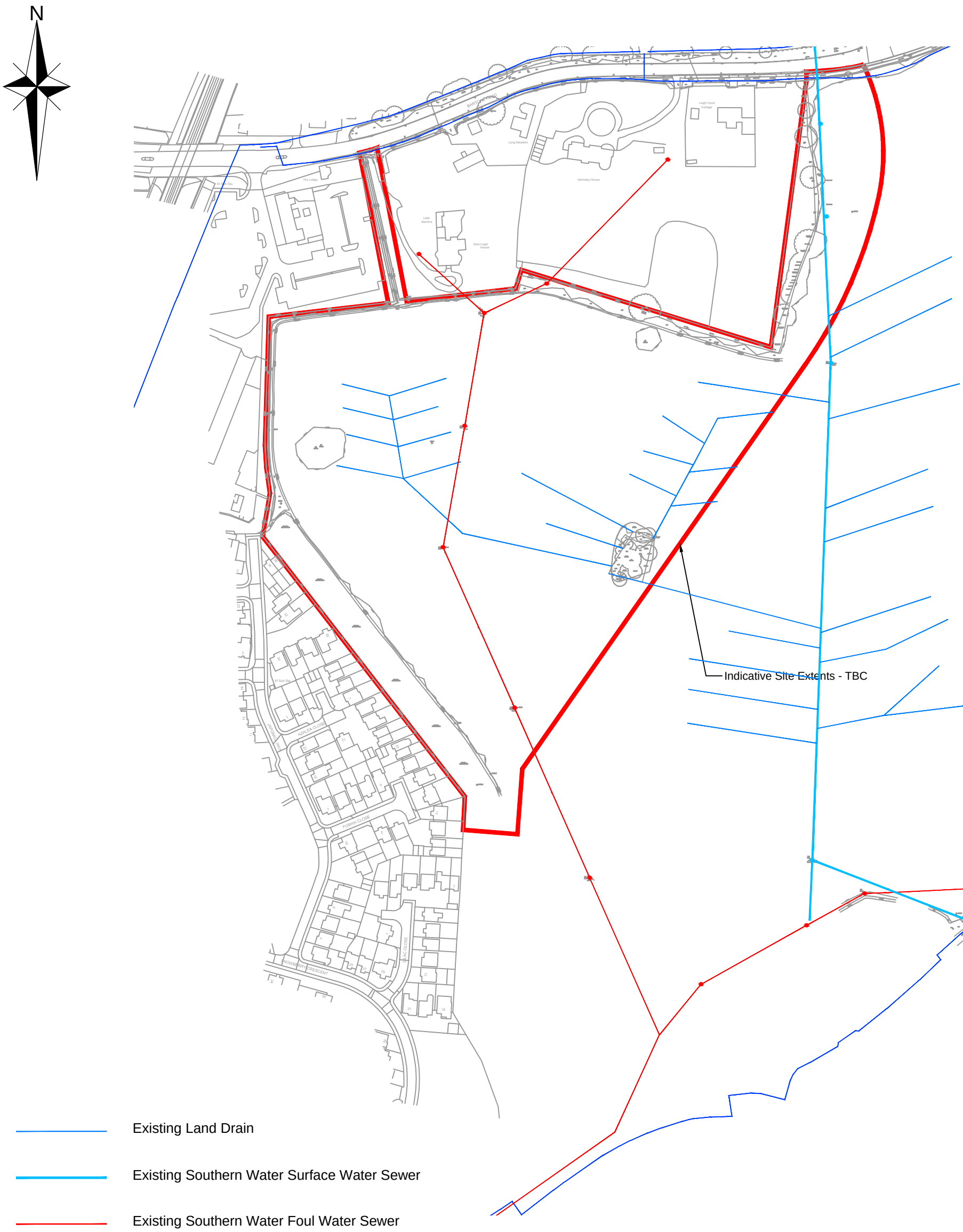
Rev	Amendments	Drn	Chk	App	Date

Consulting Engineers Ltd

Issued by ☒ Offices 8 & 9 Aldershot Enterprise Centre Mandora House Louise Margaret Road Aldershot, Hampshire GU11 2PW 01252 939000

☐ Office 17, Wealden Place Bradbourne Vale Road Sevenoaks, Kent TN13 3QQ 01732 448120

Job Title: Land South of Bartons Road, Havant	Scale: NTS	Date: Nov 15	Designed: n/a
Drawing Title: Site Location Plan	Drawn: EV	Checked: GC	Approved: GC
Client: Chidden Farm	Job No: 14-018	Figure No: FIGURE 1	Rev:



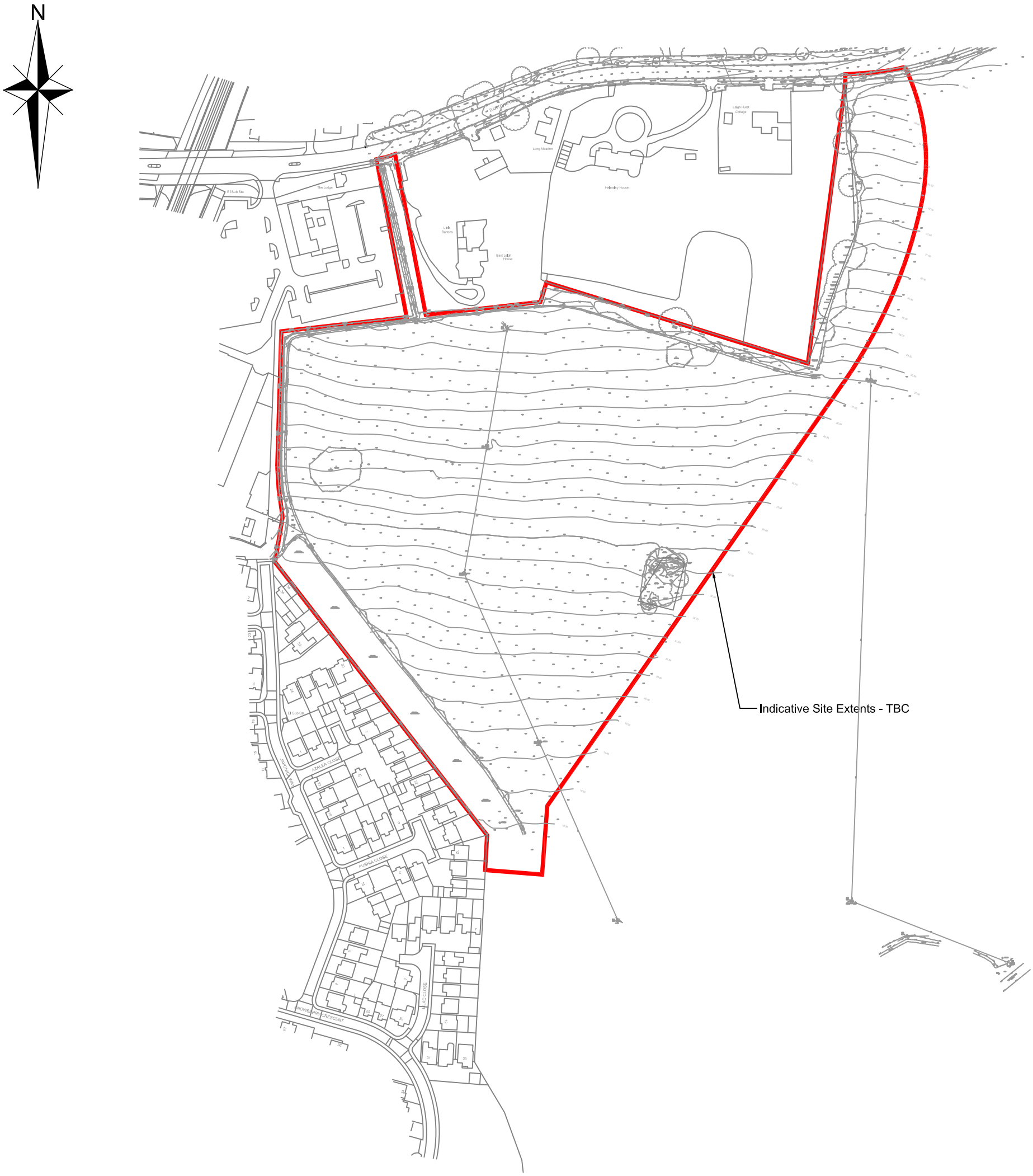
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Job Title: Land South of Bartons Road, Havant	Scale: 1:2500@A3	Date: Nov 15	Designed: n/a
Drawing Title: Site Boundary Plan and Existing Drainage	Drawn: EV	Checked: GG	Approved: GC
Client: Chidden Farms	Job No: 14-018	Figure No: FIGURE 2	Rev:



Site Boundary

Site centre co-ordinates
Easting 470050
Northing 115020

Rev	Amendments	Drn	Chk	App	Date

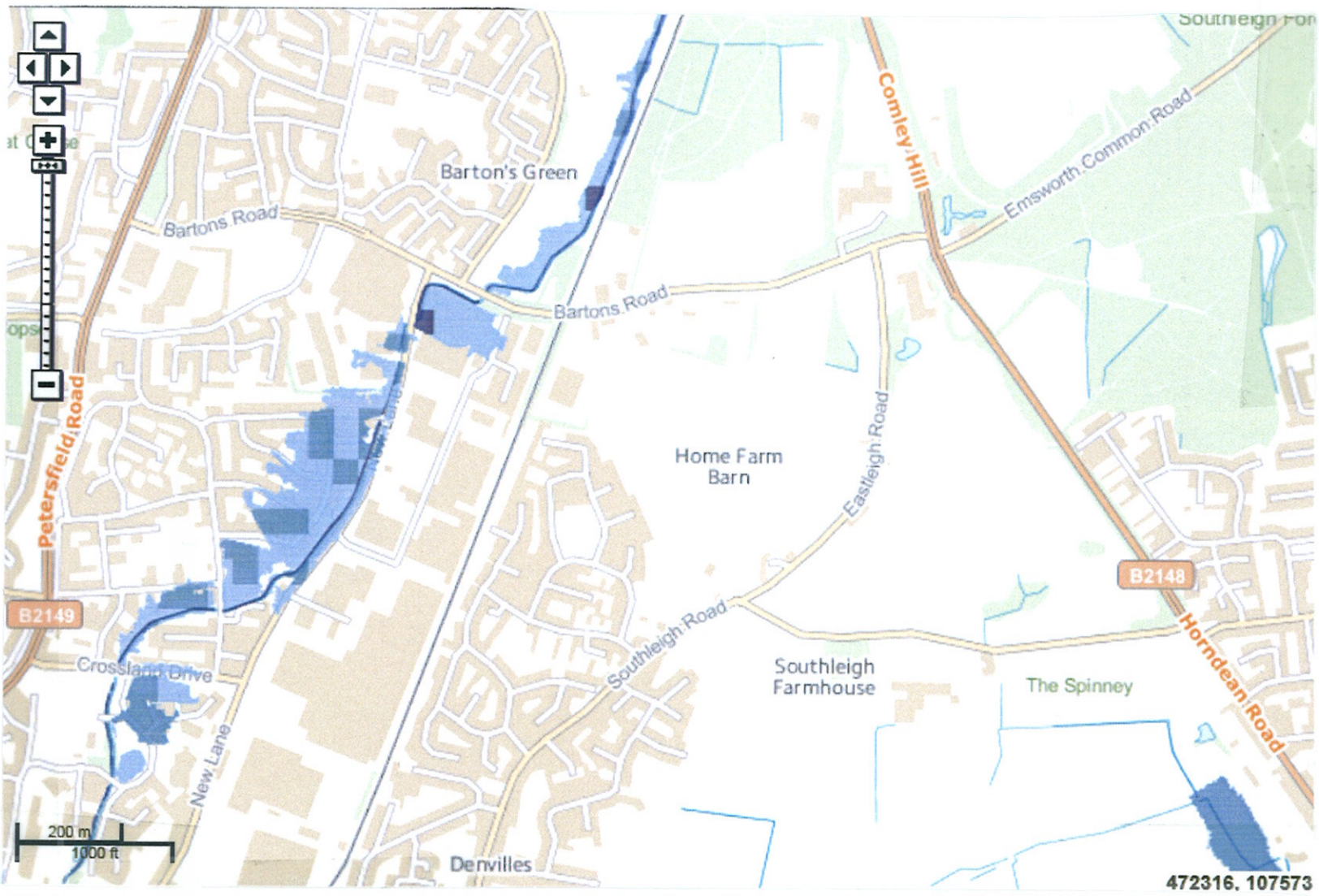
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TN13 3QQ
01732 448120

Job Title: Land South of Bartons Road, Havant	Scale: 1:2500@A3	Date: Nov 15	Designed: n/a	
Drawing Title: Topographical Information	Drawn: EV	Checked: GG	Approved: GC	
Client: Chidden Farms	Job No: 14-018	Figure No: FIGURE 3		Rev

N



Map legend

- ☑ Risk of Flooding from Rivers and Sea
- High
- Medium
- Low
- Very Low

Rev	Amendments	Drn	Chk	App	Date

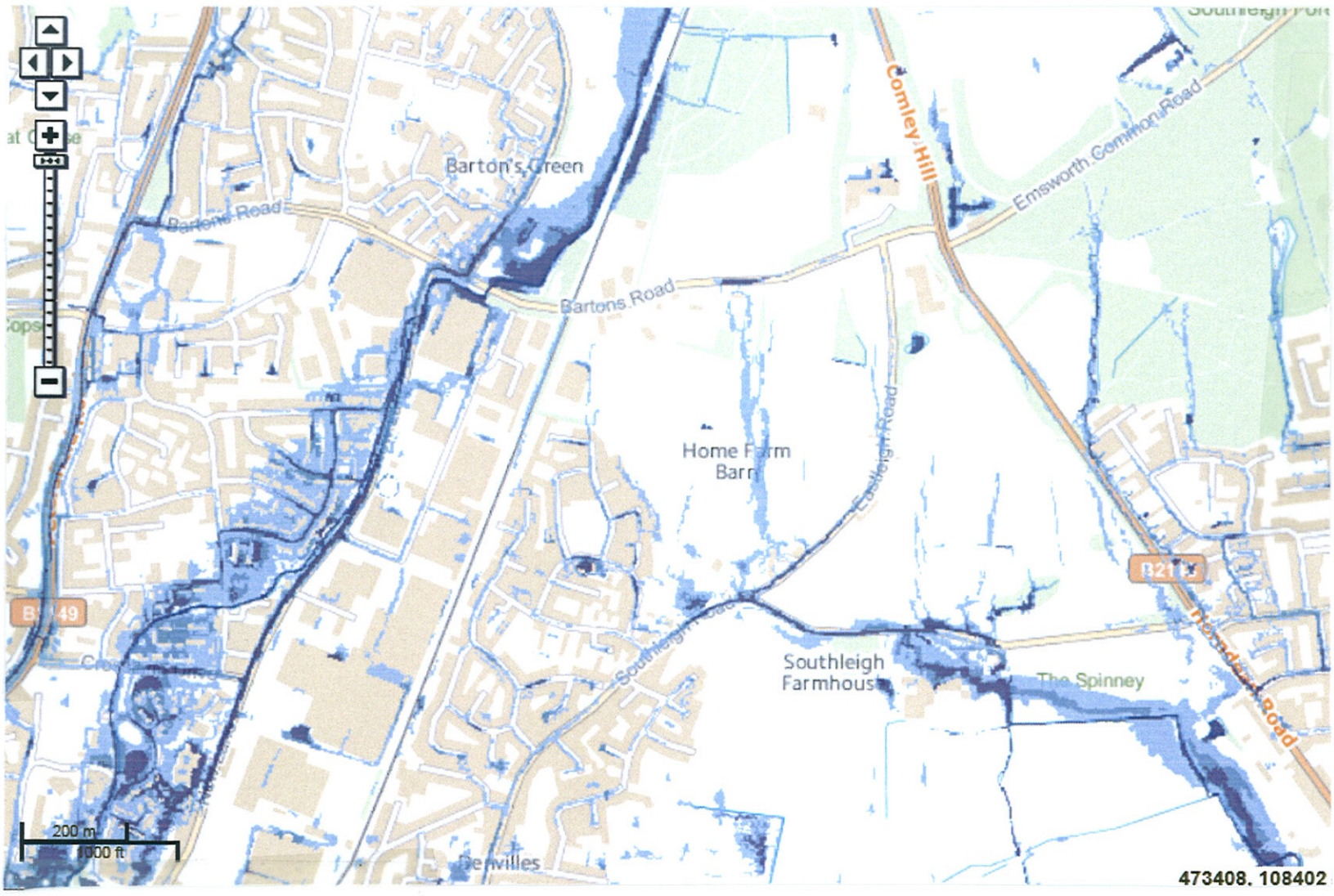
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Job Title: Land South of Bartons Road, Havant	Scale: NTS @ A3	Date: Nov 15	Designed: n/a
Drawing Title: Flood Zones derived from EA	Drawn: EV	Checked: GG	Approved: GC
Client: Chidden Farms	Job No: 14-018	Figure No: FIGURE 4	Rev:

N



Map legend

- ☑ Risk of Flooding from Surface Water
- High
- Medium
- Low
- Very Low

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Job Title: Land South of Bartons Road, Havant	Scale: NTS @ A3	Date: Nov 15	Designed: n/a
Drawing Title: Surface Flood Zones derived from EA	Drawn: EV	Checked: GG	Approved: GC
Client: Chidden Farms	Job No: 14-018	Figure No: FIGURE 5	Rev:

N



1:50 000 scale geology

Bedrock geology

- BOGNOR SAND MEMBER - SAND
- LONDON CLAY FORMATION - CLAY, SILT AND SAND
- LONDON CLAY FORMATION - SAND
- LAMBETH GROUP - CLAY, SILT AND SAND
- LAMBETH GROUP - SAND
- PORTSDOWN CHALK FORMATION - CHALK
- SPETISBURY CHALK MEMBER - CHALK
- TARRANT CHALK MEMBER - CHALK
- LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION, NEWHAVEN CHALK FORMATION, CULVER CHALK FORMA

Rev	Amendments	Drn	Chk	App	Date

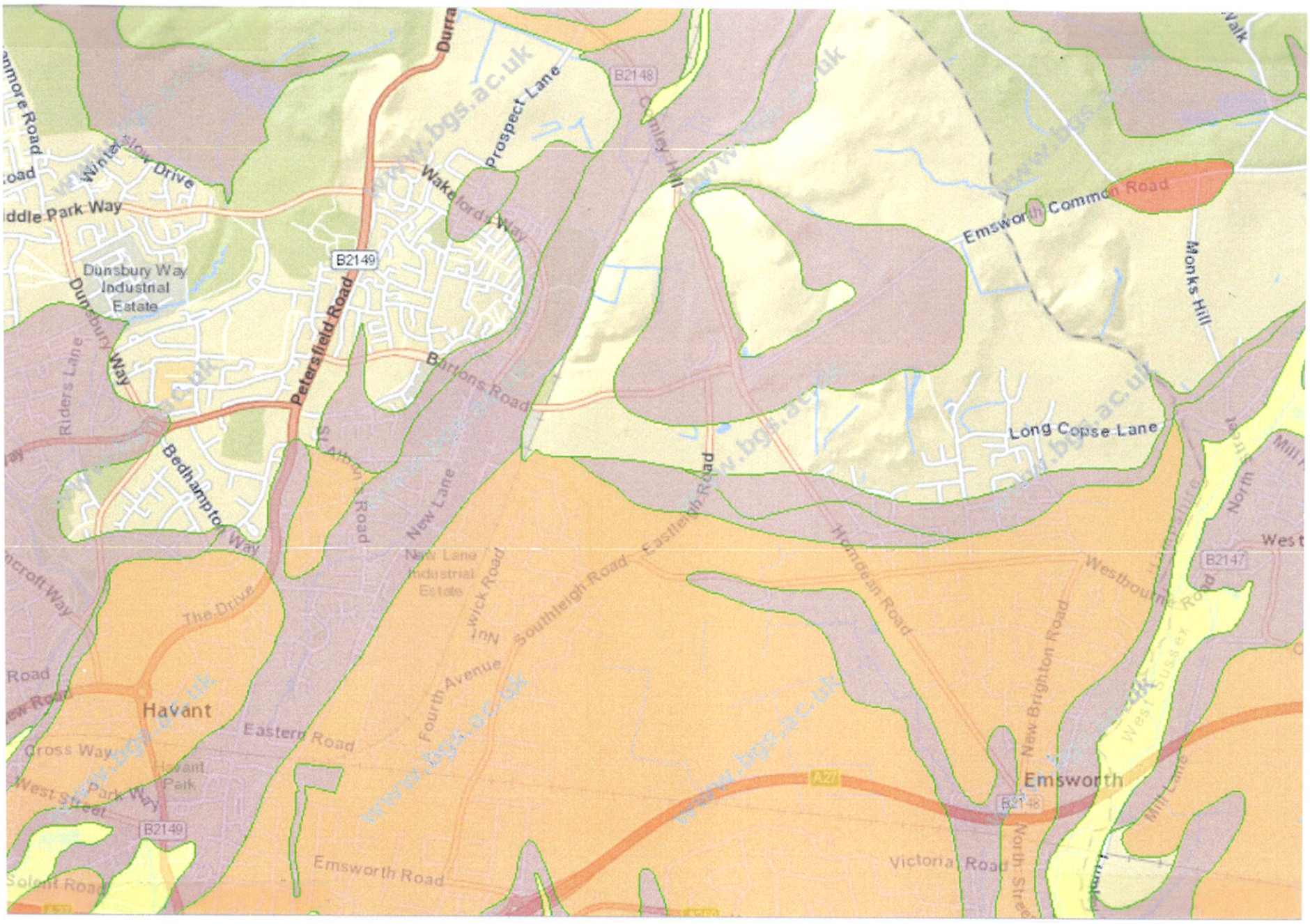
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Job Title: Land South of Bartons Road, Havant	Scale: NTS @ A3	Date: Nov 15	Designed: n/a	
Drawing Title: BGS data - Bedrock	Drawn: EV	Checked: GG	Approved: GC	
Client: Chidden Farms	Job No: 14-018	Figure No: FIGURE 6	Rev:	

N



1:50 000 scale geology

Superficial deposits

- ALLUVIUM - CLAY, SILT, SAND AND GRAVEL
- HEAD - GRAVEL, CLAYEY
- HEAD - CLAY, SILT, SAND AND GRAVEL
- RAISED STORM BEACH DEPOSITS, 2 - GRAVEL
- RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND, SILT AND CLAY
- CLAY-WITH-FLINTS FORMATION - CLAY, SILT, SAND AND GRAVEL

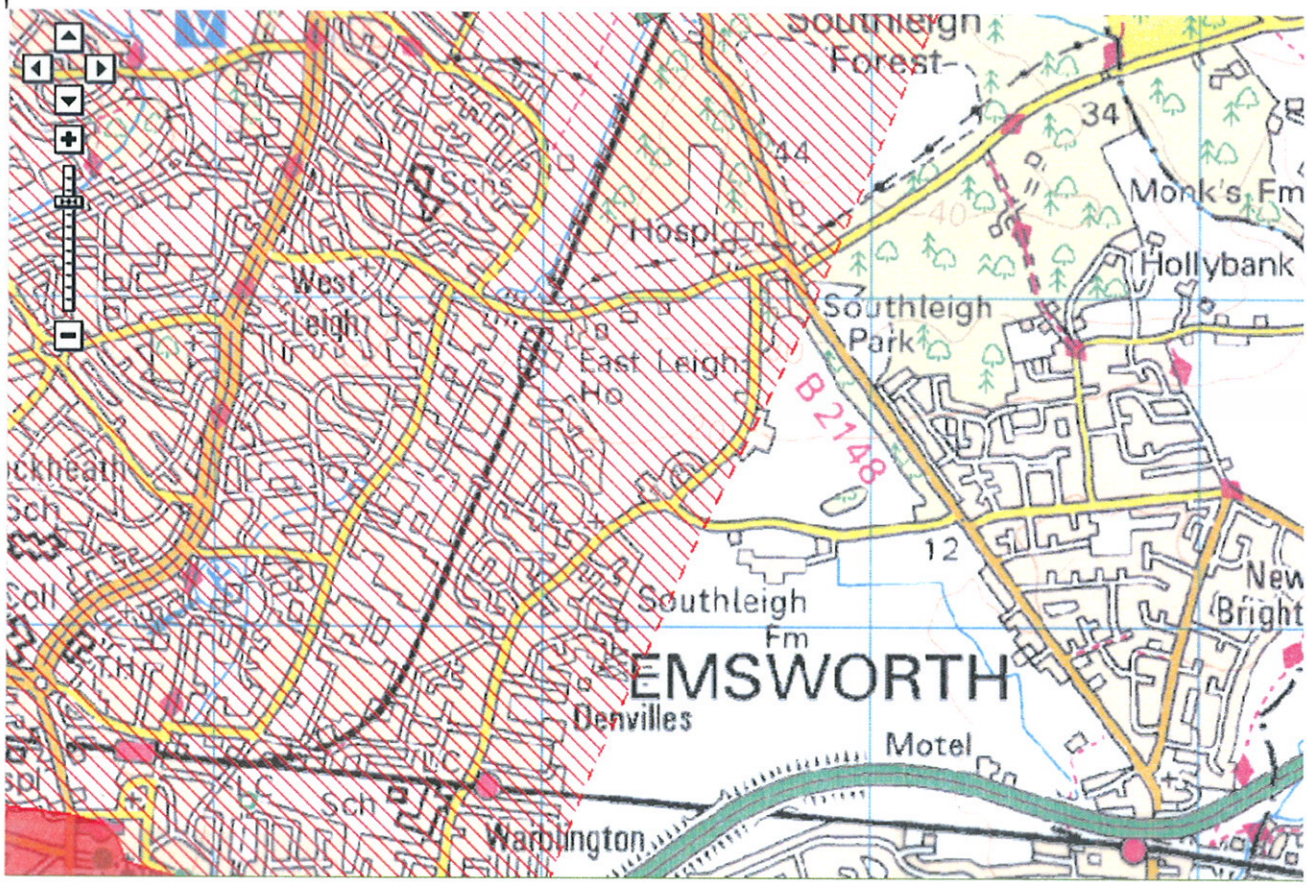
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Job Title: Land South of Bartons Road, Havant	Scale: NTS @ A3	Date: Nov 15	Designed: n/a	
Drawing Title: BGS data - Superficial	Drawn: EV	Checked: GG	Approved: GC	
Client: Chidden Farms	Job No: 14-018	Figure No: FIGURE 7		Rev



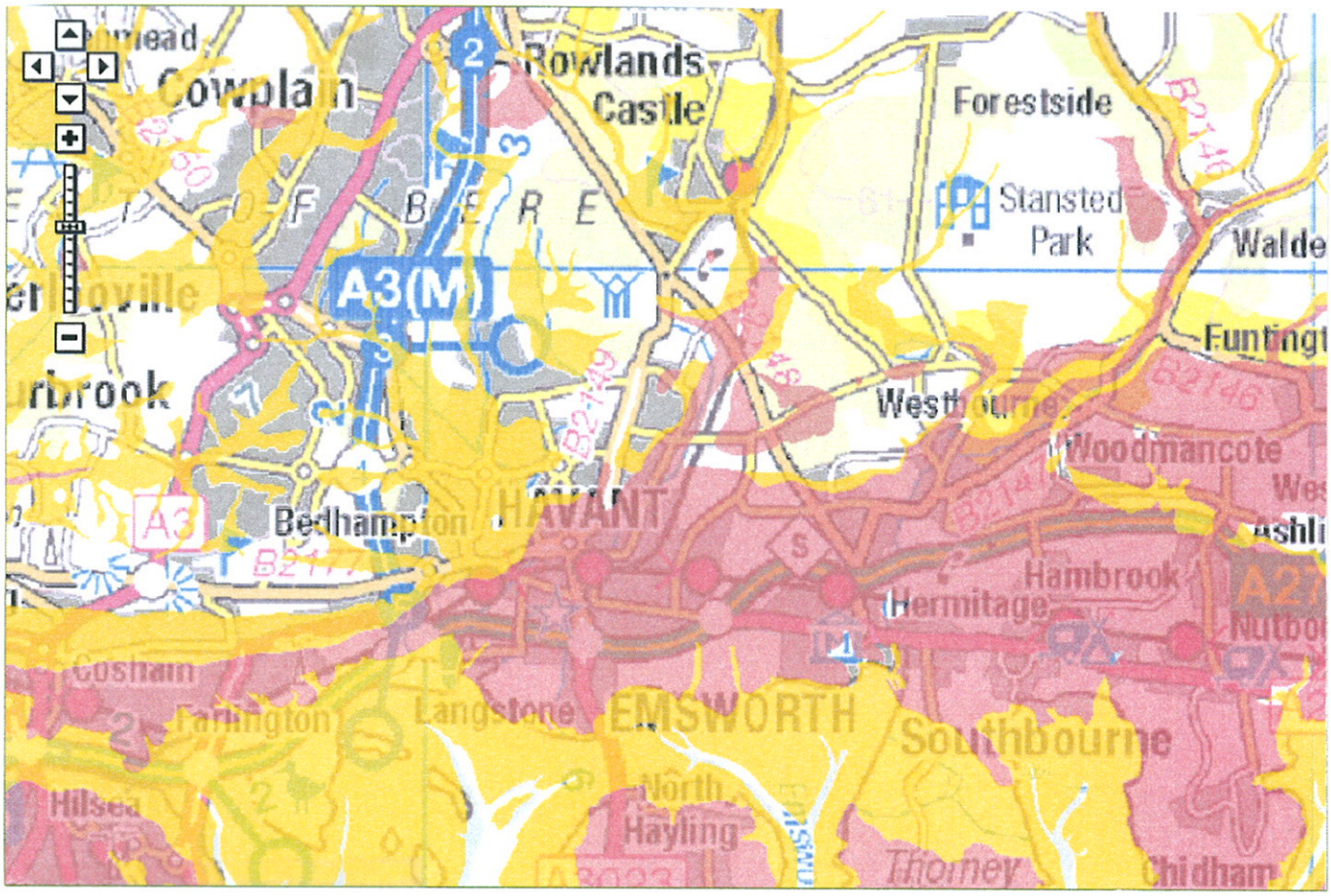
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Job Title: Land South of Bartons Road, Havant	Scale: NTS	Date: Nov 15	Designed: n/a	
Drawing Title: Groundwater Source Protection Zones	Drawn: EV	Checked: GC	Approved: GC	
Client: Chidden Farm	Job No: 14-018	Figure No: FIGURE 8		Rev



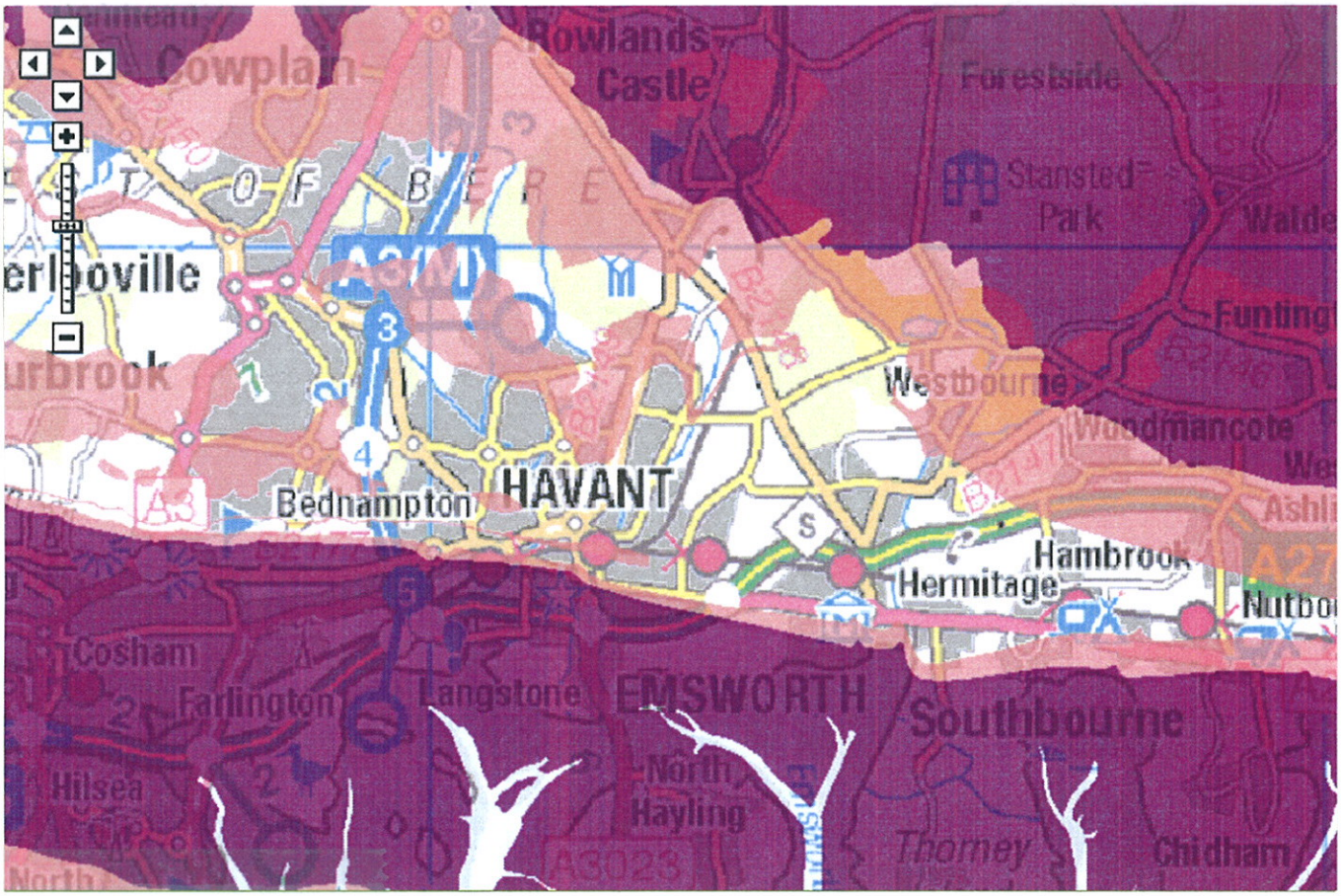
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Job Title: Land South of Bartons Road, Havant	Scale: NTS	Date: Nov 15	Designed: n/a
Drawing Title: Aquifer Maps - Superficial Deposits	Drawn: EV	Checked: GC	Approved: GC
Client: Chidden Farm	Job No: 14-018	Figure No: FIGURE 9	Rev



BGS Aquifer Maps - Bedrock Designation

- Principal
- Secondary A
- Secondary B
- Secondary (undifferentiated)

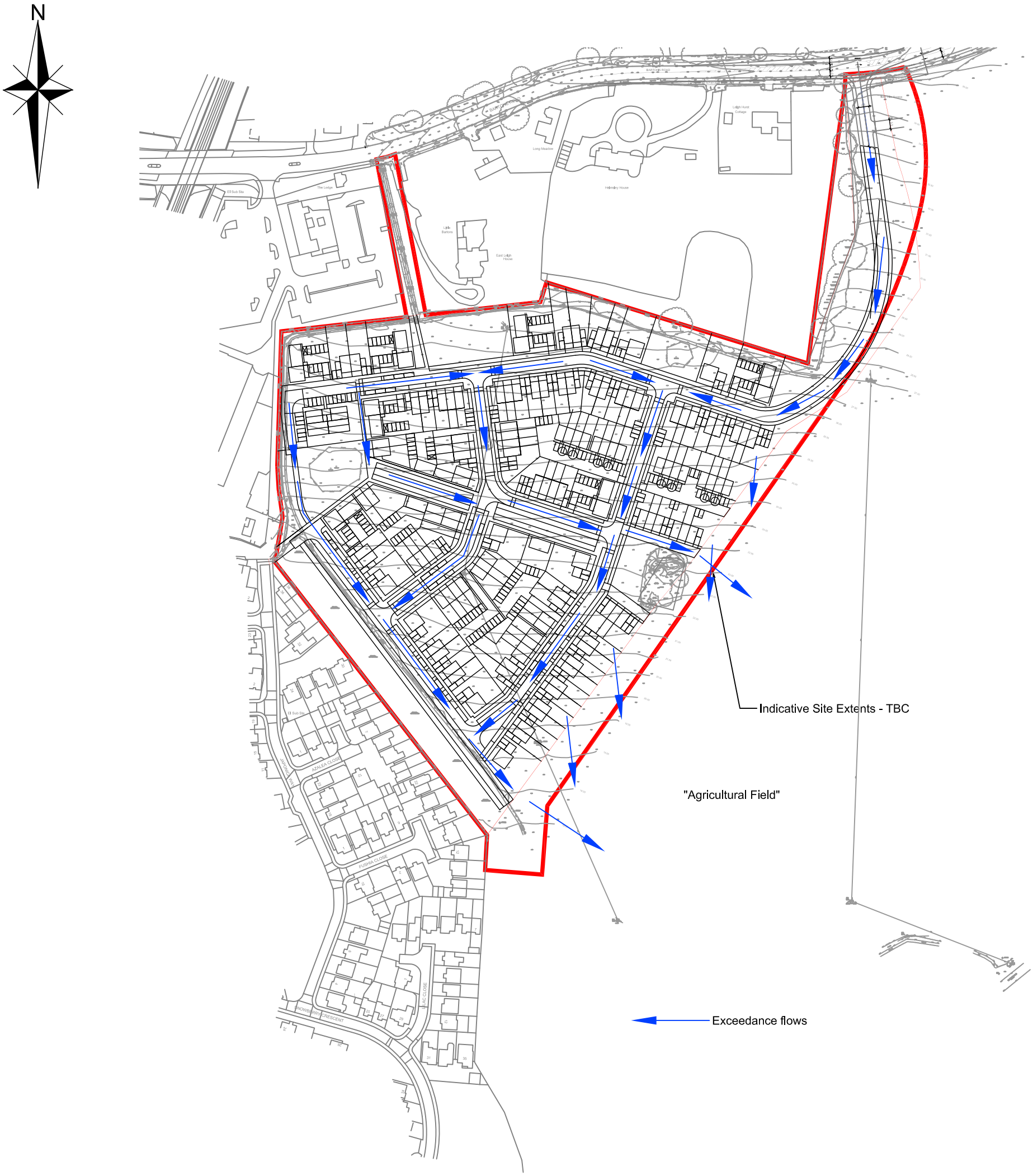
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Job Title: Land South of Bartons Road, Havant	Scale: NTS	Date: Nov 15	Designed: n/a
Drawing Title: Aquifer Maps - Bedrock Deposits	Drawn: EV	Checked: GC	Approved: GC
Client: Chidden Farm	Job No: 14-018	Figure No: FIGURE 10	Rev



Site Boundary

Site centre co-ordinates
Easting 470050
Northing 115020

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Job Title: Land South of Bartons Road, Havant	Scale: 1:2500@A3	Date: Nov 15	Designed: GC
Drawing Title: Post Development Overland Flow Paths	Drawn: EV	Checked: GG	Approved: GC
Client: Chidden Farms	Job No: 14-018	Figure No: FIGURE 11	Rev:

APPENDIX A

CORRESPONDENCE WITH THE ENVIRONMENT AGENCY

Agadi, Praful

From: SSD Enquiries [SSDEnquiries@environment-agency.gov.uk]
Sent: 15 April 2015 16:19
To: Statutory Enquiries
Subject: 150415 SSD/6319 PLANT ENQUIRY : LM 37493/SD - Bartons Road, HAVANT, Hampshire

Dear Shovon

Thank you for your recent consultation regarding the above site.

Although the Environment Agency is classed as a statutory undertaker for certain purposes we do not generally have plant equipment or pipelines situated in the public highway. Our consent as a regulator may be required if you are intending to carry out work within 8 metres of a Main River as defined in the Water Resources Act 1991 or within 16 metres of the Tidal Thames.

This reply has been drafted without conducting a specific search of our records. If you have reason to think that your proposal will affect land or equipment which we own please resubmit your enquiry making this clear.

I hope that we have correctly interpreted your request.

Should you have any further queries, please do not hesitate to contact me.

Kind regards
Hannah

Hannah Osborn
Customers and Engagement Officer
Customers & Engagement Team
Covering Sussex, Hampshire and the IoW (Solent & South Downs Area)

Guildbourne House, Chatsworth Road, Worthing, West Sussex, BN11 1LD
01903 832064

ssdenquiries@environment-agency.gov.uk

We would be really grateful if you could spare five minutes to help us improve our service. Please click on the link below and fill in our survey – we use every piece of feedback we receive:
http://feedback1.environmentagency.uk.com/s3/SSDCustomer

protect invest improve
Planning for the future of water
FLOODS DESTROY BE PREPARED

Have your say on the draft updates to the river basin management plans and the draft flood risk management plans

www.gov.uk/government/consultations/update-to-the-draft-river-basin-management-plans
www.gov.uk/government/consultations/draft-flood-risk-management-plans

From: Enquiries, Unit
Sent: 14 April 2015 14:49
To: Statutory Enquiries
Subject: 1504014/MB12 RE: PLANT ENQUIRY : LM 37493/SD - Bartons Road, HAVANT, Hampshire

Dear Shovon,

I have passed your enquiry to our customer team for the relevant area and they will be in touch with you shortly.

The Freedom of Information Act and Environmental Information Regulations state that a public authority must respond to requests for information within 20 working days, but we aim to respond to all enquiries as quickly as we can.

You can find more information about our service commitment by clicking on the link below:
https://www.gov.uk/government/publications/environment-agency-customer-service-commitment

Should you wish to contact the customer team directly, please use the contact details below. Please quote your Enquiry Reference 1504014/MB12 in any correspondence with us regarding this matter.

Customer and Engagement
Environment Planning & Engagement
Environment Agency
Solent and South Downs Area
Guildbourne House
Chatsworth Road
Worthing
West Sussex
BN11 1LD

Tel 03708 506506

I trust the above is of assistance to you.

Kind Regards

Matthew Bembridge
Customer Service Adviser

National Customer Contact Centre - Part of National Operations Services
☎ Tel: 03708 506 506
💻 Web Site: www.gov.uk/environment-agency

So how did we do...?

Our National Customer Contact Centre relies on customer feedback, so we really value your thoughts on how we are doing. We will always make changes where we can to improve our service. This will only take three minutes to complete:

http://feedback1.environmentagency.uk.com/s3/NCCCsurvey

From: Das, Shovon [mailto:Shovon.Das@atkinsglobal.com] **On Behalf Of** Statutory Enquiries
Sent: 14 April 2015 10:35
To: National Plant Enquiry's; nrswa@bskyb.com; Enquiries, Unit; 'Interoute'; 'McNic'; 'Global Crosing New'; 'Networkrail'; 'verizonbusiness'; 'plantenquiries@energetics-uk.com'; 'plantenquiries@cityfibreholdings.com'; 'plantenquiries@catelecomuk.com'; NRSWA@cofely-gdfsuez.com; plant-enquiries@redcentricplc.com
Subject: PLANT ENQUIRY : LM 37493/SD - Bartons Road, HAVANT, Hampshire

To whom it may concern,

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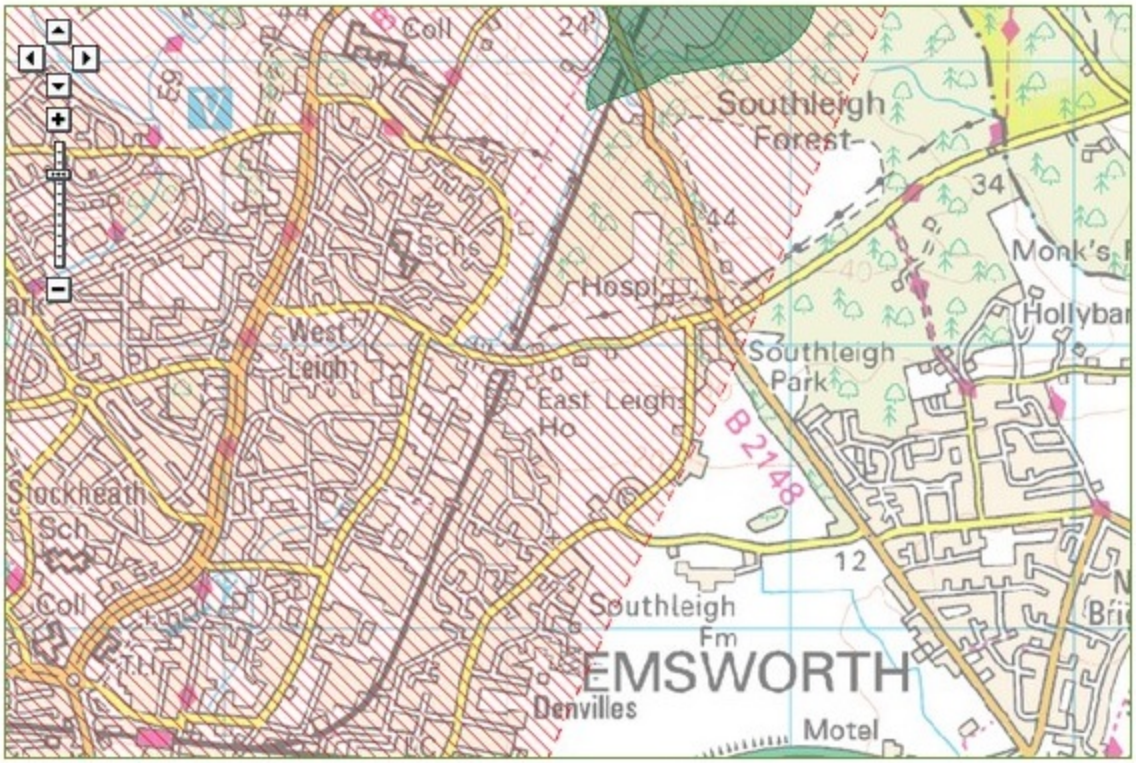
Other topics for this area... Groundwater ▼

Groundwater

Map legend

X: 473,225;Y: 107,864 at scale 1:20,000

Other maps · Data search · Text only version



- Groundwater source protection zones
  - Inner zone (Zone 1)
  - Inner zone - subsurface activity only (Zone 1c)
  - Outer zone (Zone 2)
  - Outer zone - subsurface activity only (Zone 2c)
  - Total catchment (Zone 3)
  - Total catchment - subsurface activity only (Zone 3c)
  - Special interest (Zone 4)
- Aquifer Maps - Superficial Deposits Designation
- Aquifer Maps - Bedrock Designation
  - Principal
  - Secondary A
  - Secondary B
  - Secondary (undifferentiated)
- Groundwater Vulnerability Zones
  - Major Aquifer High
  - Major Aquifer Intermediate
  - Major Aquifer Low
  - Minor Aquifer High
  - Minor Aquifer Intermediate
  - Minor Aquifer Low
- Other national environmental organisations
  - Natural Resources Wales Area of responsibility
  - Scottish Environment Protection Agency Area of responsibility

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More about Groundwater

Groundwater Source Protection Zones:

Groundwater provides a third of our drinking water. We ensure that your water is safe to drink defining Source Protection Zones. These zones help to monitor the risk of contamination from any activities that might cause pollution in the area.

The Source Protection Zones are not displayed at scales greater than 1:20,000 (Ordnance Survey 1:50,000 scale) as the data was only modelled to this level and is not accurate pass this. They should not be compared against field boundaries.

Understanding Groundwater Source Protection Zones maps

British Geological Survey Aquifer Maps:

From 1st April 2010 new aquifer designations replace the old system of classifying aquifers as Major, Minor and Non-Aquifer. This new system is in line with our Groundwater Protection Policy (GP3) and the Water Framework Directive (WFD) and is based on British Geological Survey mapping.

The Aquifer Extents are not displayed at scales greater than 1:75,000 (Ordnance Survey 1:250,000 scale) as the data was only modelled to this level and is not accurate pass this.

Understanding Groundwater Source Protection Zones maps

Environment Agency

Enter a postcode or place name: **Other topics for this area...**

Go | Risk of Flooding from Surface Water | View other Interactive Maps

Risk of Flooding from Surface Water

Surface water flooding happens when rainwater does not drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead.

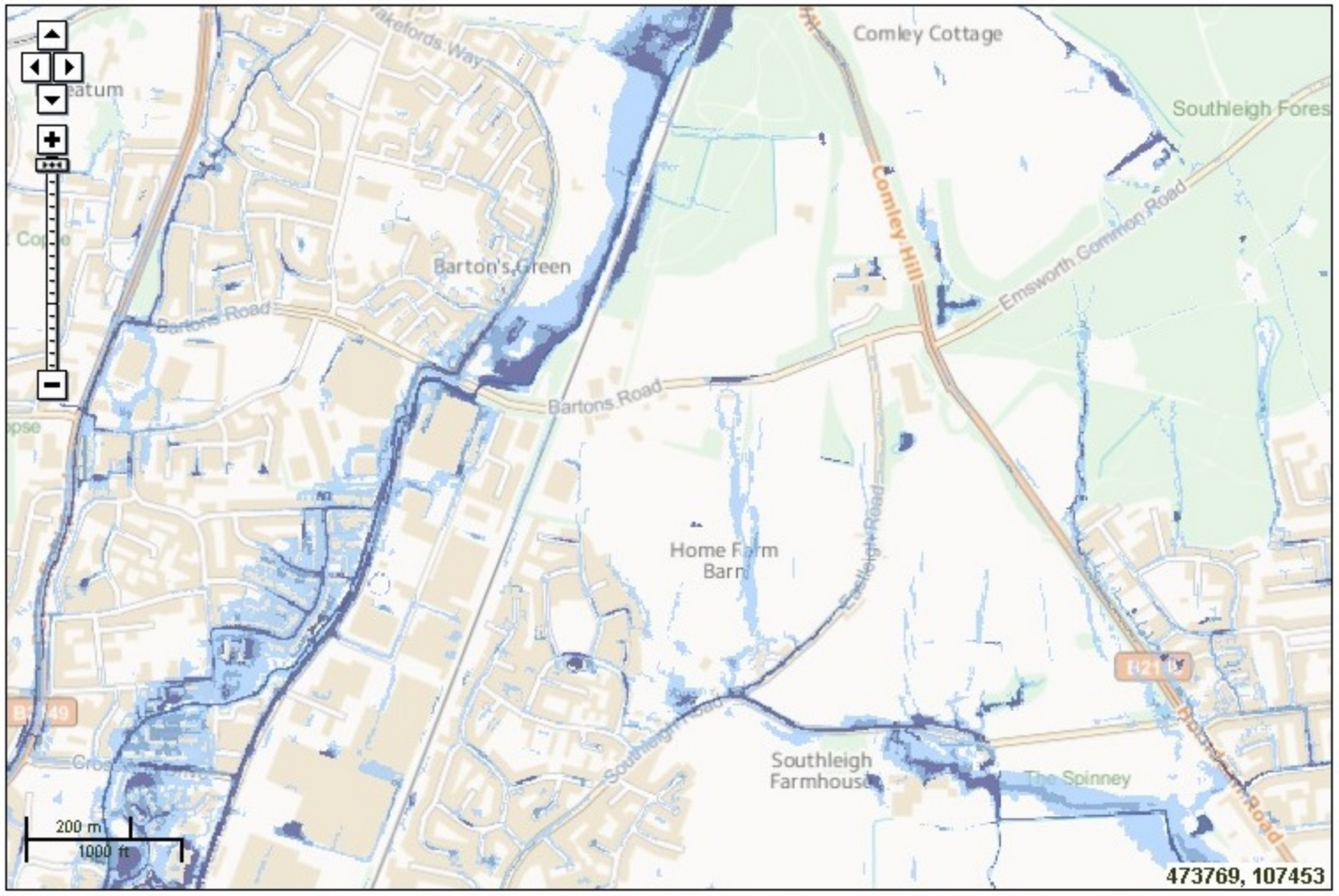
The shading on the map shows the risk of flooding from surface water in this particular area.

Click on the map for a more detailed explanation.

Map legend

- Risk of Flooding from Surface Water
- High
- Medium
- Low
- Very Low

Map of X: 473,225; Y: 107,864 at scale 1:10,000 **Data search**



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Other topics for this area...

Flood Map for Planning (Rivers and Sea)

Flood Map for Planning (Rivers and Sea)

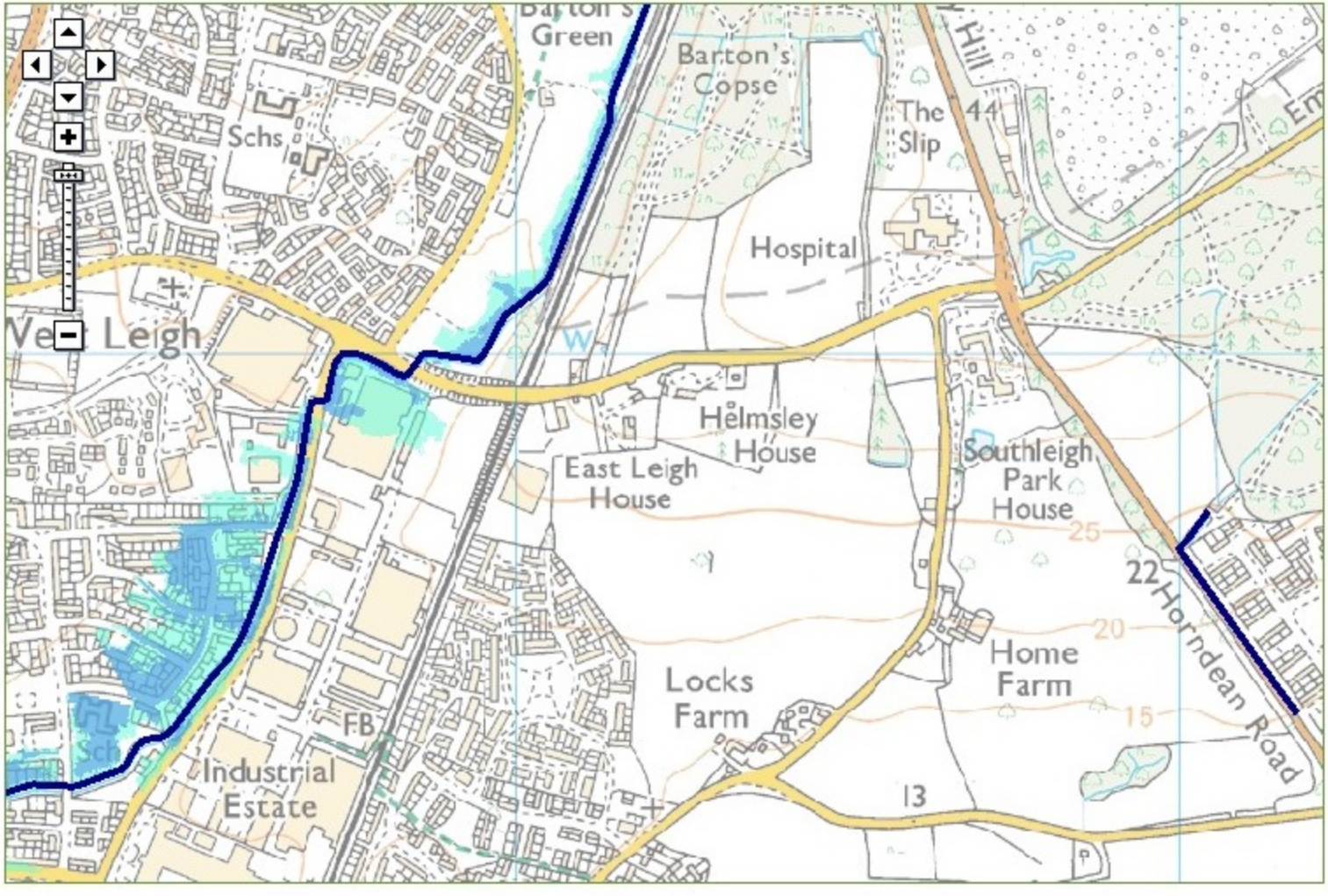
Map of X: 473,225; Y: 107,864 at scale 1:10,000

Other maps | Data search | Text only version

Map legend

Click on the map to see what Flood Zone (National Planning Policy Guidance definitions) the proposed development is in.

- Flood Map for Planning (Rivers and Sea)
  - Flood Zone 3
  - Flood Zone 2
  - Flood defences (Not all may be shown*)
  - Areas benefiting from flood defences (Not all may be shown*)
- Main Rivers
  - River line



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Environment Agency

Enter a postcode or place name: **Other topics for this area...**

Go | Risk of Flooding from Reservoirs | View other Interactive Maps

Risk of Flooding from Reservoirs

Reservoir flooding is extremely unlikely to happen.

The shading on the map shows the area that could be flooded if a large reservoir were to fail and release the water it holds. A large reservoir is one that holds over 25,000 cubic metres of water, equivalent to approximately 10 Olympic sized swimming pools. Since this is a worst case scenario, it's unlikely that any actual flood would be this large.

Click on the shading to see details of reservoirs that could cause flooding in this area.

Map legend

- Risk of Flooding from Reservoirs
- Maximum extent of flooding

Map of X: 473,225; Y: 107,864 at scale 1:10,000

Data search



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APPENDIX B

ILLUSTRATIVE MASTERPLAN


BARTONS ROAD
Leigh Hunt Cottage
Long Meadow
Helmsley House
The Lodge
El Sub Sta
Little Bartons
East Leigh House
El Sub Sta
AZALEA CLOSE
JASMINE WAY
FUSHIA CLOSE
South Leigh Cottage
The White House
Old Stable House
0 10 20 30 40 50m

APPENDIX C

OUTLINE DEVELOPMENT SURFACE WATER DRAINAGE DRAWINGS



NOTES

KEY

- Network 1 Catchment area - 0.087Ha
- Network 1 Outfall location
- Network 2 Catchment area - 0.092Ha
- Network 2 Outfall location
- Network 3 Catchment area - 0.220Ha
- Network 3 Outfall location
- Network 4 Catchment area - 0.159Ha
- Network 4 Outfall location
- Network 5 Catchment area - 0.084Ha
- Network 5 Outfall location
- Network 6 Catchment area - 0.075Ha
- Network 6 Outfall location
- Network 7 Catchment area - 0.069Ha
- Network 7 Outfall location
- Network 8 Catchment area - 0.088Ha
- Network 8 Outfall location
- Network 9 Catchment area - 0.018Ha
- Network 9 Outfall location
- Network 10 Catchment area - 0.131Ha
- Network 10 Outfall location
- Network 11 Catchment area - 0.025Ha
- Network 11 Outfall location
- Network 12 Catchment area - 0.313Ha
- Network 12 Outfall location
- Network 13 Catchment area - 0.232Ha
- Network 13 Outfall location
- Network 14 Catchment area - 0.565Ha
- Network 14 Outfall location
- Network 15 Catchment area - 0.142Ha
- Network 15 Outfall location
- Network 16 Catchment area - 0.089Ha
- Network 16 Outfall location
- Network 17 Catchment area - 0.272Ha
- Network 17 Outfall location

Rev	Amendments	Drn	Chk	App	Date

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Bradbourne Vale Road
Sevenoaks
Kent
TN13 3QQ
01732 448120

enquiries@c-a.uk.com
www.c-a.uk.com

Job Title

Land South of Bartons Road
Havant

Drawing Title

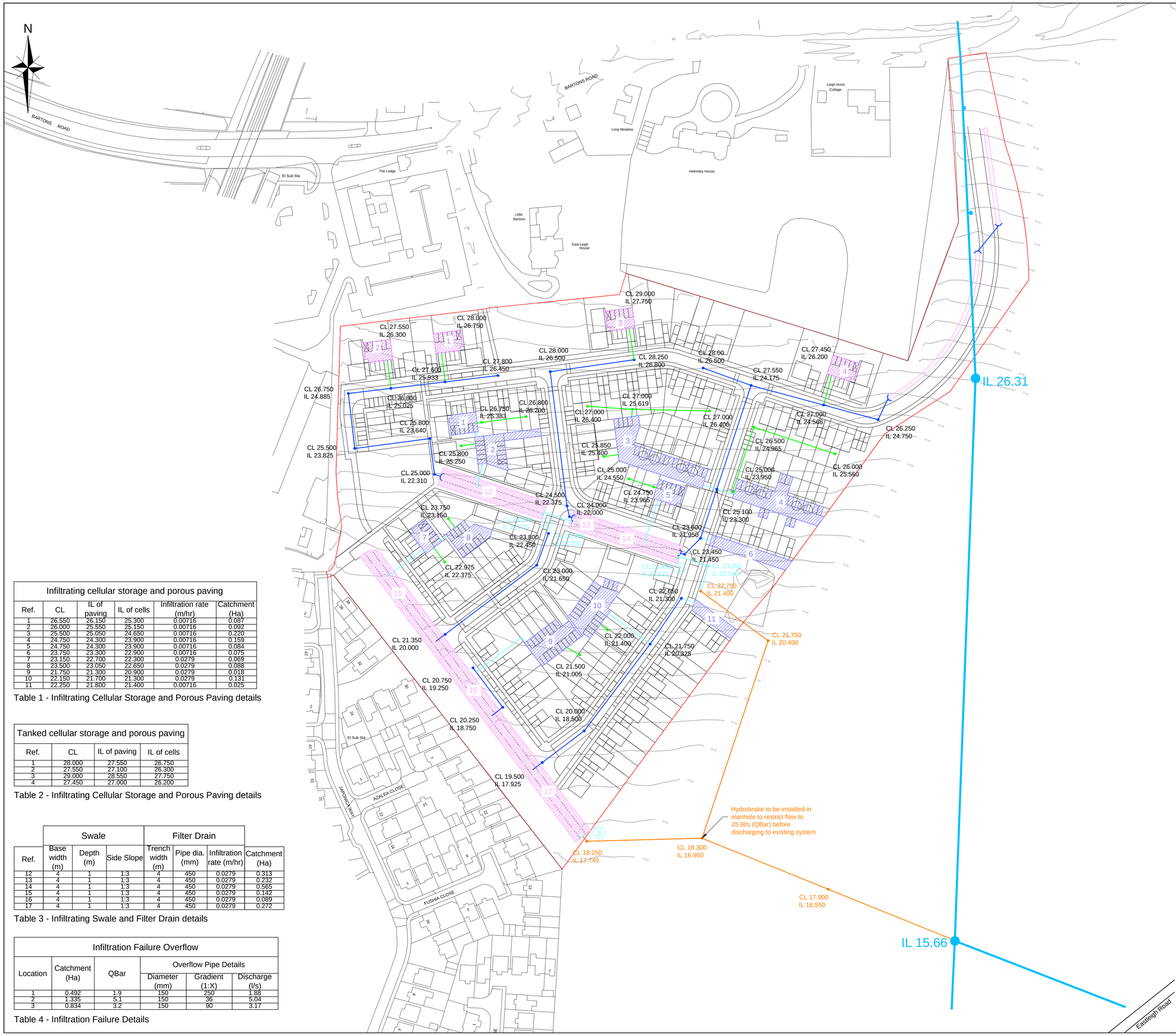
Proposed Surface Water
Catchment Plan

Client

Chidden Farms

Scale	Date	Designed
1:1000 @ A1	Dec' 15	TSH
Drawn	**Checked**	**Approved**
TSH	GAC	GAC

Job No	Drawing No	Rev
14-018	14-018-012	-



Infiltrating cellular storage and porous paving					
Ref.	CL	IL of paving	IL of cells	Infiltration rate (m/hr)	Catchment (Ha)
1	26.550	26.150	25.300	0.00716	0.087
2	26.000	25.550	25.150	0.00716	0.092
3	25.500	25.050	24.650	0.00716	0.220
4	24.750	24.300	23.900	0.00716	0.159
5	24.750	24.300	23.900	0.00716	0.084
6	23.750	23.300	22.900	0.00716	0.075
7	23.150	22.700	22.300	0.0279	0.069
8	23.500	23.050	22.650	0.0279	0.088
9	21.750	21.300	20.900	0.0279	0.018
10	22.150	21.700	21.300	0.0279	0.131
11	22.250	21.800	21.400	0.00716	0.025

Table 1 - Infiltrating Cellular Storage and Porous Paving details

Tanked cellular storage and porous paving			
Ref.	CL	IL of paving	IL of cells
1	28.000	27.550	26.750
2	27.550	27.100	26.300
3	29.000	28.550	27.750
4	27.450	27.000	26.200

Table 2 - Infiltrating Cellular Storage and Porous Paving details

	Swale			Filter Drain			
Ref.	Base width (m)	Depth (m)	Side Slope	Trench width (m)	Pipe dia. (mm)	Infiltration rate (m/hr)	Catchment (Ha)
12	4	1	1:3	4	450	0.0279	0.313
13	4	1	1:3	4	450	0.0279	0.232
14	4	1	1:3	4	450	0.0279	0.565
15	4	1	1:3	4	450	0.0279	0.142
16	4	1	1:3	4	450	0.0279	0.089
17	4	1	1:3	4	450	0.0279	0.272

Table 3 - Infiltrating Swale and Filter Drain details

Infiltration Failure Overflow					
Location	Catchment (Ha)	QBar	Overflow Pipe Details		
			Diameter (mm)	Gradient (1:X)	Discharge (l/s)
1	0.492	1.9	150	250	1.88
2	1.335	5.1	150	36	5.04
3	0.834	3.2	150	90	3.17

Table 4 - Infiltration Failure Details

NOTES

KEY

- Proposed adoptable surface water sewer and manhole
- Proposed private surface water sewer and manhole
- Proposed infiltration failure overflow piped system
- (2) Proposed infiltration failure location reference
- Proposed adoptable requisition sewer and manhole
- (1) Proposed private infiltrating cellular storage, porous paving and reference
- (3) Proposed private tanked cellular storage, porous paving and reference
- (15) Swale above infiltrating filter drain and reference
- Conveyance swale
- Headwall

Rev	Amendments	Drn	Chk	App	Date
C	Infiltration failure overflow provisions provide	TH	GC	GC	02/2016
B	Drainage Amended	TH	GC	GC	02/2016
A	Drainage Amended	BL	SA	SA	02/2016

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Job Title

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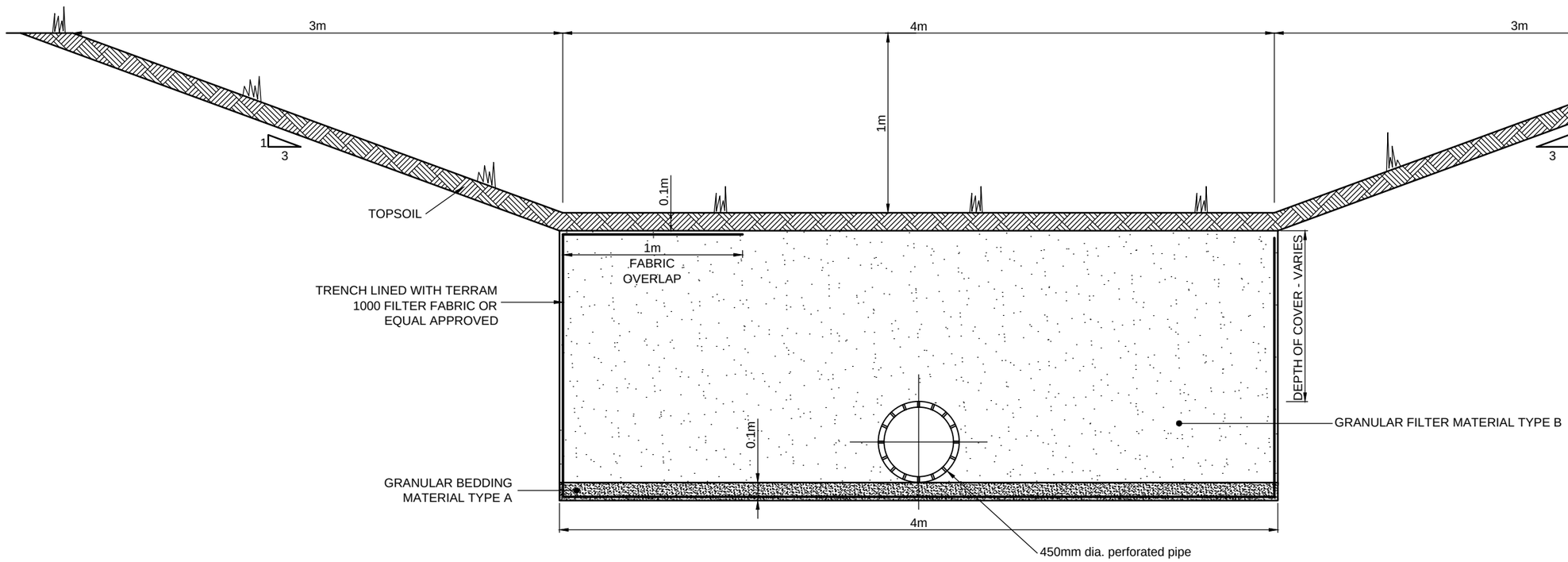
Drawing Title

Proposed Surface Water
Drainage Strategy

Client

Chidden Farms

Scale	Date	Designed
1:1000 @ A1	Dec' 15	TSH
Drawn	Checked	Approved
TSH	GAC	GAC
Job No	Drawing No	Rev
14-018	14-018-005	C



Rev	Amendments	Drn	Chk	App	Date

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Job Title: Land South of Bartons Road Havant

Drawing Title: Proposed Complex Structure Detail

Client: Chidden Farms

Scale	Date	Designed
NTS	Dec' 15	TSH
Drawn	Checked	Approved
TSH	GAC	GAC
Job No	Drawing No	Rev
14-018	14-018-013	-

APPENDIX D

OUTLINE DEVELOPMENT SURFACE WATER DRAINAGE CALCULATIONS

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.400
Area (ha)	6.800	Urban	0.000
SAAR (mm)	771	Region Number	Region 7

Results l/s

QBAR Rural	25.9
QBAR Urban	25.9
Q100 years	82.6
Q1 year	22.0
Q30 years	58.7
Q100 years	82.6

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.600	Minimum Backdrop Height (m)	0.200
Ratio R	0.350	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	6.169	0.283	21.8	0.050	5.00	0.0	0.600	o	100	
2.000	24.519	0.817	30.0	0.037	5.00	0.0	0.600	o	150	
2.001	2.458	0.083	29.6	0.000	0.00	0.0	0.600	o	150	
1.001	1.000	0.001	1000.0	0.000	0.00	0.0	0.600	o	100	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.06	25.583	0.050	0.0	0.0	0.0	1.66	13.0	6.8
2.000	50.00	5.22	26.200	0.037	0.0	0.0	0.0	1.84	32.6	5.0
2.001	50.00	5.24	25.383	0.037	0.0	0.0	0.0	1.86	32.8	5.0
1.001	50.00	5.31	26.450	0.087	0.0	0.0	0.0	0.24	1.9«	11.8

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
3	26.900	1.317	Open Manhole	1200	1.000	25.583	100				
5	26.800	0.600	Open Manhole	1200	2.000	26.200	150				
6	26.750	1.367	Open Manhole	1200	2.001	25.383	150	2.000	25.383	150	
4	26.550	1.250	Open Manhole	1200	1.001	26.450	100	1.000	25.300	100	
								2.001	25.300	150	
	27.000	0.551	Open Manhole	0		OUTFALL		1.001	26.449	100	

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.001		27.000	26.449	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.350		

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Storage Structures for Storm

Complex Manhole: 4, DS/PN: 1.001

Cellular Storage

Invert Level (m) 25.300 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00716 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00716

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	204.0	204.0	0.800	204.0	250.0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	14.3
Membrane Percolation (mm/hr)	1000	Length (m)	14.3
Max Percolation (l/s)	56.8	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	26.100	Cap Volume Depth (m)	0.000

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.350
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+30%	30/15 Summer				
2.000	15 Winter	100	+30%					
2.001	2160 Winter	100	+30%	100/15 Summer				
1.001	2160 Winter	100	+30%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	3	26.475	0.792	0.000	1.94	0.0	22.6	SURCHARGED
2.000	5	26.288	-0.062	0.000	0.64	0.0	19.8	OK
2.001	6	25.656	0.123	0.000	0.04	0.0	0.8	SURCHARGED
1.001	4	25.656	-0.894	0.000	0.00	0.0	0.0	OK

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.600	Minimum Backdrop Height (m)	0.200
Ratio R	0.350	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	8.000	0.100	80.0	0.092	5.00	0.0	0.600	o	225	
1.001	1.000	0.001	1000.0	0.000	0.00	0.0	0.600	o	100	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.09	25.250	0.092	0.0	0.0	0.0	1.46	58.2	12.5
1.001	50.00	5.16	25.900	0.092	0.0	0.0	0.0	0.24	1.9«	12.5

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
1	25.800	0.550	Open Manhole	1200	1.000	25.250	225				
4	26.000	0.850	Open Manhole	1200	1.001	25.900	100	1.000	25.150	225	
	26.500	0.601	Open Manhole	0		OUTFALL		1.001	25.899	100	

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.001		26.500	25.899	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.350		

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Storage Structures for Storm

Complex Manhole: 4, DS/PN: 1.001

Cellular Storage

Invert Level (m) 25.150 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00716 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00716

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	378.0	378.0	0.400	378.0	409.0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	19.4
Membrane Percolation (mm/hr)	1000	Length (m)	19.4
Max Percolation (l/s)	104.5	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	25.550	Cap Volume Depth (m)	0.000

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.350
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+30%	100/15 Winter				
1.001	960 Winter	100	+30%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	25.490	0.015	0.000	1.09	0.0	48.6	SURCHARGED
1.001	4	25.331	-0.669	0.000	0.00	0.0	0.0	OK

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.600	Minimum Backdrop Height (m)	0.200
Ratio R	0.350	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	42.370	0.706	60.0	0.049	5.00	0.0	0.600	o	150	
2.000	24.633	0.706	34.9	0.039	5.00	0.0	0.600	o	150	
1.001	4.000	0.969	4.1	0.102	0.00	0.0	0.600	o	225	
3.000	8.000	0.750	10.7	0.030	5.00	0.0	0.600	o	150	
1.002	1.000	0.010	100.0	0.000	0.00	0.0	0.600	o	100	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.54	26.400	0.049	0.0	0.0	0.0	1.30	23.0	6.6
2.000	50.00	5.24	26.400	0.039	0.0	0.0	0.0	1.71	30.2	5.3
1.001	50.00	5.55	25.619	0.190	0.0	0.0	0.0	6.49	257.9	25.7
3.000	50.00	5.04	25.400	0.030	0.0	0.0	0.0	3.10	54.8	4.1
1.002	50.00	5.57	25.400	0.220	0.0	0.0	0.0	0.77	6.0«	29.8

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
1	27.000	0.600	Open Manhole	1200	1.000	26.400	150				
2	27.000	0.600	Open Manhole	1200	2.000	26.400	150				
3	27.000	1.381	Open Manhole	1200	1.001	25.619	225	1.000	25.694	150	
								2.000	25.694	150	
4	25.850	0.450	Open Manhole	1200	3.000	25.400	150				
4	25.500	0.850	Open Manhole	1200	1.002	25.400	100	1.001	24.650	225	
								3.000	24.650	150	
	26.000	0.610	Open Manhole	0		OUTFALL		1.002	25.390	100	

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.002		26.000	25.390	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.350		

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Storage Structures for Storm

Complex Manhole: 4, DS/PN: 1.002

Cellular Storage

Invert Level (m) 24.650 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00716 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00716

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	655.0	655.0	0.400	655.0	696.0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	25.6
Membrane Percolation (mm/hr)	1000	Length (m)	25.6
Max Percolation (l/s)	182.0	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	25.050	Cap Volume Depth (m)	0.000

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.350
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+30%	100/15 Summer				
2.000	15 Winter	100	+30%					
1.001	15 Winter	100	+30%					
3.000	15 Winter	100	+30%					
1.002	1440 Winter	100	+30%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	26.657	0.107	0.000	1.07	0.0	23.8	SURCHARGED
2.000	2	26.496	-0.054	0.000	0.73	0.0	20.9	OK
1.001	3	25.764	-0.080	0.000	0.73	0.0	101.8	OK
3.000	4	25.461	-0.089	0.000	0.34	0.0	16.1	OK
1.002	4	24.921	-0.579	0.000	0.00	0.0	0.0	OK

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.600	Minimum Backdrop Height (m)	0.200
Ratio R	0.350	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	46.902	0.585	80.2	0.064	5.00	0.0	0.600	o	225	
1.001	38.557	1.015	38.0	0.000	0.00	0.0	0.600	o	225	
1.002	1.036	0.050	20.7	0.095	0.00	0.0	0.600	o	225	
1.003	1.000	0.001	1000.0	0.000	0.00	0.0	0.600	o	100	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.53	25.550	0.064	0.0	0.0	0.0	1.46	58.1	8.7
1.001	50.00	5.84	24.965	0.064	0.0	0.0	0.0	2.13	84.7	8.7
1.002	50.00	5.84	23.950	0.159	0.0	0.0	0.0	2.89	114.8	21.5
1.003	50.00	5.91	24.650	0.159	0.0	0.0	0.0	0.24	1.9«	21.5

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
1	26.000	0.450	Open Manhole	1200	1.000	25.550	225				
4	26.500	1.535	Open Manhole	1200	1.001	24.965	225	1.000	24.965	225	
5	24.750	0.800	Open Manhole	1200	1.002	23.950	225	1.001	23.950	225	
6	24.750	0.850	Open Manhole	1200	1.003	24.650	100	1.002	23.900	225	
	25.000	0.351	Open Manhole	0		OUTFALL		1.003	24.649	100	

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.350		

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Storage Structures for Storm

Complex Manhole: 6, DS/PN: 1.003

Cellular Storage

Invert Level (m) 23.900 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00716 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00716

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	587.0	587.0	0.400	587.0	625.8

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	24.2
Membrane Percolation (mm/hr)	1000	Length (m)	24.2
Max Percolation (l/s)	162.7	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	24.300	Cap Volume Depth (m)	0.000

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.350
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+30%					
1.001	15 Winter	100	+30%					
1.002	15 Winter	100	+30%	30/15 Summer				
1.003	1440 Winter	100	+30%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	25.679	-0.096	0.000	0.61	0.0	33.8	OK
1.001	4	25.067	-0.123	0.000	0.42	0.0	33.9	OK
1.002	5	24.479	0.304	0.000	2.65	0.0	83.6	FLOOD RISK
1.003	6	24.107	-0.643	0.000	0.00	0.0	0.0	OK

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.600	Minimum Backdrop Height (m)	0.200
Ratio R	0.350	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	14.375	0.585	24.6	0.033	5.00	0.0	0.600	o	150	
1.001	1.539	0.065	23.7	0.051	0.00	0.0	0.600	o	150	
1.002	1.000	0.001	1000.0	0.000	0.00	0.0	0.600	o	100	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.12	24.550	0.033	0.0	0.0	0.0	2.04	36.0	4.5
1.001	50.00	5.13	23.965	0.084	0.0	0.0	0.0	2.08	36.7	11.4
1.002	50.00	5.20	24.650	0.084	0.0	0.0	0.0	0.24	1.9«	11.4

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
1	25.000	0.450	Open Manhole	1200	1.000	24.550	150				
2	24.750	0.785	Open Manhole	1200	1.001	23.965	150	1.000	23.965	150	
3	24.750	0.850	Open Manhole	1200	1.002	24.650	100	1.001	23.900	150	
	25.000	0.351	Open Manhole	0		OUTFALL		1.002	24.649	100	

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.002		25.000	24.649	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.350		

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Storage Structures for Storm

Complex Manhole: 3, DS/PN: 1.002

Cellular Storage

Invert Level (m) 23.900 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00716 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00716

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	162.0	162.0	0.400	162.0	182.0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	12.7
Membrane Percolation (mm/hr)	1000	Length (m)	12.7
Max Percolation (l/s)	44.8	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	24.300	Cap Volume Depth (m)	0.000

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.350
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+30%					
1.001	15 Winter	100	+30%	30/15 Summer				
1.002	2160 Winter	100	+30%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	24.673	-0.027	0.000	0.52	0.0	17.3	OK
1.001	2	24.537	0.422	0.000	2.72	0.0	43.4	FLOOD RISK
1.002	3	24.338	-0.412	0.000	0.00	0.0	0.0	OK

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.600	Minimum Backdrop Height (m)	0.200
Ratio R	0.350	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	10.000	0.125	80.0	0.075	5.00	0.0	0.600	o	150	
1.001	5.000	0.001	5000.0	0.000	0.00	0.0	0.600	o	100	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.15	23.025	0.075	0.0	0.0	0.0	1.12	19.9	10.2
1.001	50.00	5.98	23.650	0.075	0.0	0.0	0.0	0.10	0.8«	10.2

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
1	23.750	0.725	Open Manhole	1200	1.000	23.025	150				
1	23.750	0.850	Open Manhole	1200	1.001	23.650	100	1.000	22.900	150	
	24.500	0.851	Open Manhole	0		OUTFALL		1.001	23.649	100	

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.001		24.500	23.649	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.350		

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Storage Structures for Storm

Complex Manhole: 1, DS/PN: 1.001

Cellular Storage

Invert Level (m) 22.900 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00716 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00716

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	269.0	269.0	0.400	269.0	295.0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	16.4
Membrane Percolation (mm/hr)	1000	Length (m)	16.4
Max Percolation (l/s)	74.7	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	23.300	Cap Volume Depth (m)	0.000

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.350
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+30%	30/15 Summer				
1.001	1440 Winter	100	+30%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	23.602	0.427	0.000	2.08	0.0	36.8	FLOOD RISK
1.001	1	23.113	-0.637	0.000	0.00	0.0	0.0	OK

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.600	Minimum Backdrop Height (m)	0.200
Ratio R	0.350	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	10.000	0.125	80.0	0.069	5.00	0.0	0.600	o	225	
1.001	5.000	0.001	5000.0	0.000	0.00	0.0	0.600	o	100	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.11	22.425	0.069	0.0	0.0	0.0	1.46	58.2	9.3
1.001	50.00	5.94	23.000	0.069	0.0	0.0	0.0	0.10	0.8«	9.3

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
1	22.975	0.550	Open Manhole	1200	1.000	22.425	225				
2	23.150	0.850	Open Manhole	1200	1.001	23.000	100	1.000	22.300	225	
	23.500	0.501	Open Manhole	0		OUTFALL		1.001	22.999	100	

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.350		

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Storage Structures for Storm

Complex Manhole: 2, DS/PN: 1.001

Cellular Storage

Invert Level (m) 22.300 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.02790 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.02790

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	162.0	162.0	0.400	162.0	182.0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	12.7
Membrane Percolation (mm/hr)	1000	Length (m)	12.7
Max Percolation (l/s)	44.8	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	22.700	Cap Volume Depth (m)	0.000

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.350
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+30%					
1.001	360 Winter	100	+30%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	22.575	-0.075	0.000	0.76	0.0	36.9	OK
1.001	2	22.540	-0.560	0.000	0.00	0.0	0.0	OK

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.600	Minimum Backdrop Height (m)	0.200
Ratio R	0.350	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	6.000	0.075	80.0	0.010	5.00	0.0	0.600	o	100	
1.001	5.000	0.001	5000.0	0.078	0.00	0.0	0.600	o	100	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.12	23.150	0.010	0.0	0.0	0.0	0.86	6.8	1.4
1.001	50.00	5.94	23.300	0.088	0.0	0.0	0.0	0.10	0.8«	11.9

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
1	23.750	0.600	Open Manhole	1200	1.000	23.150	100				
2	23.500	0.425	Open Manhole	1200	1.001	23.300	100	1.000	23.075	100	
	24.000	0.701	Open Manhole	0		OUTFALL		1.001	23.299	100	

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.001		24.000	23.299	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.350		

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Storage Structures for Storm

Complex Manhole: 2, DS/PN: 1.001

Cellular Storage

Invert Level (m) 22.650 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.02790 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.02790

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	270.0	270.0	0.400	270.0	296.3

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	16.4
Membrane Percolation (mm/hr)	1000	Length (m)	16.4
Max Percolation (l/s)	74.7	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	23.050	Cap Volume Depth (m)	0.000

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.350
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+30%					
1.001	360 Winter	100	+30%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	23.224	-0.026	0.000	0.88	0.0	5.3	OK
1.001	2	22.822	-0.578	0.000	0.00	0.0	0.0	OK

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.600	Minimum Backdrop Height (m)	0.200
Ratio R	0.350	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	8.266	0.105	78.7	0.018	5.00	0.0	0.600	o	100	
1.001	5.000	0.001	5000.0	0.000	0.00	0.0	0.600	o	100	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.16	21.005	0.018	0.0	0.0	0.0	0.87	6.8	2.4
1.001	50.00	5.99	21.500	0.018	0.0	0.0	0.0	0.10	0.8«	2.4

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
1	21.500	0.495	Open Manhole	1200	1.000	21.005	100				
2	21.750	0.850	Open Manhole	1200	1.001	21.500	100	1.000	20.900	100	
	22.000	0.501	Open Manhole	0		OUTFALL		1.001	21.499	100	

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.001		22.000	21.499	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.350		

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Storage Structures for Storm

Complex Manhole: 2, DS/PN: 1.001

Cellular Storage

Invert Level (m) 20.900 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.02790 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.02790

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	402.0	402.0	0.400	402.0	434.0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	20.1
Membrane Percolation (mm/hr)	1000	Length (m)	20.1
Max Percolation (l/s)	112.2	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	21.300	Cap Volume Depth (m)	0.000

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.350
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+30%	100/15 Summer				
1.001	180 Winter	100	+30%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	21.217	0.112	0.000	1.44	0.0	9.0	FLOOD RISK
1.001	2	20.920	-0.680	0.000	0.00	0.0	0.0	OK

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.600	Minimum Backdrop Height (m)	0.200
Ratio R	0.350	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	5.000	0.063	79.4	0.009	5.00	0.0	0.600	o	150	
1.001	5.000	0.001	5000.0	0.122	0.00	0.0	0.600	o	100	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.07	21.400	0.009	0.0	0.0	0.0	1.13	20.0	1.2
1.001	50.00	5.90	22.000	0.131	0.0	0.0	0.0	0.10	0.8«	17.7

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
1	22.000	0.600	Open Manhole	1200	1.000	21.400	150				
2	22.150	0.813	Open Manhole	1200	1.001	22.000	100	1.000	21.337	150	
	22.500	0.501	Open Manhole	0		OUTFALL		1.001	21.999	100	

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.001		22.500	21.999	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.350		

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Storage Structures for Storm

Complex Manhole: 2, DS/PN: 1.001

Cellular Storage

Invert Level (m) 21.300 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.02790 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.02790

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	479.0	479.0	0.400	479.0	514.0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	21.9
Membrane Percolation (mm/hr)	1000	Length (m)	21.9
Max Percolation (l/s)	133.2	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	21.700	Cap Volume Depth (m)	0.000

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.350
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+30%					
1.001	240 Winter	100	+30%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	21.457	-0.093	0.000	0.31	0.0	4.8	OK
1.001	2	21.438	-0.662	0.000	0.00	0.0	0.0	OK

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.600	Minimum Backdrop Height (m)	0.200
Ratio R	0.350	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	8.000	0.100	80.0	0.025	5.00	0.0	0.600	o	100	
1.001	5.000	0.001	5000.0	0.000	0.00	0.0	0.600	o	100	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.15	21.500	0.025	0.0	0.0	0.0	0.86	6.8	3.4
1.001	50.00	5.98	22.100	0.025	0.0	0.0	0.0	0.10	0.8«	3.4

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
1	21.950	0.450	Open Manhole	1200	1.000	21.500	100				
2	22.250	0.850	Open Manhole	1200	1.001	22.100	100	1.000	21.400	100	
	22.500	0.401	Open Manhole	0		OUTFALL		1.001	22.099	100	

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.001		22.500	22.099	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.350		

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Storage Structures for Storm

Complex Manhole: 2, DS/PN: 1.001

Cellular Storage

Invert Level (m) 21.400 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00716 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00716

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	167.0	167.0	0.400	167.0	187.7

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	12.9
Membrane Percolation (mm/hr)	1000	Length (m)	12.9
Max Percolation (l/s)	46.2	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	21.800	Cap Volume Depth (m)	0.000

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.350
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+30%	30/15 Summer				
1.001	720 Winter	100	+30%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	21.864	0.264	0.000	1.90	0.0	11.7	FLOOD RISK
1.001	2	21.500	-0.700	0.000	0.00	0.0	0.0	OK

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.600	Minimum Backdrop Height (m)	0.200
Ratio R	0.350	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	29.198	0.292	100.0	0.061	5.00	0.0	0.600	o	225	
2.000	16.116	0.160	100.7	0.051	5.00	0.0	0.600	o	150	
1.001	29.971	0.908	33.0	0.032	0.00	0.0	0.600	o	450	
3.000	15.723	0.500	31.4	0.051	5.00	0.0	0.600	o	150	
1.002	23.485	0.140	168.2	0.035	0.00	0.0	0.600	o	450	
1.003	30.325	1.060	28.6	0.047	0.00	0.0	0.600	o	450	
1.004	41.526	0.185	224.5	0.036	0.00	0.0	0.600	o	450	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.37	26.450	0.061	0.0	0.0	0.0	1.31	52.0	8.3
2.000	50.00	5.27	26.750	0.051	0.0	0.0	0.0	1.00	17.7	6.9
1.001	50.00	5.51	25.933	0.144	0.0	0.0	0.0	3.55	564.3	19.5
3.000	50.00	5.15	26.300	0.051	0.0	0.0	0.0	1.80	31.8	6.9
1.002	50.00	5.76	25.025	0.230	0.0	0.0	0.0	1.56	248.9	31.1
1.003	50.00	5.90	24.885	0.277	0.0	0.0	0.0	3.81	606.3	37.5
1.004	50.00	6.41	23.825	0.313	0.0	0.0	0.0	1.35	215.2	42.4

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.005	19.761	1.330	14.9	0.000	0.00	0.0	0.600	o	450	
1.006	5.000	0.001	5000.0	0.000	0.00	0.0	0.600	o	100	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.005	50.00	6.47	23.640	0.313	0.0	0.0	0.0	5.30	842.2	42.4
1.006	50.00	7.30	24.000	0.313	0.0	0.0	0.0	0.10	0.8«	42.4

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
1	27.800	1.350	Open Manhole	1200	1.000	26.450	225				
2	28.000	1.250	Open Manhole	1200	2.000	26.750	150				
2	27.600	1.667	Open Manhole	1350	1.001	25.933	450	1.000	26.158	225	
								2.000	26.590	150	357
4	27.550	1.250	Open Manhole	1200	3.000	26.300	150				
4	26.800	1.775	Open Manhole	1350	1.002	25.025	450	1.001	25.025	450	
								3.000	25.800	150	475
6	26.750	1.865	Open Manhole	1350	1.003	24.885	450	1.002	24.885	450	
7	25.500	1.675	Open Manhole	1350	1.004	23.825	450	1.003	23.825	450	
8	25.800	2.160	Open Manhole	1350	1.005	23.640	450	1.004	23.640	450	
10	24.250	1.940	Open Manhole	1350	1.006	24.000	100	1.005	22.310	450	
	25.000	1.001	Open Manhole	0		OUTFALL		1.006	23.999	100	

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	3
Number of Online Controls	3	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.350		

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Online Controls for Storm

Hydro-Brake Optimum® Manhole: 2, DS/PN: 1.001, Volume (m³): 3.8

Unit Reference	MD-SHE-0145-1000-1000-1000
Design Head (m)	1.000
Design Flow (l/s)	10.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	145
Invert Level (m)	26.158
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	10.0
Flush-Flo™	0.304	9.9
Kick-Flo®	0.672	8.3
Mean Flow over Head Range	-	8.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.2	1.200	10.9	3.000	16.8	7.000	25.2
0.200	9.6	1.400	11.7	3.500	18.1	7.500	26.0
0.300	9.9	1.600	12.4	4.000	19.3	8.000	26.9
0.400	9.8	1.800	13.2	4.500	20.4	8.500	27.7
0.500	9.6	2.000	13.8	5.000	21.4	9.000	28.4
0.600	9.1	2.200	14.5	5.500	22.4	9.500	29.2
0.800	9.0	2.400	15.1	6.000	23.4		
1.000	10.0	2.600	15.7	6.500	24.3		

Hydro-Brake Optimum® Manhole: 7, DS/PN: 1.004, Volume (m³): 7.0

Unit Reference	MD-SHE-0239-3000-0750-3000
Design Head (m)	0.750
Design Flow (l/s)	30.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	239
Invert Level (m)	23.825
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.750	29.9
Flush-Flo™	0.356	29.9

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Hydro-Brake Optimum® Manhole: 7, DS/PN: 1.004, Volume (m³): 7.0

Control Points	Head (m)	Flow (l/s)
Kick-Flo®	0.601	26.9
Mean Flow over Head Range	-	23.6

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.9	1.200	37.5	3.000	58.4	7.000	88.2
0.200	24.2	1.400	40.4	3.500	62.9	7.500	91.2
0.300	29.7	1.600	43.1	4.000	67.1	8.000	93.5
0.400	29.8	1.800	45.6	4.500	71.1	8.500	96.4
0.500	29.0	2.000	48.0	5.000	74.8	9.000	99.2
0.600	27.0	2.200	50.2	5.500	78.4	9.500	102.0
0.800	30.9	2.400	52.4	6.000	81.8		
1.000	34.4	2.600	54.5	6.500	85.0		

Hydro-Brake Optimum® Manhole: 8, DS/PN: 1.005, Volume (m³): 9.5

Unit Reference	MD-SHE-0230-3000-1500-3000
Design Head (m)	1.500
Design Flow (l/s)	30.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	230
Invert Level (m)	23.640
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	29.9
Flush-Flo™	0.465	29.7
Kick-Flo®	1.015	24.8
Mean Flow over Head Range	-	25.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.6	0.800	28.4	2.000	34.3	4.000	47.9
0.200	23.0	1.000	25.2	2.200	35.9	4.500	50.7
0.300	28.8	1.200	26.8	2.400	37.4	5.000	53.3
0.400	29.6	1.400	28.9	2.600	38.9	5.500	55.9
0.500	29.7	1.600	30.8	3.000	41.7	6.000	58.3
0.600	29.4	1.800	32.6	3.500	44.9	6.500	60.6

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Hydro-Brake Optimum® Manhole: 8, DS/PN: 1.005, Volume (m³): 9.5

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
7.000	62.8	8.000	67.0	9.000	71.0		
7.500	64.9	8.500	69.0	9.500	72.9		

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Storage Structures for Storm

Complex Manhole: 2, DS/PN: 2.000

Cellular Storage

Invert Level (m)	26.750	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	162.0	162.0	0.800	162.0	202.7

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	12.7
Membrane Percolation (mm/hr)	1000	Length (m)	12.7
Max Percolation (l/s)	44.8	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	27.550	Cap Volume Depth (m)	0.000

Complex Manhole: 4, DS/PN: 3.000

Cellular Storage

Invert Level (m)	26.300	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	162.0	162.0	0.800	162.0	202.7

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	12.7
Membrane Percolation (mm/hr)	1000	Length (m)	12.7
Max Percolation (l/s)	44.8	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	27.100	Cap Volume Depth (m)	0.000

Complex Manhole: 10, DS/PN: 1.006

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Filter Drain

Infiltration Coefficient Base (m/hr)	0.02790	Trench Length (m)	60.0
Infiltration Coefficient Side (m/hr)	0.02790	Pipe Diameter (m)	0.450
Safety Factor	2.0	Pipe Depth above Invert (m)	0.000
Porosity	0.30	Slope (1:X)	1000.0
Invert Level (m)	22.310	Cap Volume Depth (m)	0.000
Trench Width (m)	4.0	Cap Infiltration Depth (m)	0.000

Swale

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.02790	Length (m)	60.0
Infiltration Coefficient Side (m/hr)	0.02790	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	80.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	23.310	Cap Infiltration Depth (m)	0.000
Base Width (m)	4.0	Include Swale Volume	Yes

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	3
Number of Online Controls	3	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.350
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+30%	30/15 Summer				
2.000	60 Winter	100	+30%	100/30 Summer				
1.001	15 Winter	100	+30%	30/15 Summer				
3.000	30 Winter	100	+30%					
1.002	30 Winter	100	+30%	100/30 Winter				
1.003	30 Winter	100	+30%	100/15 Winter				
1.004	30 Winter	100	+30%	30/15 Summer				
1.005	30 Winter	100	+30%	100/15 Summer				
1.006	600 Winter	100	+30%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	27.594	0.919	0.000	0.60	0.0	29.0	FLOOD RISK
2.000	2	26.949	0.049	0.000	0.52	0.0	8.5	SURCHARGED
1.001	2	27.487	1.104	0.000	0.02	0.0	11.3	FLOOD RISK
3.000	4	26.362	-0.088	0.000	0.36	0.0	10.7	OK
1.002	4	25.511	0.036	0.000	0.14	0.0	28.9	SURCHARGED
1.003	6	25.501	0.166	0.000	0.09	0.0	45.0	SURCHARGED
1.004	7	25.486	1.211	0.000	0.21	0.0	40.3	FLOOD RISK
1.005	8	25.076	0.986	0.000	0.05	0.0	29.7	SURCHARGED

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.006	10	23.855	-0.245	0.000	0.00	0.0	0.0	OK

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.600	Minimum Backdrop Height (m)	0.200
Ratio R	0.350	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
2.000	17.429	0.175	99.6	0.051	5.00	0.0	0.600	o	150	
2.001	46.459	0.300	154.9	0.073	0.00	0.0	0.600	o	300	
2.002	74.254	4.125	18.0	0.084	0.00	0.0	0.600	o	300	
2.003	6.885	0.375	18.4	0.024	0.00	0.0	0.600	o	300	
2.004	5.000	0.001	5000.0	0.000	0.00	0.0	0.600	o	100	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
2.000	50.00	5.29	27.750	0.051	0.0	0.0	0.0	1.01	17.8	6.9
2.001	50.00	5.90	26.800	0.124	0.0	0.0	0.0	1.26	89.1	16.8
2.002	50.00	6.23	26.500	0.208	0.0	0.0	0.0	3.72	263.2	28.2
2.003	50.00	6.27	22.375	0.232	0.0	0.0	0.0	3.69	260.6	31.4
2.004	50.00	7.09	23.900	0.232	0.0	0.0	0.0	0.10	0.8«	31.4

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
8	29.000	1.250	Open Manhole	1200	2.000	27.750	150				
9	28.250	1.450	Open Manhole	1200	2.001	26.800	300	2.000	27.575	150	625
10	28.000	1.500	Open Manhole	1200	2.002	26.500	300	2.001	26.500	300	
11	24.500	2.125	Open Manhole	1200	2.003	22.375	300	2.002	22.375	300	
5	24.000	2.000	Open Manhole	1200	2.004	23.900	100	2.003	22.000	300	
	24.000	0.101	Open Manhole	0		OUTFALL		2.004	23.899	100	

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	2
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.350		

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Online Controls for Storm

Hydro-Brake Optimum® Manhole: 9, DS/PN: 2.001, Volume (m³): 1.9

Unit Reference	MD-SHE-0189-1800-1000-1800
Design Head (m)	1.000
Design Flow (l/s)	18.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	189
Invert Level (m)	26.800
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	17.9
Flush-Flo™	0.331	17.9
Kick-Flo®	0.710	15.3
Mean Flow over Head Range	-	15.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.6	1.200	19.6	3.000	30.3	7.000	45.7
0.200	17.1	1.400	21.1	3.500	32.7	7.500	47.2
0.300	17.8	1.600	22.5	4.000	34.9	8.000	48.7
0.400	17.8	1.800	23.8	4.500	36.9	8.500	50.2
0.500	17.4	2.000	25.0	5.000	38.8	9.000	51.6
0.600	16.9	2.200	26.1	5.500	40.7	9.500	53.0
0.800	16.1	2.400	27.3	6.000	42.4		
1.000	17.9	2.600	28.3	6.500	44.1		

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Storage Structures for Storm

Complex Manhole: 8, DS/PN: 2.000

Cellular Storage

Invert Level (m)	27.750	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	162.0	162.0	0.800	162.0	202.7

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	12.7
Membrane Percolation (mm/hr)	1000	Length (m)	12.7
Max Percolation (l/s)	44.8	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	28.550	Cap Volume Depth (m)	0.000

Complex Manhole: 5, DS/PN: 2.004

Filter Drain

Infiltration Coefficient Base (m/hr)	0.02790	Trench Length (m)	15.7
Infiltration Coefficient Side (m/hr)	0.02790	Pipe Diameter (m)	0.450
Safety Factor	2.0	Pipe Depth above Invert (m)	0.000
Porosity	0.30	Slope (1:X)	1000.0
Invert Level (m)	21.100	Cap Volume Depth (m)	0.000
Trench Width (m)	4.0	Cap Infiltration Depth (m)	0.000

Swale

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.02790	Length (m)	15.7
Infiltration Coefficient Side (m/hr)	0.02790	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	1000.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	23.000	Cap Infiltration Depth (m)	0.000
Base Width (m)	4.0	Include Swale Volume	Yes

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	2
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.350
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
2.000	30 Winter	100	+30%					
2.001	15 Winter	100	+30%	30/15 Summer				
2.002	15 Winter	100	+30%					
2.003	960 Winter	100	+30%	1/360 Winter				
2.004	960 Winter	100	+30%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
2.000	8	27.852	-0.048	0.000	0.69	0.0	11.4	OK
2.001	9	28.169	1.069	0.000	0.24	0.0	20.4	FLOOD RISK
2.002	10	26.606	-0.194	0.000	0.27	0.0	67.2	OK
2.003	11	23.907	1.232	0.000	0.06	0.0	8.8	SURCHARGED
2.004	5	23.906	-0.094	0.000	0.00	0.0	0.0	FLOOD RISK

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.600	Minimum Backdrop Height (m)	0.200
Ratio R	0.350	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	30.946	0.182	170.0	0.221	5.00	0.0	0.600	o	300	
2.000	16.800	0.170	98.8	0.051	5.00	0.0	0.600	o	100	
1.001	41.221	0.318	129.6	0.049	0.00	0.0	0.600	o	300	
3.000	27.971	2.175	12.9	0.071	5.00	0.0	0.600	o	150	
1.002	59.926	0.875	68.5	0.073	0.00	0.0	0.600	o	300	
1.003	33.652	1.350	24.9	0.036	0.00	0.0	0.600	o	300	
1.004	8.826	0.500	17.7	0.064	0.00	0.0	0.600	o	300	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.43	24.750	0.221	0.0	0.0	0.0	1.20	85.0	29.9
2.000	50.00	5.36	26.200	0.051	0.0	0.0	0.0	0.77	6.1«	6.9
1.001	50.00	5.93	24.568	0.321	0.0	0.0	0.0	1.38	97.5	43.5
3.000	50.00	5.17	26.500	0.071	0.0	0.0	0.0	2.82	49.9	9.6
1.002	50.00	6.45	24.175	0.465	0.0	0.0	0.0	1.90	134.5	63.0
1.003	50.00	6.63	23.300	0.501	0.0	0.0	0.0	3.16	223.5	67.8
1.004	50.00	6.67	21.950	0.565	0.0	0.0	0.0	3.76	265.8	76.5

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.005	5.000	0.001	5000.0	0.000	0.00	0.0	0.600	o	100	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.005	50.00	7.50	23.300	0.565	0.0	0.0	0.0	0.10	0.8«	76.5

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
1	26.250	1.500	Open Manhole	1200	1.000	24.750	300				
2	27.450	1.250	Open Manhole	1200	2.000	26.200	100				
2	27.000	2.432	Open Manhole	1200	1.001	24.568	300	1.000	24.568	300	
								2.000	26.030	100	1262
4	28.000	1.500	Open Manhole	1200	3.000	26.500	150				
5	27.550	3.375	Open Manhole	1200	1.002	24.175	300	1.001	24.250	300	75
								3.000	24.325	150	
6	25.100	1.800	Open Manhole	1200	1.003	23.300	300	1.002	23.300	300	
7	23.600	1.650	Open Manhole	1200	1.004	21.950	300	1.003	21.950	300	
12	23.450	2.000	Open Manhole	1200	1.005	23.300	100	1.004	21.450	300	
	24.000	0.701	Open Manhole	0		OUTFALL		1.005	23.299	100	

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.005		24.000	23.299	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	2
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.350		

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Storage Structures for Storm

Complex Manhole: 2, DS/PN: 2.000

Cellular Storage

Invert Level (m)	26.200	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	162.0	162.0	0.800	162.0	182.0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	12.7
Membrane Percolation (mm/hr)	1000	Length (m)	12.7
Max Percolation (l/s)	44.8	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	27.000	Cap Volume Depth (m)	0.000

Complex Manhole: 12, DS/PN: 1.005

Filter Drain

Infiltration Coefficient Base (m/hr)	0.02790	Trench Length (m)	47.1
Infiltration Coefficient Side (m/hr)	0.02790	Pipe Diameter (m)	0.600
Safety Factor	2.0	Pipe Depth above Invert (m)	0.000
Porosity	0.30	Slope (1:X)	750.0
Invert Level (m)	21.250	Cap Volume Depth (m)	0.000
Trench Width (m)	4.0	Cap Infiltration Depth (m)	0.000

Swale

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.02790	Length (m)	47.1
Infiltration Coefficient Side (m/hr)	0.02790	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	143.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	22.250	Cap Infiltration Depth (m)	0.000
Base Width (m)	4.0	Include Swale Volume	Yes

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	2
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.350
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+30%	100/15 Summer				
2.000	60 Winter	100	+30%					
1.001	15 Winter	100	+30%	100/15 Summer				
3.000	15 Winter	100	+30%					
1.002	15 Winter	100	+30%	100/15 Summer				
1.003	15 Winter	100	+30%	100/15 Summer				
1.004	960 Winter	100	+30%	1/180 Winter				
1.005	960 Winter	100	+30%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	26.081	1.031	0.000	1.23	0.0	95.1	FLOOD RISK
2.000	2	26.284	-0.016	0.000	1.00	0.0	5.8	OK
1.001	2	25.802	0.934	0.000	1.26	0.0	114.5	SURCHARGED
3.000	4	26.603	-0.047	0.000	0.80	0.0	38.2	OK
1.002	5	25.297	0.822	0.000	1.35	0.0	172.7	SURCHARGED
1.003	6	23.822	0.222	0.000	0.85	0.0	173.9	SURCHARGED
1.004	7	23.240	0.990	0.000	0.12	0.0	21.6	SURCHARGED
1.005	12	23.238	-0.162	0.000	0.00	0.0	0.0	OK

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.600	Minimum Backdrop Height (m)	0.200
Ratio R	0.350	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	18.611	0.800	23.3	0.013	5.00	0.0	0.600	o	150	
1.001	62.953	1.650	38.2	0.058	0.00	0.0	0.600	o	150	
1.002	6.419	1.030	6.2	0.071	0.00	0.0	0.600	o	150	
1.003	5.000	0.001	5000.0	0.000	0.00	0.0	0.600	o	100	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.15	22.450	0.013	0.0	0.0	0.0	2.10	37.1	1.8
1.001	50.00	5.79	21.650	0.071	0.0	0.0	0.0	1.63	28.9	9.6
1.002	50.00	5.82	20.000	0.142	0.0	0.0	0.0	4.06	71.8	19.2
1.003	50.00	6.64	20.800	0.142	0.0	0.0	0.0	0.10	0.8«	19.2

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
1	23.800	1.350	Open Manhole	1200	1.000	22.450	150				
2	23.000	1.350	Open Manhole	1200	1.001	21.650	150	1.000	21.650	150	
3	21.350	1.350	Open Manhole	1200	1.002	20.000	150	1.001	20.000	150	
4	20.950	1.980	Open Manhole	1200	1.003	20.800	100	1.002	18.970	150	
	21.500	0.701	Open Manhole	0		OUTFALL		1.003	20.799	100	

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.350		

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Storage Structures for Storm

Complex Manhole: 4, DS/PN: 1.003

Filter Drain

Infiltration Coefficient Base (m/hr)	0.02790	Trench Length (m)	71.6
Infiltration Coefficient Side (m/hr)	0.02790	Pipe Diameter (m)	0.450
Safety Factor	2.0	Pipe Depth above Invert (m)	0.000
Porosity	0.30	Slope (1:X)	500.0
Invert Level (m)	18.950	Cap Volume Depth (m)	0.000
Trench Width (m)	4.0	Cap Infiltration Depth (m)	0.000

Swale

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.02790	Length (m)	71.6
Infiltration Coefficient Side (m/hr)	0.02790	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	37.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	19.950	Cap Infiltration Depth (m)	0.000
Base Width (m)	4.0	Include Swale Volume	Yes

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.350
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+30%					
1.001	15 Winter	100	+30%	100/15 Summer				
1.002	15 Winter	100	+30%	100/15 Summer				
1.003	360 Winter	100	+30%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	22.496	-0.104	0.000	0.20	0.0	7.0	OK
1.001	2	22.453	0.653	0.000	1.11	0.0	31.4	SURCHARGED
1.002	3	20.413	0.263	0.000	1.08	0.0	65.4	SURCHARGED
1.003	4	19.786	-1.114	0.000	0.00	0.0	0.0	OK

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.600	Minimum Backdrop Height (m)	0.200
Ratio R	0.350	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	27.117	0.500	54.2	0.046	5.00	0.0	0.600	o	150	
1.001	7.565	0.741	10.2	0.043	0.00	0.0	0.600	o	150	
1.002	5.000	0.001	5000.0	0.000	0.00	0.0	0.600	o	100	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.33	19.250	0.046	0.0	0.0	0.0	1.37	24.2	6.2
1.001	50.00	5.37	18.750	0.089	0.0	0.0	0.0	3.17	56.1	12.1
1.002	50.00	6.20	19.850	0.089	0.0	0.0	0.0	0.10	0.8«	12.1

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
1	20.750	1.500	Open Manhole	1200	1.000	19.250	150				
2	20.250	1.500	Open Manhole	1200	1.001	18.750	150	1.000	18.750	150	
3	20.000	1.991	Open Manhole	1200	1.002	19.850	100	1.001	18.009	150	
	20.500	0.651	Open Manhole	0		OUTFALL		1.002	19.849	100	

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.350		

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Storage Structures for Storm

Complex Manhole: 3, DS/PN: 1.002

Filter Drain

Infiltration Coefficient Base (m/hr)	0.02790	Trench Length (m)	45.9
Infiltration Coefficient Side (m/hr)	0.02790	Pipe Diameter (m)	0.450
Safety Factor	2.0	Pipe Depth above Invert (m)	0.000
Porosity	0.30	Slope (1:X)	500.0
Invert Level (m)	18.000	Cap Volume Depth (m)	0.000
Trench Width (m)	4.0	Cap Infiltration Depth (m)	0.000

Swale

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.02790	Length (m)	45.9
Infiltration Coefficient Side (m/hr)	0.02790	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	51.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	19.000	Cap Infiltration Depth (m)	0.000
Base Width (m)	4.0	Include Swale Volume	Yes

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.350
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+30%	100/15 Winter				
1.001	15 Winter	100	+30%	100/15 Winter				
1.002	360 Winter	100	+30%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	19.433	0.033	0.000	1.03	0.0	23.8	SURCHARGED
1.001	2	18.906	0.006	0.000	0.97	0.0	46.7	SURCHARGED
1.002	3	18.773	-1.177	0.000	0.00	0.0	0.0	OK

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.600	Minimum Backdrop Height (m)	0.200
Ratio R	0.350	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	30.415	0.975	31.2	0.044	5.00	0.0	0.600	o	150	
1.001	59.796	1.750	34.2	0.141	0.00	0.0	0.600	o	225	
1.002	28.806	0.575	50.1	0.044	0.00	0.0	0.600	o	225	
1.003	6.566	1.600	4.1	0.043	0.00	0.0	0.600	o	225	
1.004	5.000	0.001	5000.0	0.000	0.00	0.0	0.600	o	100	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.28	21.300	0.044	0.0	0.0	0.0	1.81	32.0	6.0
1.001	50.00	5.72	20.250	0.185	0.0	0.0	0.0	2.25	89.3	25.1
1.002	50.00	5.98	18.500	0.229	0.0	0.0	0.0	1.85	73.7	31.0
1.003	50.00	6.00	17.925	0.272	0.0	0.0	0.0	6.50	258.6	36.8
1.004	50.00	6.83	18.100	0.272	0.0	0.0	0.0	0.10	0.8«	36.8

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
1	22.650	1.350	Open Manhole	1200	1.000	21.300	150				
2	21.750	1.500	Open Manhole	1200	1.001	20.250	225	1.000	20.325	150	
3	20.000	1.500	Open Manhole	1200	1.002	18.500	225	1.001	18.500	225	
4	19.500	1.575	Open Manhole	1200	1.003	17.925	225	1.002	17.925	225	
5	18.300	1.975	Open Manhole	1200	1.004	18.100	100	1.003	16.325	225	
19	19.000	0.901	Open Manhole	0		OUTFALL		1.004	18.099	100	

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.004	19	19.000	18.099	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.350		

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Storage Structures for Storm

Complex Manhole: 5, DS/PN: 1.004

Filter Drain

Infiltration Coefficient Base (m/hr)	0.02790	Trench Length (m)	78.5
Infiltration Coefficient Side (m/hr)	0.02790	Pipe Diameter (m)	0.450
Safety Factor	2.0	Pipe Depth above Invert (m)	0.000
Porosity	0.30	Slope (1:X)	500.0
Invert Level (m)	16.300	Cap Volume Depth (m)	0.000
Trench Width (m)	4.0	Cap Infiltration Depth (m)	0.000

Swale

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.02790	Length (m)	78.5
Infiltration Coefficient Side (m/hr)	0.02790	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	46.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	17.300	Cap Infiltration Depth (m)	0.000
Base Width (m)	4.0	Include Swale Volume	Yes

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.350
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+30%	100/15 Summer				
1.001	15 Winter	100	+30%	100/15 Summer				
1.002	15 Winter	100	+30%	30/15 Summer				
1.003	15 Winter	100	+30%					
1.004	480 Winter	100	+30%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	21.591	0.141	0.000	0.70	0.0	21.5	SURCHARGED
1.001	2	21.181	0.706	0.000	0.98	0.0	84.6	SURCHARGED
1.002	3	19.471	0.746	0.000	1.51	0.0	103.6	SURCHARGED
1.003	4	18.065	-0.085	0.000	0.69	0.0	123.8	OK
1.004	5	17.716	-0.484	0.000	0.00	0.0	0.0	OK

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ICP SUDS Mean Annual Flood

Input

Return Period (years) 100 SAAR (mm) 771 Urban 0.000
Area (ha) 0.834 Soil 0.400 Region Number Region 7

Results l/s

QBAR Rural 3.2
QBAR Urban 3.2

Q100 years 10.1

Q1 year 2.7
Q30 years 7.2
Q100 years 10.1

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ICP SUDS Mean Annual Flood

Input

Return Period (years) 100 SAAR (mm) 771 Urban 0.000
Area (ha) 1.335 Soil 0.400 Region Number Region 7

Results l/s

QBAR Rural 5.1
QBAR Urban 5.1

Q100 years 16.2

Q1 year 4.3
Q30 years 11.5
Q100 years 16.2

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ICP SUDS Mean Annual Flood

Input

Return Period (years) 100 SAAR (mm) 771 Urban 0.000
Area (ha) 0.492 Soil 0.400 Region Number Region 7

Results l/s

QBAR Rural 1.9
QBAR Urban 1.9

Q100 years 6.0

Q1 year 1.6
Q30 years 4.2
Q100 years 6.0

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APPENDIX E

EXISTING DRAINAGE CORRESPONDENCE & PUBLIC SEWER RECORDS

From: Andrews, MichaelRichard
<MichaelRichard.Andrews@southernwater.co.uk>
Sent: 03 February 2016 12:52
To: Glenn Charles
Subject: RE: Land South of Bartons Road Surface Water Drainage Capacity Check

Good Afternoon Glenn,

Further to my previous email confirming that i would provide you with the revised full report for the Level 2 capacity Check.

I have attached the Surface Water drainage study for the 20l/s based on the evidence confirmed from the CCTV survey that was conducted to establish the size of the pipe near the proposed development. On the attachment I have dated the letter confirm from today's date so that you can see we rerun the study with the additional information, along with the amendments of discharge you requested.

The alternatives based on the fact there is no available capacity would be completing a S98 application through which appropriate infrastructure can be requested (By the developer) to drain to a specific location. As there is no available capacity for surface water taken from the proposed site this would be the alternative method that we would work with you to identify the appropriate solution.

Kind regards

Michael Andrews
Customer Service Manager

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Southern Water, Southern House, Sparrowgrove, Otterbourne , SO21 2SW

From: Glenn Charles [mailto:gcharles@c-a.uk.com]
Sent: 01 February 2016 14:48
To: Andrews, MichaelRichard
Subject: RE: Land South of Bartons Road Surface Water Drainage Capacity Check

Michael,
With this in mind are you able to provide a response to my last email regarding alternatives?

Regards Glenn Charles

From: Andrews, MichaelRichard [mailto:MichaelRichard.Andrews@southernwater.co.uk]
Sent: 01 February 2016 12:57
To: Glenn Charles <gcharles@c-a.uk.com>
Subject: RE: Land South of Bartons Road Surface Water Drainage Capacity Check

Good Afternoon Glenn,

I have clarified this to make sure that the inadequate capacity is reflective for 20 l/s not the original request raised when the CCTV report was indentified – Even with 20 l/s discharge there would still be no capacity to support the additional discharge. I have asked Rob our modeller to provide you with a letter also confirming this reflective for the 20 l/s not 475 l/s that original was placed on the form at the time for reference. .

I will send this across to confirm by Tomorrow when rob provide the update report- however his confirmation against the CCTV survey still confirm that there would be inadequate capacity.

So sorry that I cannot give you a different answer, but this is what the report when remodelling shows against even 20 l/s of additional flow

Kind regards

Michael Andrews
Customer Service Manager

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Southern Water, Southern House, Sparrowgrove, Otterbourne , SO21 2SW

From: Glenn Charles [mailto:gcharles@c-a.uk.com]
Sent: 28 January 2016 14:52
To: Andrews, MichaelRichard
Subject: RE: Land South of Bartons Road Surface Water Drainage Capacity Check

Michael,
Further to my previous email I note the application you sent me, relates to the original flow of 475l/s you will recall we subsequently submitted a flow of 20l/s I hope this was what was remodelled? Can you please confirm with a revised report.

Regards Glenn Charles
B. Eng. C.Eng MICE MIE (Aust)
Managing Director

C & A Consulting Engineers LTD
Offices 8 & 9,
Aldershot Enterprise Centre
Mandora House
Louise Margaret Road
Aldershot Hampshire
GU11 2PW (Use 2DD for Sat Nav)
TDL: 01252 939001
Also at:
Office 17, Wealden Place
Bradbourne Vale Road
Sevenoaks
Kent
TN13 3QQ
T : 01732 448120

07436 563862
gcharles@c-a.uk.com
www.c-a.uk.com

From: Andrews, MichaelRichard [mailto:MichaelRichard.Andrews@southernwater.co.uk]
Sent: 28 January 2016 14:40
To: Glenn Charles <gcharles@c-a.uk.com>
Subject: RE: Land South of Bartons Road Surface Water Drainage Capacity Check
Importance: High

Good Afternoon Glenn,

Please accept my sincerest apologies for not returning you emails sooner.

I have now received the CCTV survey of the pipe within the initial Capacity Check Level 2 report that at the time was inconclusive. Since the survey was conducted over the Christmas period the report confirms that the diameter of the pipe does in fact go from an 825mm diameter into a 225m diameter pipe as our original report indicates

What this actually means is that in fact when the original report was issues dated 16 June 2015 we suggested that there was inadequate capacity to support the additional surface water Flow. Following the additional letter dated 9th October 2015 under reference SWS CC-00030 it would mean that there is inadequate capacity to support the additional flow (Surface Water). So nothing would have changed since the original letter (Attachment 2) dated 16th June 2015.

What this would unfortunately mean is that in order to progress and identify an appropriate solution the only alternative option would be to apply under the Section 98 of the Water industry Act which provides a legal mechanism through which the appropriate infrastructure can be requested (By the developer) to review an alternative solution.

I have enclosed below the links that would take you to the S98 application forms and guidance notes, so that you can review this and consider this option. If you then submit a S98 application through to developer service this will be reviewed through an SL1 design option for an alternative method to work with you on a way to support the development an discharge the additional flows you intend too..

APPLICATION FORM
https://www.southernwater.co.uk/Media/Default/PDFs/SR1-S98-requisition-of-sewer.pdf
GUIDEANCE NOTES
https://www.southernwater.co.uk/Media/Default/PDFs/SewerReqNotes.pdf

Once again I'd like to apologies that the news I have provided hasn't been the one you were hoping for but as the surface water flows generated by the proposed development are significant in relation to the capacity of the existing surface water system, the only feasible solution is discharge to soakaway, if ground conditions are favourable or discharge direct to a local water course, subject to approval from all interested parties.

Kind regards

Michael Andrews
Customer Service Manager

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Southern Water, Southern House, Sparrowgrove, Otterbourne , SO21 2SW

From: Glenn Charles [mailto:gcharles@c-a.uk.com]
Sent: 25 January 2016 16:03
To: Andrews, MichaelRichard
Subject: Land South of Bartons Road Surface Water Drainage Capacity Check

Mike,
I understand you have been off work ill. I hope you are recovering to full health. Are you able to shed any light on the capacity check for the above site?

Regards Glenn Charles
B. Eng. C.Eng MICE MIE (Aust)
Managing Director

C & A Consulting Engineers LTD
Offices 8 & 9,
Aldershot Enterprise Centre
Mandora House
Louise Margaret Road
Aldershot Hampshire
GU11 2PW (Use 2DD for Sat Nav)
TDL: 01252 939001
Also at:
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Southern Water

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TN13 3QQ

Developer Services
Southern Water
Sparrowgrove House
Sparrowgrove
Otterbourne
Hampshire
SO21 2SW

Tel: **0330 303 0119**
Email: ***developerservices@southernwater.co.uk***

Your Ref:
14-01839/SB/sb/002

Our Ref:
CC-HANT-00030

Date:
03 February 2016

F.A.O: Mr. Simon Brown,

Site: Land South of Burtons Road, Havant, Hampshire, PO9 5NB.

Dear Sirs,

Further to your recent application for a level 2 enquiry regarding the above development site.

SURFACE WATER

Please find enclosed the report which details the extent of works required in order for your proposed development site to be accommodated within the local sewerage infrastructure. It should be noted that the report is only a hydraulic solution to provide capacity for the proposed development site. There are other options available to you/ your client in discharging your proposed flows from the site such as making a connection application/requisition to a sewer at a point where capacity is currently available. Section 98 of the Water Industry Act 1991 provides a legal mechanism through which the appropriate infrastructure can be requested (by the developer) and provided to drain a specific location.

As you are aware the owner or occupier of the premises or private sewer or drain must give the sewerage undertaker notice of the proposed works. Upon receipt of the notice the undertaker may, within 21 days, refuse to allow him to make the connection if it considers that the mode of construction or the condition of the connecting sewer or drain either does

not satisfy the standards reasonably required by the undertaker, or is such that the making of the communication would be prejudicial to its sewerage system.

The right of refusal is limited to these criteria alone and the undertaker cannot refuse to allow the connection on the grounds that the sewerage system is inadequate to take the extra liquid that the connection will discharge into it. This is a matter that should be dealt with at the planning stage.

Yours faithfully

Developer Services

Please note: -

The information provided above does not grant approval for any designs/drawings submitted for the capacity analysis. The results quoted above are only valid for 12 months from the date of issue of this letter.

Southern Water

INFRASTRUCTURE ASSESSMENT FOR STORM DRAINAGE AT LAND SOUTH OF BARTONS ROAD HAVANT HAMPSHIRE PO9 5NB

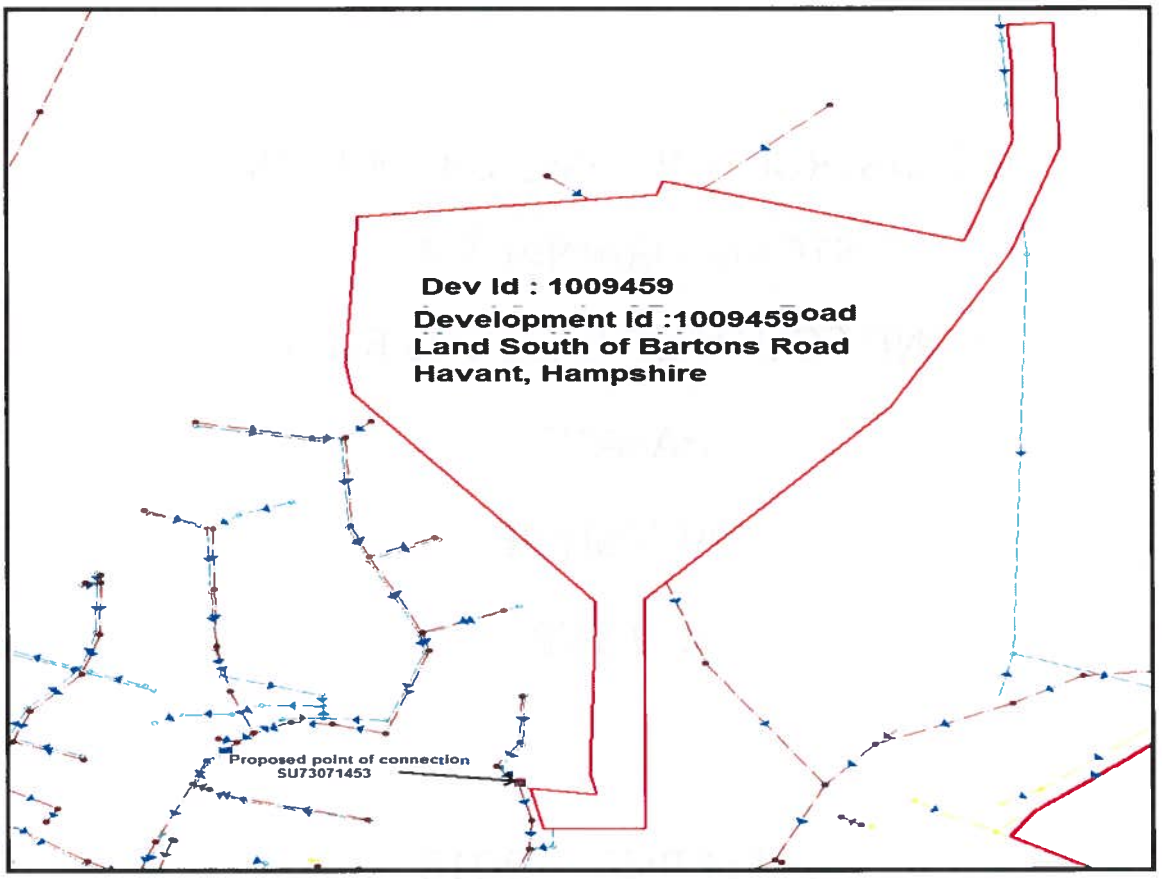
03 FEBRUARY 2016

REQUESTED:
RMB CONSULTANTS (CIVIL ENG) LTD

I. Development Details:

The proposal is to connect 20l/s storm water flow to the local storm system at manhole reference SU73071453 which is located on Snowberry Crescent.

Figure 1 - Proposed Development



II. Results and Conclusions:

Foul Water:

Foul water capacity check has been requested by separate application.

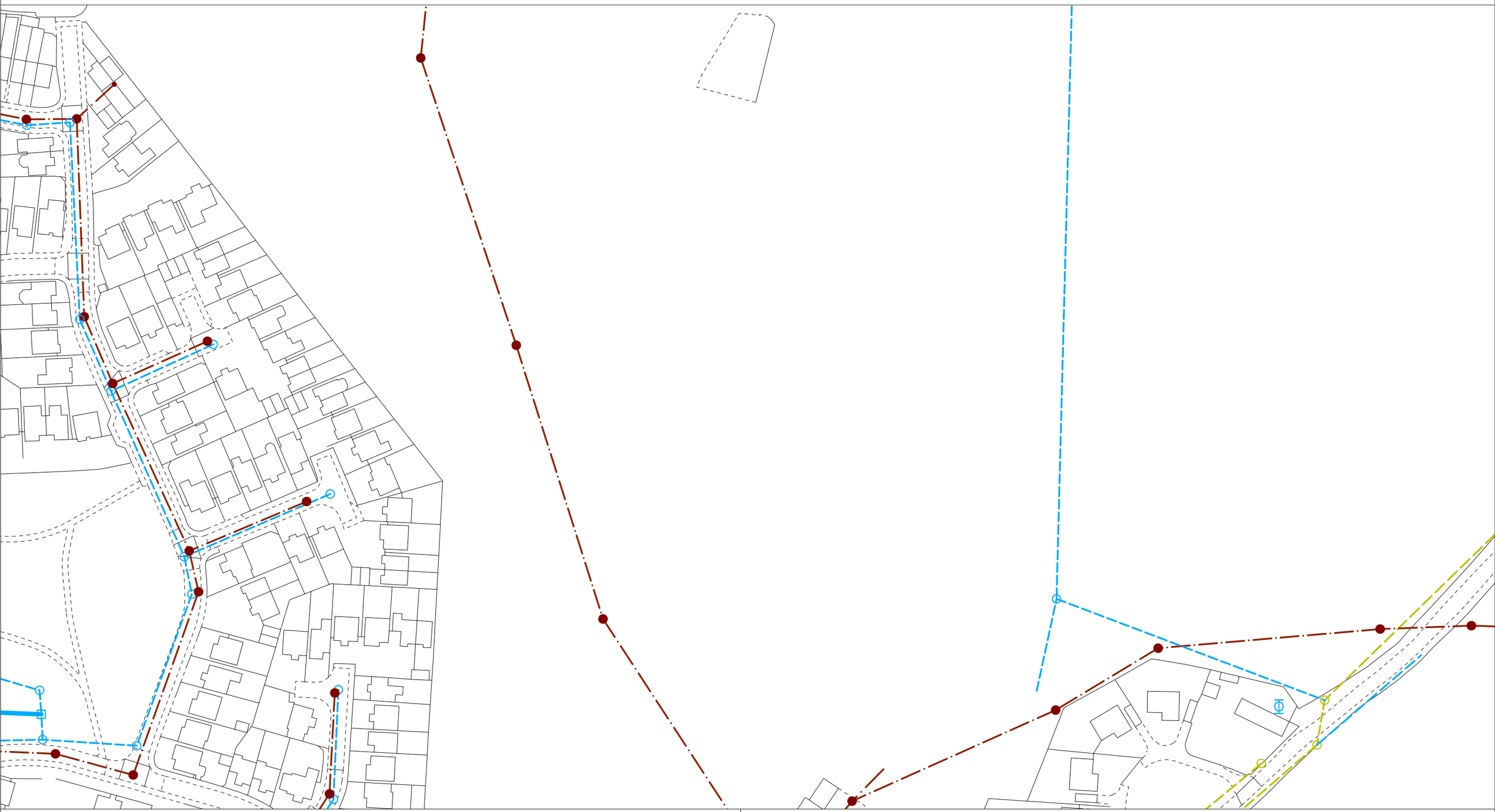
Surface Water:

There is currently inadequate capacity within the storm water sewer network to accommodate the flow of 20 l/s at manhole reference SU73071453. The proposed development would increase flows to the local network and as a result existing properties may be subject to a greater risk of flooding. As the surface water flows generated by the proposed development are significant in relation to the capacity of the existing surface water system, the only feasible solution is discharge to soakaway, if ground conditions are favourable or discharge direct to a local water course, subject to approval from all interested parties.

Please note: - The information provided above does not grant approval for any designs /drawings submitted for the capacity analysis. . The results are an indicative hydraulic assessment and should not be used as a basis for design. The results quoted above are only valid for 12 months from the date of issue of this letter.

PUBLIC SEWER RECORD

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 298530

Southern Water

O.S. REF: SU7307NW

Scale: 1:1250

N

Printed By: sierrob

Date: 16-6-2015

Sewer Plot

Southern Water MapGuide Browser

WARNING: BAC pipes are constructed of Bonded Asbestos Cement

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

Requested By:
A3 Location Plan

CHECKED

Southern Water

Your Ref LM 37493/SD
Our Ref 194153
Date 04 May 2015
Contact searches@southernwater.co.uk
Fax 01634 844514
DX:400450 Chatham 5

Atkins
Atkins Telecoms - Stats Enquiries Team
The Hub - 500 Park Avenue
Aztec West
Almondsbury
Bristol
Attention: Nicholas Westcott

Dear Sirs

Provision of Sewer only Main Record Extracts – VAT Receipt

Bartons Road, Havant, Hampshire PO9 5NB
Further to your recent enquiry regarding the provision of Southern Water apparatus record extracts for the above location.

Please be aware that there are areas within our region in which there are neither sewers nor water mains. Similarly, whilst the enclosed extract may indicate the approximate location of our apparatus in the area of interest, it should not be relied upon as showing that further infrastructure does not exist and may subsequently be found following site investigation. Therefore actual positions of the disclosed (and any undisclosed) infrastructure should be determined on site, because Southern Water does not accept any responsibility for inaccuracy or omission regarding the enclosed plan and accordingly it should not be considered to be a definitive document.

I confirm payment of the appropriate fee in the sum of £49.92

The breakdown of costs is as follows: -

- Provision of record extracts £41.60
- VAT @ 20.0% £8.32

VAT Registration Number 813 0378 56

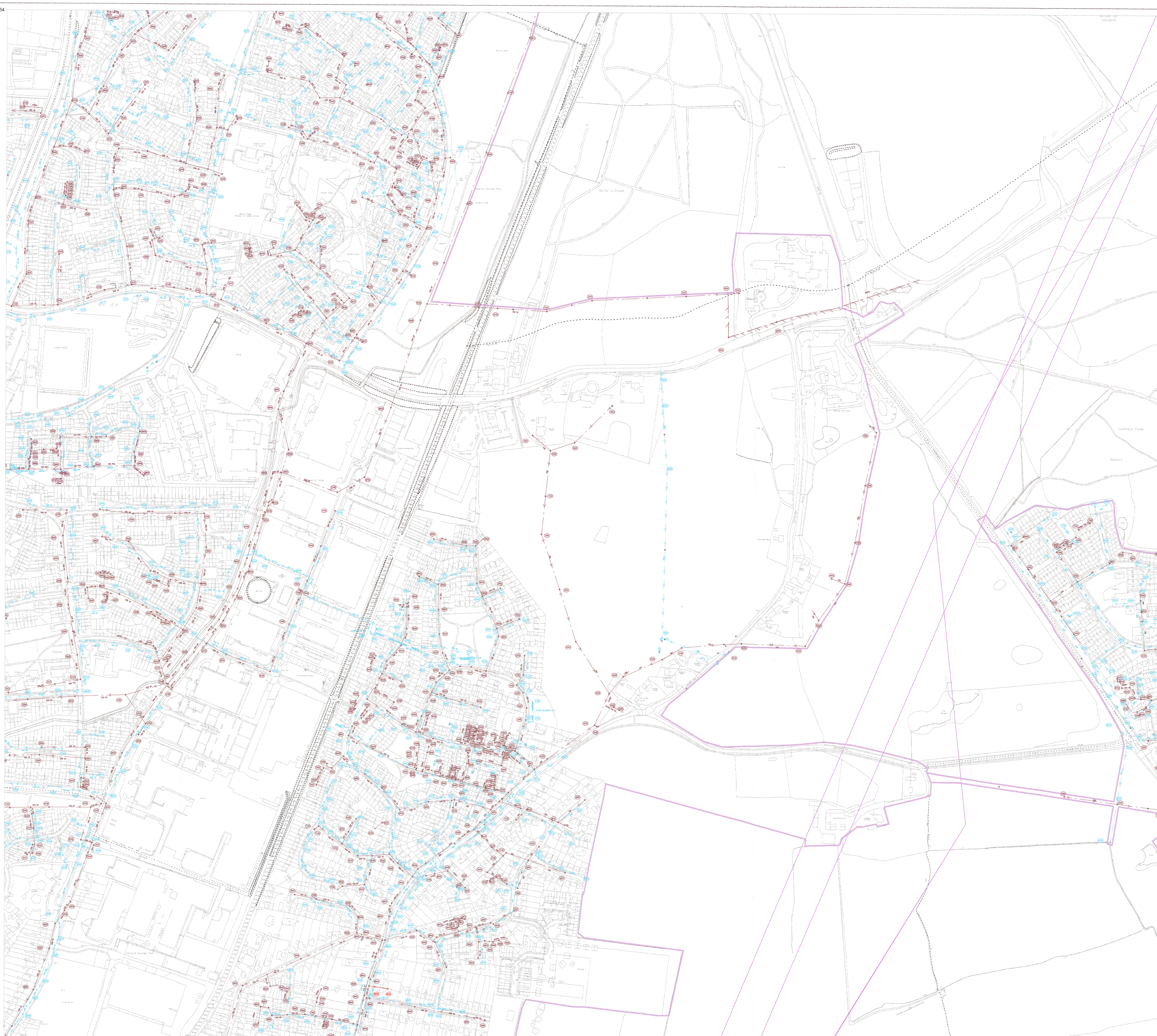
Should you require any additional information regarding this matter please contact this office at the address given at the foot of this letter.

Yours faithfully

Land Search Department

Letter B

108654



Node	Cover	Invert	Size	Material	Shape	
0001X	14.784	13.614	150	UNK	CIRC	
0002X			UNK	UNK	CIRC	
0003X			UNK	UNK	CIRC	
0004X			UNK	UNK	CIRC	
000DX			UNK	UNK	CIRC	
002DX			UNK	UNK	CIRC	
003DX			150	UNK	CIRC	
0050X	14.56	13.67	150	UNK	CIRC	
0051X	14.585	13.665	225	UNK	CIRC	
0053X			UNK	UNK	UNK	
0101X			UNK	UNK	CIRC	*
0101X	15.771		225	UNK	CIRC	*
0102X			UNK	UNK	CIRC	*
0102X	15.471	13.171	225	UNK	CIRC	*
0103X	15.526	13.766	225	UNK	CIRC	
0104X	15.305	12.935	150	UNK	CIRC	
0105X	15.135	12.635	225	UNK	CIRC	
0106X	15.238	13.168	150	UNK	CIRC	
010DX			225	UNK	CIRC	
0150X	14.735	13.235	225	UNK	CIRC	
0151X	14.86	14.19	225	UNK	CIRC	
0152X	14.905	14.315	225	UNK	CIRC	
0153X	14.855		UNK	UNK	UNK	
0154X	15.04	12.44	300	UNK	CIRC	
0155X	15.165	14.515	225	UNK	CIRC	
0156X	15.255	12.705	225	UNK	CIRC	
0157X	15.135		750	UNK	CIRC	
0158X	15.37	12.76	225	UNK	CIRC	
0159X	15.375		UNK	UNK	UNK	
0160X	15.445	14.035	225	UNK	CIRC	
0161X	14.595	13.955	225	UNK	CIRC	
0201X	15.493	12.493	225	UNK	CIRC	
0202X	15.93	13.47	150	UNK	CIRC	
0203X	15.864	13.554	150	UNK	CIRC	
0204X	15.659	13.479	225	UNK	CIRC	
0205X			UNK	UNK	CIRC	*
0205X			UNK	UNK	CIRC	*
0206X			UNK	UNK	CIRC	*
0206X			UNK	UNK	CIRC	*
0207X			UNK	UNK	CIRC	
0208X			UNK	UNK	CIRC	
0209X			UNK	UNK	CIRC	
020BX			150	UNK	CIRC	
020DX			100	VC	CIRC	
021DX			150	VC	CIRC	*
021DX			100	VC	CIRC	*
021DX			UNK	UNK	CIRC	*
022DX			150	VC	CIRC	
023DX			UNK	UNK	CIRC	
024DX			UNK	UNK	CIRC	
0250X	15.49	13.82	225	UNK	CIRC	
0251X	15.635	13.755	300	UNK	CIRC	
0252X	15.95	14.19	375	UNK	CIRC	
0253X	16.125	14.655	225	UNK	CIRC	
0254X	16.025	14.855	225	UNK	CIRC	
02ADX			UNK	UNK	CIRC	
02CDX			UNK	UNK	CIRC	
02FDX			UNK	UNK	CIRC	
02GDX			100	VC	CIRC	
02JDX			UNK	UNK	CIRC	
0301X			UNK	UNK	UNK	*
0301X	16.263	13.783	225	UNK	CIRC	*
0302X			UNK	UNK	CIRC	*
0302X	17.63	15.73	150	VC	CIRC	*
0303X			100	VC	CIRC	*
0303X			UNK	UNK	UNK	*
0304X			100	VC	CIRC	
0305X			100	VC	CIRC	
0306X			100	VC	CIRC	
0307X			100	VC	CIRC	
0309X			UNK	UNK	CIRC	
030DX			100	VC	CIRC	
0311X			UNK	UNK	CIRC	
031DX			100	VC	CIRC	
032DX			100	VC	CIRC	
033DX			100	VC	CIRC	
034DX			UNK	UNK	CIRC	
0350X	16.255	14.435	525	UNK	CIRC	*
0350X	15.659		UNK	UNK	UNK	*
0351X	16.555	14.585	525	UNK	CIRC	
0352X	16.73		225	UNK	CIRC	
0353X	17.65	16.4	300	CO	CIRC	
03ADX			UNK	UNK	CIRC	
03BDX			UNK	UNK	CIRC	
03DDX			UNK	UNK	CIRC	
03HDX			UNK	UNK	CIRC	
03KDX			UNK	VC	CIRC	
0400X	17.12	15.63	225	VC	CIRC	
0401X	16.88	15.49	225	VC	CIRC	
0402X	16.98	15.38	225	VC	CIRC	
0403X	17.25	15.27	225	VC	CIRC	
0450X	17.09	15.54	375	CP	CIRC	
0451X	18.14	15.37	300	CP	CIRC	
0452X	17.2	15.49	300	CP	CIRC	
0453X	17.2	15.36	300	CP	CIRC	
0454X		15.331	UNK	UNK	RECT	
045DX		15.31	450	CP	CIRC	
0500X	18.5	17.3	150	VC	CIRC	
0501X	18.84	17.69	150	VC	CIRC	
0502X	17.85	16.54	150	VC	CIRC	
0503X	17.59	16.4	150	VC	CIRC	
0550X	18.46	16.72	150	VC	CIRC	
0551X	18.83	17.28	150	VC	CIRC	
0552X	17.81	15.95	375	CP	CIRC	
0553X	17.56	15.81	375	CP	CIRC	
0600X	20.96	18.86	150	VC	CIRC	
0601X			UNK	UNK	UNK	*
0601X	20.265	17.785	150	UNK	CIRC	*
0601X	21.29	18.73	150	VC	CIRC	*
0602X	18.99	17.63	150	VC	CIRC	*
0602X	21.876	19.416	150	UNK	CIRC	*
0603X	22.033	20.203	150	UNK	CIRC	
0650X	20.91	19.08	225	VC	CIRC	
0651X	21.18	18.96	225	VC	CIRC	*
0651X	21.847	20.307	225	UNK	CIRC	*
0652X	18.99	17.12	300	CP	CIRC	*
0652X	21.888	19.888	225	UNK	CIRC	*
0653X	19.29	16.98	150	VC	CIRC	*
0653X	16.553		225	UNK	CIRC	*
0751X	22.486	20.566	225	UNK	CIRC	
0752X	22.754	20.804	225	UNK	CIRC	
0800X	14.11	12.29	225	VC	CIRC	
0801X	13.55	12.55	150	VC	CIRC	
0850X			225	UNK	CIRC	
0900X	14.43	13.43	150	VC	CIRC	
0902X	14.62	13.29	150	VC	CIRC	
0903X	14.58	13.44	150	VC	CIRC	
0904X	14.51		225	VC	CIRC	
0905X			UNK	UNK	CIRC	
0907X			UNK	UNK	CIRC	
0908X			UNK	UNK	CIRC	
0909X			UNK	UNK	CIRC	
090DX			225	VC	CIRC	
0910X			UNK	UNK	CIRC	
0911X			UNK	UNK	CIRC	
0912X			UNK	UNK	CIRC	
0913X			UNK	UNK	CIRC	
094DX			UNK	UNK	CIRC	
0950X	13.53		150	UNK	CIRC	
0951X	14.6	13.59	150	UNK	CIRC	
0952X	14.388	13.513	225	UNK	CIRC	
0953X	14.475	13.52	150	UNK	CIRC	
1001X	14.891	13.881	150	UNK	CIRC	
1002X	15.048	13.908	150	UNK	CIRC	
1003X	14.851	13.941	150	UNK	CIRC	
1004X	14.986		150	UNK	CIRC	
1050X	14.895	14.195	225	UNK	CIRC	
1051X	15.005		225	UNK	CIRC	
1052X	14.98	12.86	225	UNK	CIRC	
1053X	14.885	13.755	225	UNK	CIRC	
1054X	15.07	14.04	300	UNK	CIRC	
1100X	21.47	19.42	300	VC	CIRC	*
1100X	12.7	9.95	675	CP	CIRC	*
1101X	15.301	13.201	150	UNK	CIRC	*
1101X			150	VC	CIRC	*
1102X	15.52	13.23	150	UNK	CIRC	
1103X	15.468	14.778	150	UNK	CIRC	
1104X	14.987	13.977	150	UNK	CIRC	
1105X	15.226	13.586	150	UNK	CIRC	
1106X	15.155		150	UNK	CIRC	
1150X			300	VC	CIRC	
1151X	15.655		UNK	UNK	CIRC	*
1151X			375	CP	CIRC	*
1152Y	15.1	13.595	UNK	UNK	CIRC	
1153X	15.11	14.16	300	UNK	CIRC	
1154X	15.08		UNK	UNK	CIRC	
1155X			225	UNK	CIRC	
1200X	13.34	12.4	225	VC	CIRC	
1201X			225	UNK	CIRC	*
1201X	15.123		225	UNK	CIRC	*
1202X	15.612	13.272	225	UNK	CIRC	
1203X	15.558	12.948	225	UNK	CIRC	
1204X	16.236	13.576	225	UNK	CIRC	
1205X			UNK	UNK	CIRC	
121DX			225	UNK	CIRC	
1250X	15.41	12.92	UNK	UNK	CIRC	
1251X	15.285		750	UNK	CIRC	
1252X	15.535	13.455	450	UNK	CIRC	
1253X	24.89	23.16	225	VC	CIRC	*
1253X	15.845	14.365	UNK	UNK	CIRC	*
1254X	13.3	12.2	300	CP	CIRC	*
1254X	15.09		600	UNK	CIRC	*
1255X	15.16	14.21	225	UNK	CIRC	
1256X	15.935	14.205	525	UNK	CIRC	
1257X	16.075	14.195	UNK	UNK	CIRC	
125DX			450	UNK	CIRC	
1300X	16.09	13.94	225	VC	CIRC	
1301X	16.18	13.85	225	VC	CIRC	
1302X			UNK	UNK	CIRC	

Node	Cover	Invert	Size	Material	Shape	
1303X			UNK	UNK	CIRC	
1307X	14.54	12.76	225	VC	CIRC	
130DX			UNK	UNK	CIRC	
131DX			UNK	UNK	CIRC	
132DX			UNK	UNK	CIRC	
1350X	16.07	14.335	225	UNK	CIRC	
1351X	15.98	14.52	225	UNK	CIRC	
1352X			225	UNK	CIRC	*
1352X	16.21	14.56	225	VC	CIRC	*
1353X	16.31	14.61	225	VC	CIRC	
135DX	16.25	14.69	UNK	CP	RECT	
1400X	16.6	15.08	150	VC	CIRC	
1401X	16.47	14.59	150	VC	CIRC	
1402X	16.41	14.41	150	VC	CIRC	
1403X	16.04	14.08	225	VC	CIRC	
1450X	14.02	12.62	300	UNK	CIRC	*
1450X	16.61	15.32	225	VC	CIRC	*
1451X	16.47	15.09	225	VC	CIRC	*
1451X	14.66	13.46	UNK	UNK	CIRC	*
1452X	16.42	14.87	300	CP	CIRC	*
1452X	13.785		525	UNK	CIRC	*
1453X	16.08	14.8	300	CP	CIRC	
1500X	17.57	16.84	150	VC	CIRC	
1501X	15.591	13.611	UNK	UNK	CIRC	*
1501X			UNK	UNK	CIRC	*
1502X	17.836		150	UNK	CIRC	
1550X	17.6	16.42	150	VC	CIRC	
1551X	17.755		225	UNK	CIRC	
1552X	16.222	14.192	300	UNK	CIRC	
1553X	16.502	15.582	150	UNK	CIRC	
1601X	22.812	21.562	150	UNK	CIRC	*
1601X	22.298	20.298	150	UNK	CIRC	*
1601X			UNK	UNK	CIRC	*
1602X	19.644	17.454	UNK	UNK	CIRC	
1603X	18.214	16.074	150	UNK	CIRC	
1604X			UNK	UNK	CIRC	
1605X			UNK	UNK	CIRC	
160DX			UNK	UNK	CIRC	
161DX			150	UNK	CIRC	
1650X	18.215		300	UNK	CIRC	
1651X	20.632		300	UNK	CIRC	
1652X	22.044	20.324	225	UNK	CIRC	
1700X	12.13	9.94	225	VC	CIRC	
1701X	26.257	25.007	UNK	UNK	CIRC	
1702X			100	VC	CIRC	
1750X	12.06	10.33	675	CP	CIRC	*
1750X	22.892	21.342	225	UNK	CIRC	*
1751X	23.843	22.093	225	UNK	CIRC	
1752X	23.941	22.311	225	UNK	CIRC	
1801X	30.658	28.658	150	UNK	CIRC	
1802X			225	UNK	CIRC	*
1802X	29.306		150	UNK	CIRC	*
1856X			525	UNK	CIRC	
185DX			UNK	UNK	CIRC	
190DX			UNK	UNK	CIRC	
195DX			300	CP	CIRC	
2001X	14.988	14.278	150	UNK	CIRC	
2050X	21.95	19.91	450	CP	CIRC	
2051X	15.11	13.8	225	UNK	CIRC	*
2051X	22.31	20.26	450	CP	CIRC	*
2100X	22.09	20.39	225	VC	CIRC	*
2100X	12.8	10.2	675	CP	CIRC	*
2101X		11.302	150	VC	CIRC	*
2101X			UNK	UNK	CIRC	*
2101X	15.155		150	UNK	CIRC	*
2101X	23.15	20.97	300	VC	CIRC	*
2102X		11.232	150	VC	CIRC	
2103X		11.122	150	VC	CIRC	
2104X		10.925	150	VC	CIRC	
2105X		10.738	150	VC	CIRC	
2106X		10.12	675	CP	CIRC	
2150X			300	VC	CIRC	*
2150X	22.86	20.45	750	CP	CIRC	*
2150X	15.08	14.25	150	UNK	CIRC	*
2151X			300	VC	CIRC	*
2151X	15.05	14.38	150	UNK	CIRC	*
2152X			225	VC	CIRC	
2153X			225	VC	CIRC	
2154X			225	VC	CIRC	
2155X			375	CP	CIRC	
2156X			225	VC	CIRC	
2157X			225	VC	CIRC	
2158X			225	VC	CIRC	
2200X	25.17	21.63	225	VC	CIRC	
2201X			225	UNK	CIRC	*
2201X	13.5	12.23	225	VC	CIRC	*
2201X	25.39	22.77	300	VC	CIRC	*
2201X	15.113	14.203	150	UNK	CIRC	*
2202X	13.47	12.35	225	VC	CIRC	
220DX			225	VC	CIRC	
2250X	25.27	22.27	675	CP	CIRC	*
2250X	13.35	12	600	CP	CIRC	*
2250X	14.765	13.465	300	UNK	CIRC	*
2250X	10.77	8.97	600	UNK	CIRC	*
2251X	13.15	11.79	600	CP	CIRC	*
2251X	24.26	21.34	750	CP	CIRC	*
2252X	24.02	21.9	225	VC	CIRC	*
2252X	13.72	12.5	300	VC	CIRC	*
2300X	24.44	22.09	300	VC	CIRC	*
2300X	13.84	12.39	375	CP	CIRC	*
2301X			100	VC	CIRC	*
2301X	11.567	9.967	225	UNK	CIRC	*
2301X	15.129		225	UNK	CIRC	*
2302X			100	VC	CIRC	*
2302X			UNK	UNK	CIRC	*
2302X	12.311	11.181	225	UNK	CIRC	*
2303X	12.416	11.547	150	UNK	CIRC	*
2303X			100	VC	CIRC	*
2304X			UNK	UNK	CIRC	*
2304X			100	VC	CIRC	*
2305X			100	VC	CIRC	*
2305X			UNK	UNK	CIRC	*
2306X			UNK	UNK	CIRC	
232DX			UNK	UNK	CIRC	
2350X	12.42	11.4	300	UNK	CIRC	*
2350X	25.69	23.51	675	CP	CIRC	*
2350X	13.85	12.6	600	CP	CIRC	*
2351X	13.79	12.86	600	CP	CIRC	*
2351X	11.729	10.979	300	UNK	CIRC	*
2351X	26.89	24.69	225	VC	CIRC	*
2352X	12.204	10.854	300	UNK	CIRC	
2353X	12.034	10.714	300	UNK	CIRC	
2354X	12.27	10.69	600	UNK	CIRC	
2355X	11.437		600	UNK	CIRC	
235DX			600	UNK	CIRC	
23ADX			UNK	UNK	CIRC	
23BDX			UNK	UNK	CIRC	
2400X	26.55	24.1	300	VC	CIRC	
2401X	16.84	15.47	150	UNK	CIRC	*
2401X	30.39	28.01	225	VC	CIRC	*
2401X	14.22	13	225	VC	CIRC	*
2401X	13.891	11.351	225	UNK	CIRC	*
2402X	15.501		225	UNK	CIRC	*
2402X			UNK	UNK	CIRC	*
2402X	31.01		225	VC	CIRC	*
2403X			UNK	UNK	CIRC	
2404X			UNK	UNK	CIRC	
2405X			UNK	UNK	CIRC	
240DX			UNK	UNK	CIRC	
241DX			UNK	UNK	CIRC	
2450X	13.225	11.935	300	UNK	CIRC	*
2450X	29.06	25.56	600	CP	CIRC	*
2451X	27.17	24.64	675	CP	CIRC	*
2451X	12.809	12.079	225	UNK	CIRC	*
2452X	12.799	11.779	225	UNK	CIRC	*
2452X	27.04	25.3	225	VC	CIRC	*
2453X	12.734	11.614	225	UNK	CIRC	*
2453X	30.6	29.3	225	VC	CIRC	*
2454X	12.479	11.329	225	UNK	CIRC	
2455X	13.61	11.48	UNK	UNK	CIRC	
2456X	13.06	11.94	UNK	UNK	CIRC	
2457X	13.89		525	UNK	CIRC	
2500X	15.65	14.55	225	VC	CIRC	
2501X	19.522	18.302	UNK	UNK	CIRC	*
2501X	17.351	15.241	150	UNK	CIRC	*
2502X	16.09	13.87	150	UNK	CIRC	
2550X	14.439		525	UNK	CIRC	*
2550X	16.42	15.2	225	VC	CIRC	*
2551X	15.67	13.92	225	UNK	CIRC	
2552X	16.88		225	UNK	CIRC	
2553X	17.38	15.63	225	UNK	CIRC	
2554X	17.185	15.385	225	UNK	CIRC	
2600X	17.89	16.62	225	VC	CIRC	
2601X	19.054	17.264	150	UNK	CIRC	*
2601X	17.23	15.82	225	VC	CIRC	*
2602X	16.38	14.79	225	VC	CIRC	
260DX			UNK	UNK	CIRC	
2650X	18.085	16.465	225	UNK	CIRC	
2651X	19.19	17.59	225	UNK	CIRC	
2652X	19.022	17.612	225	UNK	CIRC	
2653X	21.248	19.528	225	UNK	CIRC	
2700X	18.72	17.25	225	VC	CIRC	
2701X	19.09	16.95	225	VC	CIRC	
2702X			UNK	UNK	CIRC	
270DX			UNK	UNK	CIRC	
2750X	23.875	23.095	225	UNK	CIRC	*
2750X	18.89	16.51	225	VC	CIRC	*
2800X	12.53	10.15	225	VC	CIRC	*
2800X	19.56	17.58	150	PVC	CIRC	*
2801X			UNK	UNK	CIRC	*
2801X	19	16.75	150	PVC	CIRC	*
2802X	19.19	16.2	150	PVC	CIRC	
2803X	18.83	16.73	150	PVC	CIRC	
2804X	18.94	16.54	150	PVC	CIRC	
2805X	19.11	16.37	150	PVC	CIRC	
2806X			UNK	UNK	CIRC	
2807X			UNK	UNK	CIRC	
280DX			UNK	UNK	CIRC	
2850X	18.63	18.08	UNK	UNK	CIRC	*

Node	Cover	Invert	Size	Material	Shape	
2850X	12.4	10.57	675	CP	CIRC	*
2851X	12.59	10.72	675	CP	CIRC	*
2851X	18.75	18.24	150	UNK	CIRC	*
2852X	12.67	10.87	675	CP	CIRC	*
2852X	19.05	17.18	300	CP	CIRC	*
2853X	19.55	17.85	225	PVC	CIRC	
2854X	18.8	17.19	225	PVC	CIRC	
2855X	18.92	17.09	225	PVC	CIRC	
2856X	19.07	16.99	225	PVC	CIRC	
2857X	19.16	16.73	375	CP	CIRC	
2858X			UNK	UNK	CIRC	
285DX			375	CP	CIRC	
2900X			225	UNK	CIRC	
2901X	12.62	10.46	225	VC	CIRC	
2902X	12.67	10.65	225	VC	CIRC	
2950X	12.63	10.97	600	CP	CIRC	*
2950X	18.67		300	CP	CIRC	*
2951X	12.86	10.8	600	CP	CIRC	*
2951X	18.92	18.4	150	UNK	CIRC	*
2952X	12.58	11.09	450	CP	CIRC	
295IX	−1		UNK	UNK	CIRC	
3000X	12.5	10.33	225	VC	CIRC	
3050X	13		450	CP	CIRC	
3100X	23.96	21.56	225	VC	CIRC	*
3100X	14	12.15	225	VC	CIRC	*
3101X	13.17	11.26	300	VC	CIRC	*
3101X			225	UNK	CIRC	*
3101Y	13.17	11.26	225	VC	CIRC	*
3102X	13.06	11.06	300	VC	CIRC	
3103X	13.44	10.33	675	CP	CIRC	
3104X	13.5	10.63	675	CP	CIRC	
3105X	12.79	11.19	225	VC	CIRC	
3150X	22.86	20.73	450	CP	CIRC	*
3150X	12.4	11.79	300	VC	CIRC	*
3151X	13.18	11.92	450	CP	CIRC	*
3151X	23.68	21.88	225	VC	CIRC	*
3152X	13.13	11.81	450	CP	CIRC	
3153X	12.98	12.13	300	VC	CIRC	
3154X			450	CP	CIRC	
3155X			450	CP	CIRC	
3200X	14.32	12.04	225	VC	CIRC	*
3200X	27.09	25.15	225	VC	CIRC	*
3201X			150	UNK	CIRC	*
3201X	14.15	11.92	225	VC	CIRC	*
3202X	13.79	11.82	225	VC	CIRC	
3203X	13.71	11.75	225	VC	CIRC	
3204X	13.51	11.69	225	VC	CIRC	
3205X	13.93	10.98	600	CP	CIRC	
3206X			225	VC	CIRC	
3210X			150	UNK	CIRC	
3250X	13.69	12.62	600	CP	CIRC	*
3250X	25.36	24.16	225	VC	CIRC	*
3251X	13.76	12.27	600	CP	CIRC	*
3251X	26.2		300	CP	CIRC	*
3252X	13.42	12.14	600	CP	CIRC	
3253X	13.59	12.74	300	VC	CIRC	
3254X	14	13	225	VC	CIRC	
3300X	14.12	12.49	375	CP	CIRC	*
3300X	29.55		225	VC	CIRC	*
3301X	28.33	26.3	225	VC	CIRC	
3302X	27.95	26.01	225	VC	CIRC	
3303X	29.14	27.02	225	VC	CIRC	
3304X	28.39	25.38	225	VC	CIRC	
330DX			100	VC	CIRC	
3350X	11.659		375	UNK	CIRC	*
3350X	14.55	13.37	225	VC	CIRC	*
3350X	26.83	25.37	225	VC	CIRC	*
3351X	27.84	26.4	225	VC	CIRC	*
3351X	14.25	13.15	225	VC	CIRC	*
3352X	29.27	27.27	225	VC	CIRC	
3353X	28.05	26.5	225	VC	CIRC	
3354X	28.28	26.82	225	VC	CIRC	
3400X	30.03	26.66	225	VC	CIRC	*
3400X	14.45	13.83	225	VC	CIRC	*
3401X	14.12	13.19	225	VC	CIRC	*
3401X	16.395	14.625	150	UNK	CIRC	*
3401X	28.49	25.87	225	VC	CIRC	*
3402X	15.736	14.076	225	UNK	CIRC	*
3402X	29.43	25.41	300	VC	CIRC	*
3403X	27.46	24.79	225	VC	CIRC	*
3404X	13.524	12.364	150	UNK	CIRC	*
3404X	29.32	26.84	225	VC	CIRC	*
3450X	29.06	26.53	600	CP	CIRC	*
3450X	14.65	13.41	600	CP	CIRC	*
3451X	14.72	13.28	600	CP	CIRC	*
3451X	31.23	28.08	225	VC	CIRC	*
3452X	27.77	25.63	225	VC	CIRC	*
3452X	14.25	13	600	CP	CIRC	*
3453X	14.53	13.17	600	CP	CIRC	*
3453X	29.28	27.45	300	VC	CIRC	*
3456X	12.9	11.44	UNK	UNK	CIRC	
3457X	13.05	11.77	UNK	UNK	CIRC	
3500X	33.07	29	225	VC	CIRC	
3501X	30.92	28.97	225	VC	CIRC	*
3501X	15.45	14.72	150	VC	CIRC	*
3502X	15.87	14.54	150	VC	CIRC	*
3502X	29.67	27.44	225	VC	CIRC	*
3503X	15.66	14.33	150	VC	CIRC	
3504X	15.37	13.9	225	VC	CIRC	
3505X	15	13.7	225	VC	CIRC	
3506X			UNK	UNK	CIRC	
3550X	15.19	13.69	450	CP	CIRC	*
3550X	17.134	15.704	375	UNK	CIRC	*
3550X	29.86	26.81	600	CP	CIRC	*
3551X	31.49	28.87	225	CP	CIRC	*
3551X	14.79	13.48	225	VC	CIRC	*
3552X	16.16	13.81	450	CP	CIRC	*
3552X	32.98	30.48	225	VC	CIRC	*
3553X	15.33	14.35	300	VC	CIRC	
3554X	15.26	14.68	150	UNK	CIRC	
3600X	17.28	14.54	225	VC	CIRC	
3601X	34.15	30.57	225	VC	CIRC	*
3601X			UNK	VC	CIRC	*
3601X	18.915	17.195	150	UNK	CIRC	*
3602X			UNK	UNK	CIRC	*
3602X			UNK	VC	CIRC	*
3603X			UNK	UNK	CIRC	
3604X			UNK	VC	CIRC	*
3604X			UNK	UNK	CIRC	*
3605X			100	VC	CIRC	
3650X	31.31	28.75	450	CP	CIRC	*
3650X	17.06	15.05	225	VC	CIRC	*
3650X	18.545	16.915	225	UNK	CIRC	*
3651X	16.23	14.68	225	VC	CIRC	
3652X	17	15.99	300	CP	CIRC	*
3652X	33.04	30.34	300	CP	CIRC	*
3655X	35.79	32.29	225	CP	CIRC	
3656X	31.68	30.06	300	CP	CIRC	
3700X	18.87	16.37	225	VC	CIRC	
3750X	18.91	16.14	225	VC	CIRC	
3751X	19.08	16.82	225	VC	CIRC	
3800X	19.84	17.22	150	PVC	CIRC	
3801X	20.79	18.96	150	PVC	CIRC	
3802X	20.46	18.06	150	PVC	CIRC	
3850X	20.79	19.27	150	PVC	CIRC	
3851X	20.46	18.33	150	PVC	CIRC	
3852X	20.09	18.13	150	PVC	CIRC	
3853X	19.98	18.04	150	PVC	CIRC	
3854X	19.82	17.68	300	CP	CIRC	
3901X			UNK	UNK	CIRC	
3950X	34.843		375	UNK	CIRC	*
3950X	22.01	21.17	200	VC	CIRC	*
3951X	20.17	19.2	200	VC	CIRC	*
3951X	32.49	31.225	375	UNK	CIRC	*
3952X	19.23	18.67	200	VC	CIRC	
3953X	22.52	21.86	150	VC	CIRC	
3954X	20.05	18.62	150	PVC	CIRC	
4050X	24.13	23.7	200	UNK	CIRC	
4100X	27.64	25.06	225	VC	CIRC	
4101X	25.5	23.17	225	VC	CIRC	*
4101X			UNK	UNK	CIRC	*
4150X	26.09		300	CP	CIRC	
4151X	24.84		375	CP	CIRC	
4200X	28.09	26.2	225	VC	CIRC	
4201X	28.56	26.57	225	VC	CIRC	
4202X	26.3	24.25	225	VC	CIRC	
421DX			150	VC	CIRC	
4250X	28.41	26.8	225	CP	CIRC	
4251X	30.26	29.01	225	VC	CIRC	
4252X	30	28.2	225	VC	CIRC	
4300X	31.56		225	VC	CIRC	*
4300X	14.37	11.26	600	CP	CIRC	*
4301X	14.55	12.6	375	CP	CIRC	*
4301X	29.21	27.09	225	VC	CIRC	*
4302X	31.68	30.1	225	VC	CIRC	*
4302X	14.54	12.74	225	VC	CIRC	*
4303X	14.36	12.92	150	VC	CIRC	
4350X	14.66	13.61	450	CP	CIRC	*
4350X	29.53	27.42	225	VC	CIRC	*
4351X	14.4	13.13	450	CP	CIRC	*
4351X	30.38	28.48	225	VC	CIRC	*
4353X	14.12	12.82	600	CP	CIRC	
4400X	14.81	12.83	375	VC	CIRC	
4401X	16.714	14.794	150	UNK	CIRC	*
4401X	14.79	11.49	600	CP	CIRC	*
4401Y	14.79	12.79	375	VC	CIRC	*
4402X	14.85	12.75	375	CP	CIRC	
4403X	15.08	13.05	225	VC	CIRC	
4404X	14.84	13.18	225	VC	CIRC	
4405X			UNK	UNK	CIRC	
440DX			UNK	UNK	CIRC	
441DX			225	VC	CIRC	
4450X	31.69	29.54	225	VC	CIRC	*
4450X	14.96	13.65	600	CP	CIRC	*
4451X	14.64	13.53	600	CP	CIRC	*
4451X	31.6	29.6	225	VC	CIRC	*
4452X	33.76	30.74	225	VC	CIRC	
4453X	34.87	32.75	225	VC	CIRC	
4500X	37.15	33.94	225	VC	CIRC	*

LINE STYLES / COLOURS

- Brown: Foul; Foul Syphon Sewer; Foul Vacuum Main; Foul Rising Main
- Red: Combined; Combined Syphon Sewer; Combined Rising Main; Lateral Drain
- Orange: Building Over Agreement Area
- Dark Blue: Treated Effluent
- Purple: Sludge; Sewer Catchment; Section 104 Area
- Light Blue: Surface Water; Surface Water Rising Main
- Yellow: Private
- Green: Access Shaft; Decommissioned

MATERIALS

AK Alkathene; BAC Bonded Asbestos Cement; BRC Brick (Common); BRE Brick (Engineering); CC Concrete Box Culvert; CI Cast Iron; CO Concrete (In-Situ); CP Concrete (Pre-Cast); CSB Concrete Segments (bolted); CSU Concrete Segments (unbolted); DI Ductile Iron; GRC Glass Reinforced Concrete; GRP Glass Reinforced Plastic; MAC Masonry in regular Courses; MAR Masonry in random Courses; PE Polyethylene; PF Pitch Fibre; PP Polypropylene; PVC Polyvinyl Chloride; RPM Reinforced Plastic Matrix; SI Spun Iron; ST Steel; VC Vitrified Clay; XXX Other; ZZZ Unknown

WARNING: BAC pipes are constructed of Bonded Asbestos Cement

LEGEND - SEWERS

Manhole (SW); Manhole (F&C); Lamp hole (SW); Lamp hole (F&C); Pumping Station (SW); Pumping Station (F&C); Side entry manhole (SW); Side entry Manhole (F&C); Blind shaft (SW); Blind shaft (F&C); Ejector station (SW); Ejector station (F&C); Watertight door (SW); Watertight door (F&C); Flushing ch. Mn-e (SW); Flushing ch. Mn-e (F&C); Flushing ch. No-e (SW); Flushing ch. No-e (F&C); Demarcation Chamber

Washout (SW); Washout (F&C); Rodding Eye (SW); Rodding Eye (F&C); Gauging point (SW); Gauging point (F&C); Intercept chamber (SW); Intercept chamber (F&C); Storm Tank (SW); Storm Tank (F&C); Vortex chamber (SW); Vortex chamber (F&C); Label ellipse; Dummy/S24 manhole; Outfall; Penstock chamber; Dambaords; Storm Overflow; Backdrop manhole

Other (s); Other; Change in sewer (s); Change in sewer; Reflux valve; Flap valve; Cascade; Anode; Valve; Closed Valve; Air Valve; Hatch box (SW); Hatch box (F&C); Direction arrow; Emptying valve; Catchpit; Soakaway; Inlet; Balancing Pond

Wastewater treatment works; Marine treatment works; Outfall headworks; Vent; Vent column; Tidal storage tank; Blank end; Head of Public Sewer; Micro Pumping Station

SHAPES (S)

A Arched; B Barrel; C Circular; E Egg; H Horseshoe; R Rectangular; S Square; T Trapezoidal; U U Shape; X Other

NODE REFERENCING SYSTEM

1st digit: hundred metre easting identifier
2nd digit: hundred metre northing identifier
3rd digit: 0-4 = Foul/Combined, 5-9 = Surface Water
4th digit: next sequential node

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

O.S. Ref.	SU7307NW	Drawn by:	mondalb
Scale:	1:2500	Date:	04/05/2015

N

Title: 194153_Bartons Road, Havant, H

Southern Water

The information contained on this plan is provided as a guide to the approximate position of existing public sewers. The accuracy thereof cannot be guaranteed.

THIS INFORMATION MUST BE TREATED WITH CAUTION AND THE ACTUAL POSITION OF THE PUBLIC SEWERS MUST BE ESTABLISHED ON SITE, IN ALL CASES.

Southern Water must be informed before lifting manhole covers or excavating trial holes.

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SEWER RECORDS

APPENDIX F

COUNCIL SRFA EXTRACTS

Guidance Document: Havant Borough Council

Flood Risk Overview

Sources of Flood Risk

Havant is the eastern-most Local Authority in the PUSH sub-region. It covers a total area of approximately 55 km² which is split between the mainland and Hayling Island. The council has approximately 56 km of coastal frontage (including 42 km around Hayling Island) and 32 km of main river. At present, approximately 22% of the Borough's land area is designated as within Flood Zones 2 and 3a/3b (see SFRA Map Set 1A).

The SFRA has shown that the primary source of flood risk to Havant is from the sea. The key parts of the Borough which are currently at risk of flooding from the extreme tides include Brockhampton, Langstone and Emsworth on the mainland and Eastoke, Selsmore and Mengham on Hayling Island. Flooding due to wave overtopping is known to occur on Hayling Island, particularly along the southern frontage. Land behind this frontage has suffered significant flooding from wave overtopping even though the land is relatively high and is shown to lie within Flood Zone 1, i.e. the zone of low probability of tidal flooding.

The secondary source of flood risk to Havant Borough is from fluvial sources including the Lavant Stream, the Hermitage Stream and associated tributaries. These watercourses flow through the town centre of Havant and discharge into Langstone Harbour. Additionally, the upper reaches of the Wallington River rise near Waterlooville in Havant Borough. The key parts of the Borough which are currently at risk of fluvial flooding include Havant town centre, Leigh Park, West Leigh and Stockheath.

Historically, Havant has also been susceptible to flooding from other sources including; groundwater, surface water and flooding caused by infrastructure failure. A number of previous groundwater flooding incidents have been observed in the upper parts of the Lavant Stream between Rowlands Castle and Havant in the north of the Borough. The town of Havant has a drainage system which in many places dates back to before the mid-1960s. As such, flooding from surface water drainage systems and sewers has occurred at many locations, including along The Florins, Petersfield Road, Park Lane and Hulbert Road.

Key physical characteristics that may constrain development

Approximately 58% of Havant Borough is currently covered by existing development, suggesting that much future development will need to be concentrated on brownfield sites. A number of environmentally designated areas represent a significant constraint on development in the Borough, covering approximately 24% of its area. As such there may be only limited Greenfield land upon which development can be permitted following consideration of other planning constraints.

The topography of Havant Borough ranges from sea level to approximately 80 metres above ordnance datum (mAOD). Hayling Island is entirely below approximately 9 mAOD. Further development on the island will likely increase the pressure for further maintenance and improvement to existing flood defences, particularly following predicted rises in sea level in future. The town of Havant itself varies in elevation from 5 mAOD near the coast to 40 mAOD in Leigh Park and West Leigh. The majority of the existing development on the mainland in Havant Borough will therefore not face increasing flood risk due to sea level rise. Waterlooville is situated between 30-50 mAOD while elevations in the Purbrook area rise to approximately 65 mAOD on the approach to Portsdown Hill.

Geologically, Havant Borough is underlain by a mix of low, moderate and highly permeable bedrock formations. The towns of Havant and Waterlooville and the southern part of Hayling Island are underlain by low and moderately permeable bedrock formations, while a highly permeable chalk layer exists between these two areas, resulting in the many springs used by Portsmouth Water. However, moderately permeable superficial deposits overlie the majority of this permeable layer, reducing its permeability in terms of surface water runoff generation. This may make the implementation of Sustainable Urban Drainage Systems (SUDS) difficult, which is of particular importance in the Cowplain and Waterlooville area where deep clay strata result in a lack of positive drainage and more frequent small surface water flooding incidents.

The existing drainage systems in Havant are known to be at or below capacity in key areas and it may therefore be difficult to provide new development in parts of the town without significant investment in drainage infrastructure.

Vulnerability to Climate Change

The SFRA has generated predicted tidal outlines for a number of years up to 2115 (see SFRA Map Set 1E). These outlines account for the most up-to-date predicted rises in sea-level over the coming century due to climate change and therefore allow the identification of locations that will be most vulnerable to this change due to their local topography. In Havant Borough, Hayling Island is the most sensitive area to sea level rise, particularly the southern half of the island. With much of the island low-lying, predicted sea-level rise could result in extreme tidal events inundating more of the island. In addition to this effect of rising sea levels, it is anticipated that climate change will result in an increase in fluvial flood flows. This may put additional pressure on areas in the town of Havant adjacent to the streams.

Vulnerability of existing communities

In general, the wards of Havant Borough have a mix of average and high social vulnerability to flooding (see SFRA Map Set 2). However, within Flood Zones 2 and 3 (i.e. those areas potentially likely to experience flooding) the wards generally have a high social vulnerability to flooding on the mainland and average social vulnerability to flooding on Hayling Island. It is likely that future investment in flood defences measures will need to strike a balance between protecting high risk areas on Hayling Island and areas of high social vulnerability on the mainland.

Existing defence assets and likely future investment

The coastal frontages of Havant Borough are almost entirely defended from either wave overtopping or tidal flooding by some form of coastal defence. Approximately half the coastal defences in Havant Borough have a crest level which is higher than a present day 1 in 200 year tide. Areas where defences are below the minimum standard of protection required for new development are the north western coast of Hayling Island south of Northney, the Chichester harbour frontage at Emsworth and the frontage at Langstone. The coastal defences in Havant Borough are, however, likely to be susceptible to climate change, as 100 years of predicted sea level rise would mean that most man-made defences at their current level would fail to offer protection from a 1 in 20 year tidal flood, with the exception of the southern frontage of Hayling Island. To sustain future development in Havant Borough, particularly on Hayling Island, significant investment in flood defences and flood defence infrastructure will be required (see SFRA Map Set 3). In order to consider the sustainability of investing in improved defences, the 'danger to people from breaching' index (SFRA Map Set 1D) will provide indications as to where the residual risk due to breaching may remain unfavourably high following improvements to defences to protect from extreme tidal floods.

Sequential and Exception Test

Planning Policy Statement 25 (PPS25) sets out the Government's objectives for achieving sustainable development through the avoidance and management of flood risk. The aim of PPS25 is to ensure that flood risk is taken into account at all stages of the planning process to avoid inappropriate development in areas of flood risk. To achieve this aim, PPS25 provides a decision making tool to ensure that sites with a low probability of flooding are developed in preference to areas at higher risk. The Sequential Test is the decision process which Local Authorities must demonstrate when developing their Local Development Frameworks and Local Development Documents. This SFRA has developed a suite of mapping outputs to assist Local Authorities in applying the Sequential Test.

When applying the Sequential Test, Output Package 1 of the SFRA will provide all the necessary information required upon which to base decisions regarding the location of future development in relation to flood risk. Within Output Package 1, the key map required for applying the Sequential Test is the Flood Zones map, shown as Map Set 1A. This map shows the spatial extent of 3 of the 4 Flood Zones identified in PPS25, these include:

Map Set 1A

- **Flood Zone 2** – Medium Probability of Flooding



Fluvial (river) and Tidal Flooding

- **Flood Zone 3a** – High Probability of Flooding, sub-divided into:



Fluvial Flooding
Tidal Flooding
Tidal / Fluvial (combined flooding processes where known)

- **Flood Zone 3b** – Functional Floodplain



Fluvial Flooding only

The area outside of these zones is considered to be the fourth zone, 'Flood Zone 1' which has a low probability of flooding.

Output Package 1 also contains 5 other Map sets which provide useful information to support Local Authorities when applying the Sequential Test, these include:

- Map Set 1B – Undefended Flood Hazard Maps (Zones 2 & 3)
- Map Set 1C – Indicative Areas Benefiting From Defences
- Map Set 1D – Danger to People from Breaching Maps
- Map Set 1E – Climate Change Outlines for 2025, 2055, 2085 and 2115
- Map Set 1F – Other sources of Flooding including:
    - Wave Energy
    - Groundwater Flooding
    - Impact of Land Use Change on Surface Water Runoff
    - Overland Flow
    - Historic Incidents of Surface Water Sewer Overload

When allocating a site in line with the Sequential Test, Figure 1 illustrates the decision process, the key questions that need to be answered and details of how the outputs of the SFRA can help inform the process.

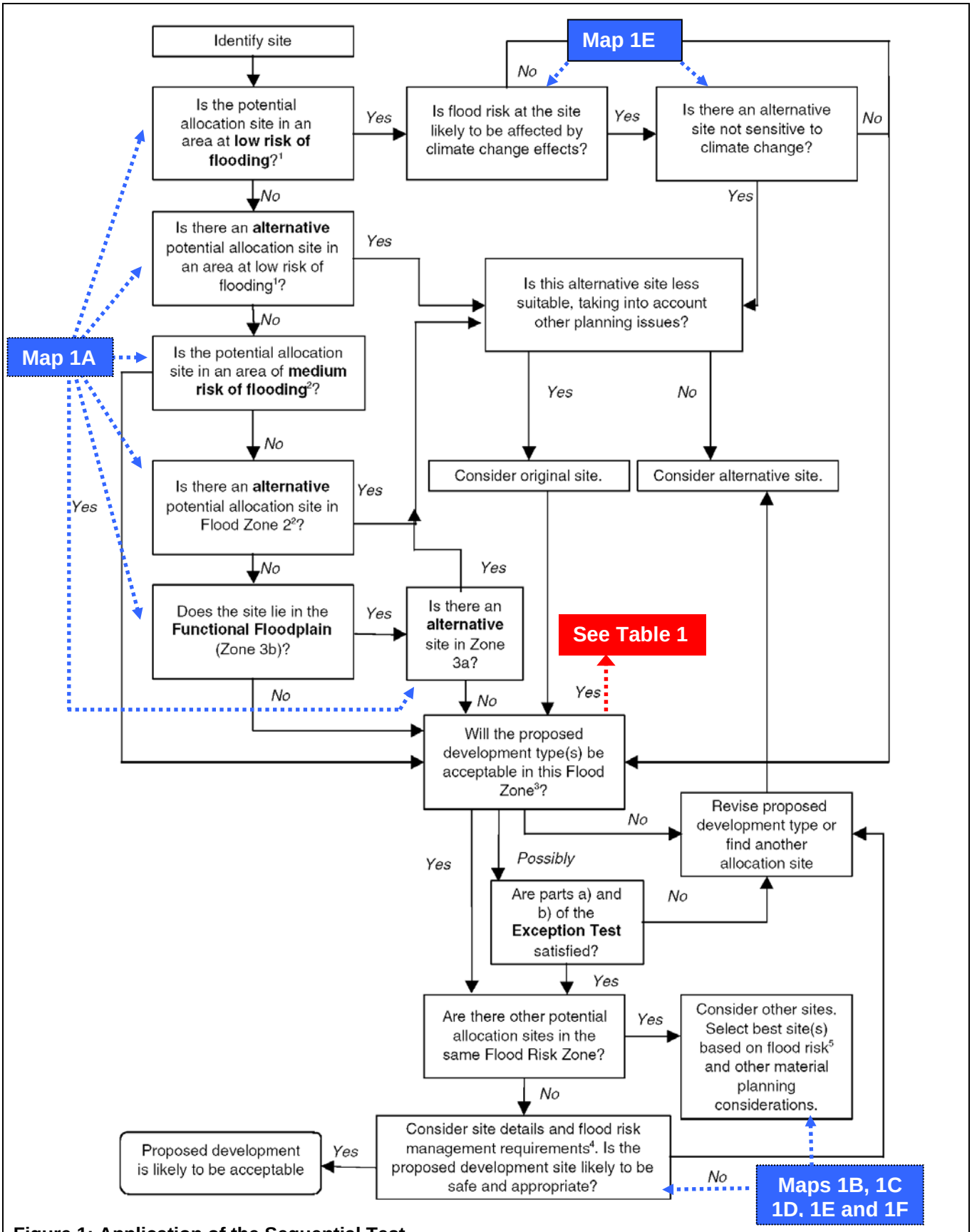


Figure 1: Application of the Sequential Test
Ref: Development and Flood Risk: A Practice Guide Companion to PPS25 'Living Draft'

Notes on Figure 1 Flow Chart

1 Flood Zone 1 for fluvial and tidal flooding and with a low risk of flooding from other sources.
2 Flood Zone 2 for fluvial and tidal flooding and with a medium risk of flooding from other sources.
3 As defined by the Sequential Test.
4 Development to be safe and to not increase flood risk elsewhere. Required to pass part c) of the Exception Test, where applicable.
5 Including susceptibility to future climate change and residual flood risk.

Flood Risk Vulnerability Classification

Where there are no reasonably available sites in Flood Zone 1, Local Authorities should take account of the flood risk vulnerability of land uses when considering the suitability of sites in Flood Zone 2 and then if necessary Flood Zone 3, applying the Exception Test if required. With reference to PPS25, Table 1 provides a summary of the appropriateness of land uses in relation to the Flood Zones.

	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception Test required	✓	✓
Zone 3a	Exception Test required	✓	×	Exception Test required	✓
Zone 3b	Exception Test required	✓	×	×	×

Table 1: Flood Risk Vulnerability and Flood Zone Compatibility (Ref: PPS25)

Key: ✓ Development is appropriate, subject to demonstrating the Sequential Test

× Development should not be permitted.

(*This table does not show: the application of the Sequential Test which guides development to FZ1 first, then FZ2, and then FZ3; FRA requirements; or the policy aims for each Flood Zone.)

If the application of the Sequential Test demonstrates a need to consider allocating sites within Flood Zones 2 or 3, a 'Sequential Approach' should also be applied within each of these Zones to steer new development to areas with the lowest probability and consequences of flooding. To facilitate this approach to site allocations within the Flood Zones, the SFRA Outputs (in particular Map Sets 1B, 1C, 1D and 3A / 3B) will provide useful information on the variation of flood hazard and the level of benefit provided by existing defences.

The findings of the Statistical Analysis undertaken in Stage 1 of this SFRA suggest that Havant Borough Council can achieve their draft South East Plan housing allocation in line with the Sequential Test. However, the need for potential commercial regeneration of the town centre and possible 'windfall' sites may mean that Havant Borough Council will need to consider development within Flood Zones 2 and 3. Where the Sequential Test alone cannot identify acceptable sites for urban regeneration or where windfall sites, having satisfied the Sequential Test, are located in Flood Zones 2 or 3, the Exception Test may need to be applied.

Exception Test

The Exception Test should only be applied following application of the Sequential Test. There are 3 elements of the Exception Test, all of which need to be demonstrated before the test can be passed. The 3 elements are:

a) It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared. If the DPD has reached the 'submission' stage – see Figure 4 of PPS12: Local Development Frameworks – the benefits of the development should contribute to the Core Strategy's Sustainability Appraisal;

b) The development should be on developable previously-developed land or, if it is not on previously-developed land, that there are no reasonable alternative sites on developable previously-developed land; and

c) A FRA must demonstrate that the development will be safe, without increasing flood risk

elsewhere, and, where possible, will reduce flood risk overall.

When developing LDDs, Local Authorities are advised by PPS25 to prepare criteria-based polices in line with their Core Strategy's Sustainability Appraisal, against which item a) of the Exception Test can be tested. This will minimise the need to consider this element of the Exception Test for each individual planning application.

By assisting Local Authorities, at the site allocation level, in steering new development to areas with the lowest probability and hazard of flooding, the use of the SFRA outputs (in particular Map Sets 1B, 1C, 1D and 3A / 3B) will mean that site specific flood risk assessments in these areas will be more likely to satisfy criteria c) of the Exception Test.

SFRA Mapping Outputs

Table 2 summaries the most relevant mapping outputs and their purpose, for each of the key users of the PUSH SFRA.

Key Users	Relevant SFRA Mapping Outputs	Purpose
Forward Planners	**Output Package 1:** PPS25 Sequential Test and Relevant Supporting Information	Output Package 1 provides all the necessary information to help planners apply the Sequential Test and Exception Test when allocating new sites for development. Output Package 1 also allows planners to identify sites with the lowest probability of flooding and lowest flood hazard / danger and how the extent of flooding is likely to change in the future due to climate change.
Flood Risk Managers	**Output Package 1:** PPS25 Sequential Test and Relevant Supporting Information	Output Package 1 helps Flood Risk Managers to identify variations in flood hazards / dangers to existing development. The data also provides mapping to show how the extent of flooding is likely to increase over time due to climate change.
	Output Package 2: Social Vulnerability of and Flood Hazard / Danger to Existing Development	Output Package 2 can help Flood Risk Managers to: o Identify critical areas where social vulnerability and flood hazard / danger are high. o Help inform assessments of the sustainability of existing development. o Help identify and prioritise asset management and improvements.
	Output Package 3: Appropriate Defence Standards and Levels of Investment	Output Package 3 can help Flood Risk Managers to: o Identify shortfalls in existing defences in providing appropriate standards of defence, now and in the future. o Identify indicative levels of investment required to provide the appropriate standards, now and in the future.
Development Control	**Output Package 1:** PPS25 Sequential Test and Relevant Supporting Information	Output Package 1 can help Development Control personnel to: o Prepare specifications for site specific FRAs. o Review site specific FRAs for new development sites and check for compliance with PPS25.
Emergency Planners	**Output Package 1:** PPS25 Sequential Test and Relevant Supporting Information	Output Package 1 can provide emergency planners with information on the variation of flood probability and hazard across the sub region. Such information can aid in the development of emergency plans and evacuation routes during flood events.
	Output Package 2: Social Vulnerability of and Flood Hazard / Danger to Existing Development	Output Package 2 can inform emergency planners of the locations where social vulnerability and flood hazard are highest. Such information can help emergency planners prioritise evacuation plans.

Table 2: The Mapping Output Packages appropriate for key users of the SFRA

Recommendations for Site Specific Flood Risk Assessments

Whilst the information presented in this SFRA will inform Local Authorities and facilitate their strategic allocation of sites for future development, it should not preclude the need for developers to undertake site specific flood risk assessments (FRAs). A SFRA, by its very nature, is a high level assessment of flood risk at the local authority level. It does not provide sufficiently detailed information to satisfy all of the requirements of a site specific FRA as outlined in PPS25.

On the 1st October 2006, the Town and Country Planning (General Development Procedure) (Amendment) (No 2) (England) Order 2006 (GDPO), made the Environment Agency a statutory consultee for planning applications involving flood risk in specified circumstances. To improve the efficiency of disseminating general guidance, the Environment Agency has produced a suite of standing advice. The advice is available to Local Authorities and the Public, via a web page http://www.pipernetworking.com/floodrisk/ . The standing advice also includes guidance on the requirements for site specific FRAs for both low and high risk developments. The web page provides Guidance Notes for 3 types of FRAs and advice on operational development less than 1 hectare in Flood Zone 1 as summarised below:

- Operational Development less than 1 hectare in Flood Zone 1.
- FRA Guidance Note 1: Development Greater than 1 hectare in Flood Zone 1.
- FRA Guidance Note 2: Minor Extensions.
- FRA Guidance Note 3: Development in Flood Zones 2 and 3.

The following sections provide additional specific guidance for assessing flood risk at the site specific level within Havant Borough and indicate how the outputs from the SFRA can inform such assessments.

Tidal Flooding

As previously discussed, flooding from tidal sources is the primary source of flood risk within Havant Borough and the areas at risk are predicted to increase significantly by 2115. Map Set 1A shows the existing areas at risk of tidal flooding and Map Set 1B shows the associated undefended flood hazard. The index of flood hazard represents a gradation of hazard within the Flood Zones based on a combination of the depth of flood water and the velocity of the water (indicative ranges for which have been assumed based on distance from the coastline).

The frontages where existing defences provide the minimum standards required for new development (i.e. 1 in 200 years for tidal flooding), are identified in Map Set 1C by a purple line. Indicative Areas Benefiting from Defences (ABDs) are also shown in Map Set 1C. The Indicative ABDs have been defined as areas where the crest levels of the existing defences are consistently equal to or higher than the present day 1 in 200 year extreme sea level.

If small lengths of defences have crest levels which fall below the 1 in 200 year extreme sea level (even for a short length), the area behind the defence has not been classed as an Indicative ABD. The frontage of Brockhampton is an example of where this study has not been able to define an Indicative ABD due to small lengths of defence where the crest levels fall below the 1 in 200 year extreme sea level. The gaps in the defence level can also be viewed in more detail using Map Set 3A. Further details of methodology and reasoning used to define the Indicative ABDs are described in Section 4.2.1.3 of the main report. It should be noted that other areas may potentially be classified as ABDs if more detailed modelling assessments of the defences, which is beyond the scope of this SFRA, are carried out.

Map Set 1D shows the flood hazard (in terms of danger to people) associated with a hypothetical breach in the defences for the whole of the tidal frontage. The Indicative ABDs shown in Map Set 1C define which of the hazard maps (1B or 1D) is most appropriate for consideration. Map Set 1D is only appropriate for considering present day flood hazards within an ABD. To aid the interpretation of Map Set 1D the areas where this index is not appropriate for present day analysis are hatched out. The benefit of showing hazard information in the hatched out areas is to allow planners and developers to understand the likely residual risks that would remain if they were to invest in defending an area to a 1 in 200 year standard. Map Set 1B (Undefended Flood Hazard) should be used to assess the variation of flood hazard within the Flood Zones for all areas outside the Indicative ABDs.

The benefit of both the undefended flood hazard maps (Map Set 1B) and the danger from breaching maps (Map Set 1D), is that the gradation of flood hazard within the Flood Zones can facilitate both planners and developers to ensure that development is steered away from the areas of highest hazard. The hazard mapping presented in Map Sets 1B and 1D, however, should only be applied when appropriate consideration has been taken of alternative sites at a lower probability of flood risk (i.e. within Flood Zone 1).

The flood hazard information, for both the undefended and breach scenario, developed as part of this SFRA, has been undertaken at a strategic level and is therefore at an appropriate level of detail to allow Local Authorities to strategically allocate sites for development. The hazard data has been classified into 4 categories to illustrate the gradation of flood hazard within Flood Zones 2 and 3 in line with best practice guidance as set out in Defra FD2320. The hazard data has not been calculated using modelling or other detailed numerical methods and is therefore not appropriate for identifying design parameters as part of site specific FRAs. It is therefore recommended that FRAs for sites located within the flood hazard zones should still include a quantitative assessment of flood hazard based on more detailed assessments of defence standards, defence failure scenarios and overland conveyance of flood flow.

The impact of climate change on increasing sea levels has a significant effect on the extents of Flood Zones 2 and 3 by 2115, especially on Hayling Island. Although present day planning decisions are based on the Flood Zones for 2007, at the site specific level consideration should be given to increases in risk as a result of climate change. The climate change flood extents presented in Map Set 1E should be used when undertaking a site specific FRA to inform the assessment of the long term sustainability of developments currently within Flood Zone 1 and the likely increases in flood risk in Flood Zones 2 and 3.

The defence information provided in Map Set 3 can provide developers undertaking site specific FRAs with an indication of the equivalent tidal return period of the crest level of the existing defences in 2007 and an indicative level of investment that may be required to raise defence standards to the minimum required for new development. Such investment could be secured through the development process by Section 106 agreements.

Wave Overtopping

Map Set 1F-1, Wave Energy, shows how exposure to wave energy varies along the frontage of the study area. Such information can be used to assess, at a high level, the risk of flooding caused by extreme wave overtopping. Historically, Hayling Island has suffered from flooding caused by extreme waver overtopping, most recently in November 2005. During this event, properties which are classified in Flood Zone 1 were flooded, as indicated on the historical information layer. It is recommended that all applications for development within the vicinity of the southern frontage of Hayling Island include an assessment of extreme wave overtopping, regardless of which Flood Zone the site is in. This will ensure that this risk is always considered for new development in the relevant locations. The assessment of extreme wave overtopping should be appropriate to the scale of risk and may, in some cases, be ruled out as a significant risk quite easily, but should nevertheless be addressed.

Fluvial Flooding

The mainland part of Havant Borough is at risk of fluvial flooding from the Lavant Stream, Hermitage Stream and, during extreme events (1 in 1000 years), the upper reaches of the River Wallington. Map Set 1A shows the fluvial Flood Zones, which show the town centre of Havant to be the key area at risk of fluvial flooding in the Borough.

Across Havant Borough, gaps in available fluvial flood risk data exist, which are being addressed by the Environment Agency's ongoing Strategic Flood Risk Mapping programme. Therefore, for the purposes of this SFRA, Flood Zone 3b (defined by PPS25 as the 'functional floodplain') has been defined as the entire extent of Flood Zone 3, as recommended by the PPS25 Draft Practice Guide. This is a precautionary approach and should be tested by site specific FRAs, where required.

Unlike the tidal Flood Zones, flood levels associated with the fluvial Flood Zones have not been identified as part of this SFRA. The variations in previous modelling approaches (some of which are awaiting EA approval) for the rivers within the PUSH sub-region, coupled with the spatial variation on flood levels along the river valleys, meant that it was not possible to provide a consistent approach to identifying fluvial flood levels without re-

modelling a number of rivers. Such detailed assessments were outside the scope of this SFRA. Developers undertaking a FRA for a site within the fluvial Flood Zones should obtain the most up to date flood risk data from the Environment Agency. If no further information is available then a site specific FRA may need to include a numerical assessment to refine the understanding of fluvial flood risk, and agree the form of this assessment with the Environment Agency.

The impacts of climate change on fluvial flooding are likely to result in a 10% increase in flows up to 2025 and 20% from 2025 to 2115. Again due to current gaps in available data that are being addressed by the Environment Agency's ongoing flood mapping programme, there are no consistent estimates for Havant Borough of the extreme fluvial flood extent taking climate change into account. Based on Environment Agency guidance, this SFRA has assumed that the present day Flood Zone 2 (medium probability) becomes Flood Zone 3 (high probability) by 2025. This is a conservative assumption which should be tested by site specific FRAs, where required. This also means that there is no data available to estimate Flood Zone 2 after the present day. Therefore, the fluvial climate change outline shown in Map Set 1E only shows a Flood Zone 3.

Undefended flood hazard information, shown in Map Set 1B, has also been developed for the fluvial Flood Zones 2 and 3. This information can provide developers with an indication of the varying degree of flood hazard within the Flood Zones which can facilitate the design and layout of development sites to avoid areas of high hazard. As with the tidal flood hazard data, it is recommended that FRAs for sites located within the flood hazard zones undertake a more detailed quantitative assessment of flood hazard based on an improved understanding of defences and flow routes.

Surface Water/Overland Flow Flooding

Map Set 1F-4 shows the variation in the potential source of overland flow across the PUSH sub-region. The areas shown in red and orange relate to areas of very high and high potential for generating overland flow. Notably, the urban areas are indicated as red or orange due to the high runoff potential from urban land uses. Within Havant Borough there is a large area of the mainland which has a high to very high potential for generating overland flow. FRAs for sites that are found to be within or in the vicinity of these areas, especially if the local topography places the site at a lower elevation than the surrounding land and hence downstream of the source, should consider the impacts and management of flooding due to overland flow.

In addition to the information provided in relation to the source of overland flow flooding, Map Set 1F-3 provides information to inform Local Authorities of the potential impacts of land use changes on the local surface water runoff regime. The areas showing diagonal hatching represent the urban areas, where a change in land use is unlikely to significantly affect the existing surface water runoff rates and volumes. This representation is a high level assessment across the PUSH sub-region and would therefore need to be confirmed when undertaking a site specific FRA. The areas outside of the hatching represent the effect that changes in land use are likely to have on the surface runoff rates and volumes from Greenfield sites. The data shows that new development located on the majority of the Greenfield Land in Havant Borough is likely to have a moderate impact on the surface water runoff regime. Site specific FRAs should therefore carefully consider the impact of development on the local surface water runoff regime and should investigate SUDS options to manage surface water where achievable.

Groundwater Flooding

Within the PUSH region the key areas at risk of groundwater flooding are north of Havant Borough in East Hampshire, Winchester, Eastleigh and Test Valley where highly permeable geology meets lower permeability geology as shown by Map Set 1F-2, which has been verified by inspection of the historical incident records. The key risks to new development in the Havant Borough come from increases in flows in the Lavant Stream as a result of high groundwater levels emerging in East Hampshire District. It is therefore recommended that site specific FRAs for sites located within the Flood Zone of the upper reaches of the Lavant Stream consider the joint effects of high groundwater flows in the Lavant Stream combined with rapid runoff from intense rainfall events.

Flooding from Infrastructure

Historically, the mainland part of Havant Borough has recorded the most incidents of flooding caused by problems relating to the drainage infrastructure as shown by Map Set 1F-5. The majority of these incidents have occurred in the vicinity of Havant Town Centre, Purbrook, Cowplain and Emsworth. When undertaking a site specific FRA for a large development site, consultation with Southern Water should always be undertaken to investigate whether the proposed development will have an adverse impact on the local drainage system.

Furthermore, a parallel study being undertaken on behalf of PUSH, 'Hampshire Integrated Water Management Study', is investigating the issues relating to the future management of surface water within the region with respect to the anticipated increases in housing as indicated in the draft South East Plan. It is recommended that those undertaking a site specific FRA within the urban areas of Havant Borough make reference to the findings of this study.

Sustainable Urban Drainage Systems (SUDS)

Conventional surface water drainage systems have traditionally used underground pipe networks to efficiently convey water away from sites. In the past this has led to problems of downstream flooding, reductions in groundwater recharge and waste pollution incidents associated with surface water overwhelming combined sewers. Both '*Making Space for Water*' and the '*Water Framework Directive*' have highlighted the need for an improved understanding and better management of how our urban environments are drained. The SUDS management train approach, as shown in Figure 2, is the principle that a range of SUDS which feed into each other can often offer benefits to the delivery of a successful surface water system/strategy.

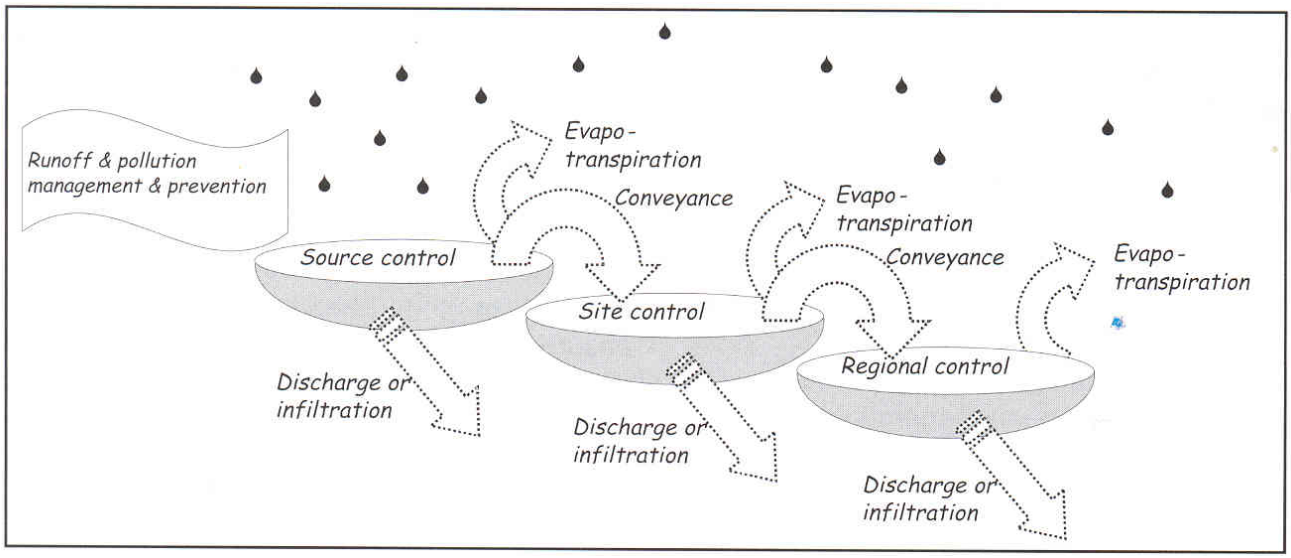


Figure 2: SUDS Management Train Approach

PPS25 states that Local Authorities should prepare and implement planning strategies that help to deliver sustainable development, by using opportunities offered by new development to reduce the causes and impacts of surface water flooding. By implementing polices to encourage developers to incorporate SUDS wherever possible, Local Authorities can help to mitigate the impacts that development has on surface water runoff rates and volumes. Appendix F of PPS25 states:

'the surface water drainage arrangements for any development site should be such that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates/volumes prior to the proposed development, unless specific off-site arrangements are made and result in the same net affect.'

Map set 1F-2 provides information relating to the spatial variation of permeability across Havant Borough. This information can be used as a first estimate of the suitability of different types of SUDS within the Borough as shown in Table 3.

Permeability	Indicative Suitability of SUDS Techniques
High Permeability	Infiltration and Combined Systems
Moderate Permeability	Infiltration and Combined Systems
Low Permeability	Attenuation Systems

Table 3: Suitability of SUDS

It is important to note that the above assessment of the spatial suitability of SUDS is an indicative estimate and should be confirmed at the site specific level, using ground investigation data.

Infiltration Systems

Infiltration systems allow surface water to discharge directly into the ground. These systems are only appropriate 1) where ground conditions permit a suitable water acceptance potential and 2) in locations where groundwater recharge will not adversely affect drinking water aquifers as identified by the Environment Agency's source protection zones, available on their website http://www.environment-agency.gov.uk. Such systems may include:

- Permeable surfaces
  - Gravel
  - Permeable Paving
  - Block Paving with voids
  - Grassed areas
- Sub Surface Infiltration
  - Filter Drains
  - Geocellular Systems
  - Soakaways

Infiltration systems may not be appropriate in areas of potentially contaminated land. In such circumstances, other systems, such as contained attenuation systems, that avoid mobilisation of contaminants may be more appropriate.

Attenuation Systems

If ground conditions cannot support infiltration systems, surface water may need to be attenuated using measures to store surface water. Attenuation systems, if designed above ground, have the potential to take up large areas of development sites. Early consideration of such constraints is therefore essential. Attenuation systems may include:

- Landscaped
  - Detention Basins
  - Balancing Ponds
  - Retention Ponds
  - Wetlands
  - Lagoons
- Engineered
  - Underground Tanks
  - Ornate Water Features
  - Rainwater Harvesting
  - Green Roofs
  - Oversized Pipes

Combined Systems

SUDS designs for most sites can include a combination of infiltration and attenuation systems and they have

been categorised above according to the dominant process. Other forms of SUDS which can provide more balanced benefits of infiltration and attenuation include:

- Swales
- Filter Strips

Emergency Planning

As well as informing the development control process, the outputs of the SFRA can also be used by the Local Authority to inform their Emergency Planning Polices. Map Sets 1A, 1B, 1C, 1D and 1E are particularly useful when considering the feasibility and sustainability of key access routes within their administrative boundaries. The benefit of producing such outputs on a sub-regional scale mean that the Local Authority can also consider access to the Borough beyond their administrative boundary where key access routes (e.g. M27) cross a number of Local Authorities.

Additional Guidance

In addition to the guidance provided by the Environment Agency http://www.pipernetworking.com/floodrisk/, there are a number of other documents that provide detailed advice and guidance for undertaking site specific FRAs:

- Planning Policy Statement 25: Development and Flood Risk, (2006), Communities and Local Government.
- Development and Flood Risk: A Practice Guide Companion to PPS25 - 'Living Draft', (2007), Communities and Local Government
- Development and Flood Risk: Guidance for the Construction Industry, (2004), CIRIA (Based on PPG25)
- Flood Risk Assessment Guidance for New Development: FD2320/TR2, (2005), Defra (Based on PPG25)
- Sustainable Urban Drainage Systems: Best Practice Manual, (2001), CIRIA

Annex 1 – Data Source for Havant Borough Council

Further to the general technical details provided in the main SFRA Stage 2 report, this annex includes data issues specific to Havant Borough Council.

Defence Data

The majority of Havant Borough Council defence data in is provided by the Havant Asset Database which holds details of most of the Borough's coastal defences from recent surveys. Surveys recorded in the database were undertaken between 2002 and 2003. The defence database for Havant was supplemented with data from the Eastoke Sectoral Strategy Study (2005) and Portchester Castle to Emsworth Coastal Defence Strategy Study (2006). Coastal defence works in other parts of Havant's coastline undertaken since 2003 may supersede records in the SFRA Defence Database.

No information on fluvial defences in Havant was available.

Topographic Data

95% of the topographic grid in Havant Borough is composed of LiDAR data. Areas where LiDAR was not available are the northern slope of Portsdown Hill to the west of Bedhampton and to the north of the Borough between Lovedean and Cowplain. In these areas, NextMap data was used to fill in the gaps in the LiDAR.

Fluvial Flood Zone 3b

In Havant Borough, fluvial Flood Zone 3b was represented as the whole of Flood Zone 3. In the absence of data to prove otherwise (i.e. detailed 1 in 20 year modelling or observed historic flood extents), this approach is in accordance with PPS25 practice guide section 3.17 and was recommended by the Environment Agency.

Fluvial Climate Change Outlines

In Havant Borough, the fluvial outlines after the present day were represented by assuming that Flood Zone 3 will expand to fill the current area of Flood Zone 2. This means there is no estimate of fluvial Flood Zone 2 after the present day for the Borough. This approach was recommended by the Environment Agency.

Guidance Document: Havant Borough Council

Flood Risk Overview

Sources of Flood Risk

Havant is the eastern-most Local Authority in the PUSH sub-region. It covers a total area of approximately 55 km² which is split between the mainland and Hayling Island. The council has approximately 56 km of coastal frontage (including 42 km around Hayling Island) and 32 km of main river. At present, approximately 22% of the Borough's land area is designated as within Flood Zones 2 and 3a/3b (see SFRA Map Set 1A).

The SFRA has shown that the primary source of flood risk to Havant is from the sea. The key parts of the Borough which are currently at risk of flooding from the extreme tides include Brockhampton, Langstone and Emsworth on the mainland and Eastoke, Selsmore and Mengham on Hayling Island. Flooding due to wave overtopping is known to occur on Hayling Island, particularly along the southern frontage. Land behind this frontage has suffered significant flooding from wave overtopping even though the land is relatively high and is shown to lie within Flood Zone 1, i.e. the zone of low probability of tidal flooding.

The secondary source of flood risk to Havant Borough is from fluvial sources including the Lavant Stream, the Hermitage Stream and associated tributaries. These watercourses flow through the town centre of Havant and discharge into Langstone Harbour. Additionally, the upper reaches of the Wallington River rise near Waterlooville in Havant Borough. The key parts of the Borough which are currently at risk of fluvial flooding include Havant town centre, Leigh Park, West Leigh and Stockheath.

Historically, Havant has also been susceptible to flooding from other sources including; groundwater, surface water and flooding caused by infrastructure failure. A number of previous groundwater flooding incidents have been observed in the upper parts of the Lavant Stream between Rowlands Castle and Havant in the north of the Borough. The town of Havant has a drainage system which in many places dates back to before the mid-1960s. As such, flooding from surface water drainage systems and sewers has occurred at many locations, including along The Florins, Petersfield Road, Park Lane and Hulbert Road.

Key physical characteristics that may constrain development

Approximately 58% of Havant Borough is currently covered by existing development, suggesting that much future development will need to be concentrated on brownfield sites. A number of environmentally designated areas represent a significant constraint on development in the Borough, covering approximately 24% of its area. As such there may be only limited Greenfield land upon which development can be permitted following consideration of other planning constraints.

The topography of Havant Borough ranges from sea level to approximately 80 metres above ordnance datum (mAOD). Hayling Island is entirely below approximately 9 mAOD. Further development on the island will likely increase the pressure for further maintenance and improvement to existing flood defences, particularly following predicted rises in sea level in future. The town of Havant itself varies in elevation from 5 mAOD near the coast to 40 mAOD in Leigh Park and West Leigh. The majority of the existing development on the mainland in Havant Borough will therefore not face increasing flood risk due to sea level rise. Waterlooville is situated between 30-50 mAOD while elevations in the Purbrook area rise to approximately 65 mAOD on the approach to Portsdown Hill.

Geologically, Havant Borough is underlain by a mix of low, moderate and highly permeable bedrock formations. The towns of Havant and Waterlooville and the southern part of Hayling Island are underlain by low and moderately permeable bedrock formations, while a highly permeable chalk layer exists between these two areas, resulting in the many springs used by Portsmouth Water. However, moderately permeable superficial deposits overlie the majority of this permeable layer, reducing its permeability in terms of surface water runoff generation. This may make the implementation of Sustainable Urban Drainage Systems (SUDS) difficult, which is of particular importance in the Cowplain and Waterlooville area where deep clay strata result in a lack of positive drainage and more frequent small surface water flooding incidents.

The existing drainage systems in Havant are known to be at or below capacity in key areas and it may therefore be difficult to provide new development in parts of the town without significant investment in drainage infrastructure.

Vulnerability to Climate Change

The SFRA has generated predicted tidal outlines for a number of years up to 2115 (see SFRA Map Set 1E). These outlines account for the most up-to-date predicted rises in sea-level over the coming century due to climate change and therefore allow the identification of locations that will be most vulnerable to this change due to their local topography. In Havant Borough, Hayling Island is the most sensitive area to sea level rise, particularly the southern half of the island. With much of the island low-lying, predicted sea-level rise could result in extreme tidal events inundating more of the island. In addition to this effect of rising sea levels, it is anticipated that climate change will result in an increase in fluvial flood flows. This may put additional pressure on areas in the town of Havant adjacent to the streams.

Vulnerability of existing communities

In general, the wards of Havant Borough have a mix of average and high social vulnerability to flooding (see SFRA Map Set 2). However, within Flood Zones 2 and 3 (i.e. those areas potentially likely to experience flooding) the wards generally have a high social vulnerability to flooding on the mainland and average social vulnerability to flooding on Hayling Island. It is likely that future investment in flood defences measures will need to strike a balance between protecting high risk areas on Hayling Island and areas of high social vulnerability on the mainland.

Existing defence assets and likely future investment

The coastal frontages of Havant Borough are almost entirely defended from either wave overtopping or tidal flooding by some form of coastal defence. Approximately half the coastal defences in Havant Borough have a crest level which is higher than a present day 1 in 200 year tide. Areas where defences are below the minimum standard of protection required for new development are the north western coast of Hayling Island south of Northney, the Chichester harbour frontage at Emsworth and the frontage at Langstone. The coastal defences in Havant Borough are, however, likely to be susceptible to climate change, as 100 years of predicted sea level rise would mean that most man-made defences at their current level would fail to offer protection from a 1 in 20 year tidal flood, with the exception of the southern frontage of Hayling Island. To sustain future development in Havant Borough, particularly on Hayling Island, significant investment in flood defences and flood defence infrastructure will be required (see SFRA Map Set 3). In order to consider the sustainability of investing in improved defences, the 'danger to people from breaching' index (SFRA Map Set 1D) will provide indications as to where the residual risk due to breaching may remain unfavourably high following improvements to defences to protect from extreme tidal floods.

Sequential and Exception Test

Planning Policy Statement 25 (PPS25) sets out the Government's objectives for achieving sustainable development through the avoidance and management of flood risk. The aim of PPS25 is to ensure that flood risk is taken into account at all stages of the planning process to avoid inappropriate development in areas of flood risk. To achieve this aim, PPS25 provides a decision making tool to ensure that sites with a low probability of flooding are developed in preference to areas at higher risk. The Sequential Test is the decision process which Local Authorities must demonstrate when developing their Local Development Frameworks and Local Development Documents. This SFRA has developed a suite of mapping outputs to assist Local Authorities in applying the Sequential Test.

When applying the Sequential Test, Output Package 1 of the SFRA will provide all the necessary information required upon which to base decisions regarding the location of future development in relation to flood risk. Within Output Package 1, the key map required for applying the Sequential Test is the Flood Zones map, shown as Map Set 1A. This map shows the spatial extent of 3 of the 4 Flood Zones identified in PPS25, these include:

Map Set 1A

- **Flood Zone 2** – Medium Probability of Flooding



Fluvial (river) and Tidal Flooding

- **Flood Zone 3a** – High Probability of Flooding, sub-divided into:



Fluvial Flooding
Tidal Flooding
Tidal / Fluvial (combined flooding processes where known)

- **Flood Zone 3b** – Functional Floodplain



Fluvial Flooding only

The area outside of these zones is considered to be the fourth zone, 'Flood Zone 1' which has a low probability of flooding.

Output Package 1 also contains 5 other Map sets which provide useful information to support Local Authorities when applying the Sequential Test, these include:

- Map Set 1B – Undefended Flood Hazard Maps (Zones 2 & 3)
- Map Set 1C – Indicative Areas Benefiting From Defences
- Map Set 1D – Danger to People from Breaching Maps
- Map Set 1E – Climate Change Outlines for 2025, 2055, 2085 and 2115
- Map Set 1F – Other sources of Flooding including:
    - Wave Energy
    - Groundwater Flooding
    - Impact of Land Use Change on Surface Water Runoff
    - Overland Flow
    - Historic Incidents of Surface Water Sewer Overload

When allocating a site in line with the Sequential Test, Figure 1 illustrates the decision process, the key questions that need to be answered and details of how the outputs of the SFRA can help inform the process.

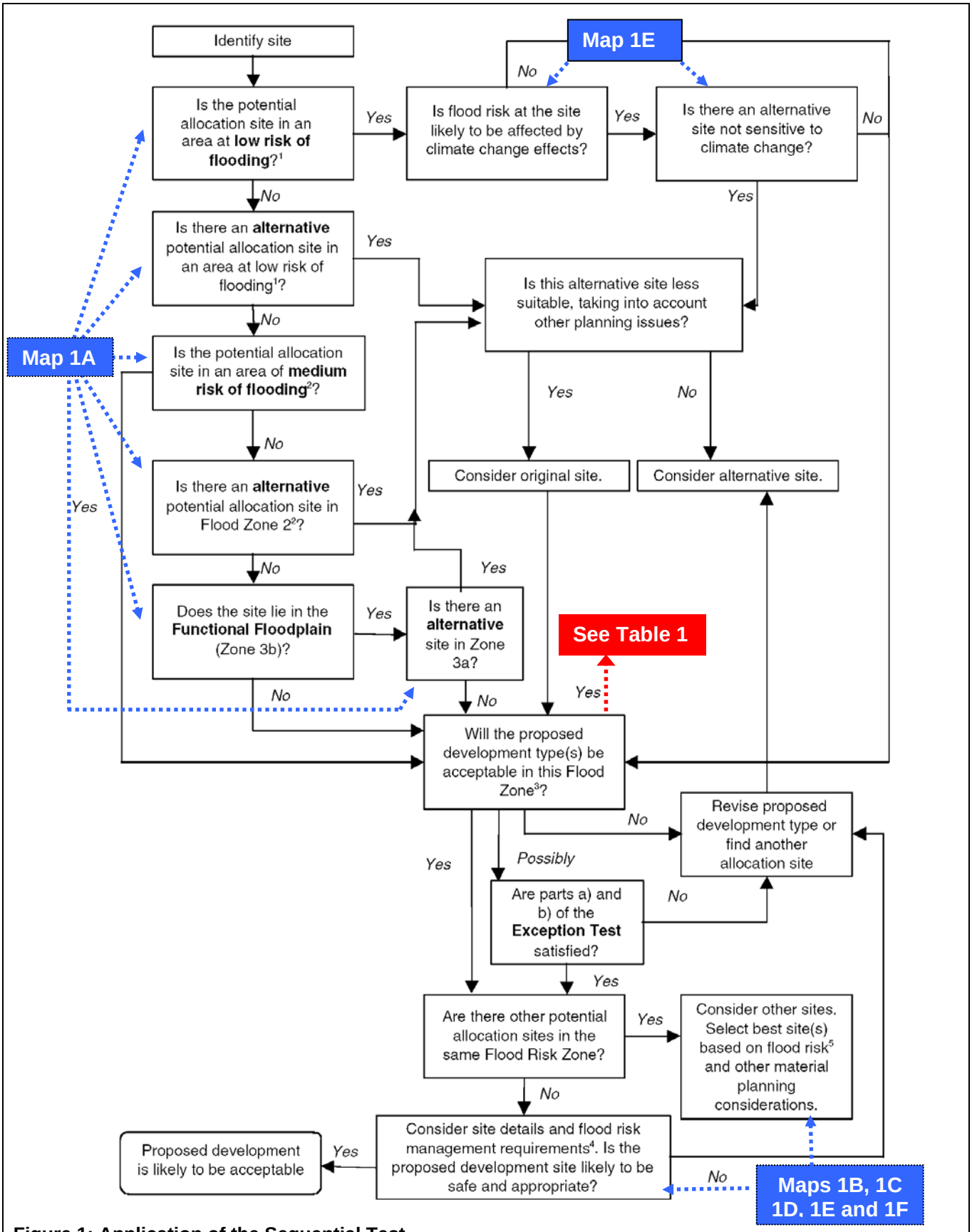


Figure 1: Application of the Sequential Test
Ref: Development and Flood Risk: A Practice Guide Companion to PPS25 'Living Draft'

Notes on Figure 1 Flow Chart

1 Flood Zone 1 for fluvial and tidal flooding and with a low risk of flooding from other sources.
2 Flood Zone 2 for fluvial and tidal flooding and with a medium risk of flooding from other sources.
3 As defined by the Sequential Test.
4 Development to be safe and to not increase flood risk elsewhere. Required to pass part c) of the Exception Test, where applicable.
5 Including susceptibility to future climate change and residual flood risk.

Flood Risk Vulnerability Classification

Where there are no reasonably available sites in Flood Zone 1, Local Authorities should take account of the flood risk vulnerability of land uses when considering the suitability of sites in Flood Zone 2 and then if necessary Flood Zone 3, applying the Exception Test if required. With reference to PPS25, Table 1 provides a summary of the appropriateness of land uses in relation to the Flood Zones.

	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception Test required	✓	✓
Zone 3a	Exception Test required	✓	×	Exception Test required	✓
Zone 3b	Exception Test required	✓	×	×	×

Table 1: Flood Risk Vulnerability and Flood Zone Compatibility (Ref: PPS25)

Key: ✓ Development is appropriate, subject to demonstrating the Sequential Test

× Development should not be permitted.

(*This table does not show: the application of the Sequential Test which guides development to FZ1 first, then FZ2, and then FZ3; FRA requirements; or the policy aims for each Flood Zone.)

If the application of the Sequential Test demonstrates a need to consider allocating sites within Flood Zones 2 or 3, a 'Sequential Approach' should also be applied within each of these Zones to steer new development to areas with the lowest probability and consequences of flooding. To facilitate this approach to site allocations within the Flood Zones, the SFRA Outputs (in particular Map Sets 1B, 1C, 1D and 3A / 3B) will provide useful information on the variation of flood hazard and the level of benefit provided by existing defences.

The findings of the Statistical Analysis undertaken in Stage 1 of this SFRA suggest that Havant Borough Council can achieve their draft South East Plan housing allocation in line with the Sequential Test. However, the need for potential commercial regeneration of the town centre and possible 'windfall' sites may mean that Havant Borough Council will need to consider development within Flood Zones 2 and 3. Where the Sequential Test alone cannot identify acceptable sites for urban regeneration or where windfall sites, having satisfied the Sequential Test, are located in Flood Zones 2 or 3, the Exception Test may need to be applied.

Exception Test

The Exception Test should only be applied following application of the Sequential Test. There are 3 elements of the Exception Test, all of which need to be demonstrated before the test can be passed. The 3 elements are:

a) It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared. If the DPD has reached the 'submission' stage – see Figure 4 of PPS12: Local Development Frameworks – the benefits of the development should contribute to the Core Strategy's Sustainability Appraisal;

b) The development should be on developable previously-developed land or, if it is not on previously-developed land, that there are no reasonable alternative sites on developable previously-developed land; and

c) A FRA must demonstrate that the development will be safe, without increasing flood risk

elsewhere, and, where possible, will reduce flood risk overall.

When developing LDDs, Local Authorities are advised by PPS25 to prepare criteria-based polices in line with their Core Strategy's Sustainability Appraisal, against which item a) of the Exception Test can be tested. This will minimise the need to consider this element of the Exception Test for each individual planning application.

By assisting Local Authorities, at the site allocation level, in steering new development to areas with the lowest probability and hazard of flooding, the use of the SFRA outputs (in particular Map Sets 1B, 1C, 1D and 3A / 3B) will mean that site specific flood risk assessments in these areas will be more likely to satisfy criteria c) of the Exception Test.

SFRA Mapping Outputs

Table 2 summaries the most relevant mapping outputs and their purpose, for each of the key users of the PUSH SFRA.

Key Users	Relevant SFRA Mapping Outputs	Purpose
Forward Planners	**Output Package 1:** PPS25 Sequential Test and Relevant Supporting Information	Output Package 1 provides all the necessary information to help planners apply the Sequential Test and Exception Test when allocating new sites for development. Output Package 1 also allows planners to identify sites with the lowest probability of flooding and lowest flood hazard / danger and how the extent of flooding is likely to change in the future due to climate change.
Flood Risk Managers	**Output Package 1:** PPS25 Sequential Test and Relevant Supporting Information	Output Package 1 helps Flood Risk Managers to identify variations in flood hazards / dangers to existing development. The data also provides mapping to show how the extent of flooding is likely to increase over time due to climate change.
	Output Package 2: Social Vulnerability of and Flood Hazard / Danger to Existing Development	Output Package 2 can help Flood Risk Managers to: o Identify critical areas where social vulnerability and flood hazard / danger are high. o Help inform assessments of the sustainability of existing development. o Help identify and prioritise asset management and improvements.
	Output Package 3: Appropriate Defence Standards and Levels of Investment	Output Package 3 can help Flood Risk Managers to: o Identify shortfalls in existing defences in providing appropriate standards of defence, now and in the future. o Identify indicative levels of investment required to provide the appropriate standards, now and in the future.
Development Control	**Output Package 1:** PPS25 Sequential Test and Relevant Supporting Information	Output Package 1 can help Development Control personnel to: o Prepare specifications for site specific FRAs. o Review site specific FRAs for new development sites and check for compliance with PPS25.
Emergency Planners	**Output Package 1:** PPS25 Sequential Test and Relevant Supporting Information	Output Package 1 can provide emergency planners with information on the variation of flood probability and hazard across the sub region. Such information can aid in the development of emergency plans and evacuation routes during flood events.
	Output Package 2: Social Vulnerability of and Flood Hazard / Danger to Existing Development	Output Package 2 can inform emergency planners of the locations where social vulnerability and flood hazard are highest. Such information can help emergency planners prioritise evacuation plans.

Table 2: The Mapping Output Packages appropriate for key users of the SFRA

Recommendations for Site Specific Flood Risk Assessments

Whilst the information presented in this SFRA will inform Local Authorities and facilitate their strategic allocation of sites for future development, it should not preclude the need for developers to undertake site specific flood risk assessments (FRAs). A SFRA, by its very nature, is a high level assessment of flood risk at the local authority level. It does not provide sufficiently detailed information to satisfy all of the requirements of a site specific FRA as outlined in PPS25.

On the 1st October 2006, the Town and Country Planning (General Development Procedure) (Amendment) (No 2) (England) Order 2006 (GDPO), made the Environment Agency a statutory consultee for planning applications involving flood risk in specified circumstances. To improve the efficiency of disseminating general guidance, the Environment Agency has produced a suite of standing advice. The advice is available to Local Authorities and the Public, via a web page http://www.pipernetworking.com/floodrisk/ . The standing advice also includes guidance on the requirements for site specific FRAs for both low and high risk developments. The web page provides Guidance Notes for 3 types of FRAs and advice on operational development less than 1 hectare in Flood Zone 1 as summarised below:

- Operational Development less than 1 hectare in Flood Zone 1.
- FRA Guidance Note 1: Development Greater than 1 hectare in Flood Zone 1.
- FRA Guidance Note 2: Minor Extensions.
- FRA Guidance Note 3: Development in Flood Zones 2 and 3.

The following sections provide additional specific guidance for assessing flood risk at the site specific level within Havant Borough and indicate how the outputs from the SFRA can inform such assessments.

Tidal Flooding

As previously discussed, flooding from tidal sources is the primary source of flood risk within Havant Borough and the areas at risk are predicted to increase significantly by 2115. Map Set 1A shows the existing areas at risk of tidal flooding and Map Set 1B shows the associated undefended flood hazard. The index of flood hazard represents a gradation of hazard within the Flood Zones based on a combination of the depth of flood water and the velocity of the water (indicative ranges for which have been assumed based on distance from the coastline).

The frontages where existing defences provide the minimum standards required for new development (i.e. 1 in 200 years for tidal flooding), are identified in Map Set 1C by a purple line. Indicative Areas Benefiting from Defences (ABDs) are also shown in Map Set 1C. The Indicative ABDs have been defined as areas where the crest levels of the existing defences are consistently equal to or higher than the present day 1 in 200 year extreme sea level.

If small lengths of defences have crest levels which fall below the 1 in 200 year extreme sea level (even for a short length), the area behind the defence has not been classed as an Indicative ABD. The frontage of Brockhampton is an example of where this study has not been able to define an Indicative ABD due to small lengths of defence where the crest levels fall below the 1 in 200 year extreme sea level. The gaps in the defence level can also be viewed in more detail using Map Set 3A. Further details of methodology and reasoning used to define the Indicative ABDs are described in Section 4.2.1.3 of the main report. It should be noted that other areas may potentially be classified as ABDs if more detailed modelling assessments of the defences, which is beyond the scope of this SFRA, are carried out.

Map Set 1D shows the flood hazard (in terms of danger to people) associated with a hypothetical breach in the defences for the whole of the tidal frontage. The Indicative ABDs shown in Map Set 1C define which of the hazard maps (1B or 1D) is most appropriate for consideration. Map Set 1D is only appropriate for considering present day flood hazards within an ABD. To aid the interpretation of Map Set 1D the areas where this index is not appropriate for present day analysis are hatched out. The benefit of showing hazard information in the hatched out areas is to allow planners and developers to understand the likely residual risks that would remain if they were to invest in defending an area to a 1 in 200 year standard. Map Set 1B (Undefended Flood Hazard) should be used to assess the variation of flood hazard within the Flood Zones for all areas outside the Indicative ABDs.

The benefit of both the undefended flood hazard maps (Map Set 1B) and the danger from breaching maps (Map Set 1D), is that the gradation of flood hazard within the Flood Zones can facilitate both planners and developers to ensure that development is steered away from the areas of highest hazard. The hazard mapping presented in Map Sets 1B and 1D, however, should only be applied when appropriate consideration has been taken of alternative sites at a lower probability of flood risk (i.e. within Flood Zone 1).

The flood hazard information, for both the undefended and breach scenario, developed as part of this SFRA, has been undertaken at a strategic level and is therefore at an appropriate level of detail to allow Local Authorities to strategically allocate sites for development. The hazard data has been classified into 4 categories to illustrate the gradation of flood hazard within Flood Zones 2 and 3 in line with best practice guidance as set out in Defra FD2320. The hazard data has not been calculated using modelling or other detailed numerical methods and is therefore not appropriate for identifying design parameters as part of site specific FRAs. It is therefore recommended that FRAs for sites located within the flood hazard zones should still include a quantitative assessment of flood hazard based on more detailed assessments of defence standards, defence failure scenarios and overland conveyance of flood flow.

The impact of climate change on increasing sea levels has a significant effect on the extents of Flood Zones 2 and 3 by 2115, especially on Hayling Island. Although present day planning decisions are based on the Flood Zones for 2007, at the site specific level consideration should be given to increases in risk as a result of climate change. The climate change flood extents presented in Map Set 1E should be used when undertaking a site specific FRA to inform the assessment of the long term sustainability of developments currently within Flood Zone 1 and the likely increases in flood risk in Flood Zones 2 and 3.

The defence information provided in Map Set 3 can provide developers undertaking site specific FRAs with an indication of the equivalent tidal return period of the crest level of the existing defences in 2007 and an indicative level of investment that may be required to raise defence standards to the minimum required for new development. Such investment could be secured through the development process by Section 106 agreements.

Wave Overtopping

Map Set 1F-1, Wave Energy, shows how exposure to wave energy varies along the frontage of the study area. Such information can be used to assess, at a high level, the risk of flooding caused by extreme wave overtopping. Historically, Hayling Island has suffered from flooding caused by extreme waver overtopping, most recently in November 2005. During this event, properties which are classified in Flood Zone 1 were flooded, as indicated on the historical information layer. It is recommended that all applications for development within the vicinity of the southern frontage of Hayling Island include an assessment of extreme wave overtopping, regardless of which Flood Zone the site is in. This will ensure that this risk is always considered for new development in the relevant locations. The assessment of extreme wave overtopping should be appropriate to the scale of risk and may, in some cases, be ruled out as a significant risk quite easily, but should nevertheless be addressed.

Fluvial Flooding

The mainland part of Havant Borough is at risk of fluvial flooding from the Lavant Stream, Hermitage Stream and, during extreme events (1 in 1000 years), the upper reaches of the River Wallington. Map Set 1A shows the fluvial Flood Zones, which show the town centre of Havant to be the key area at risk of fluvial flooding in the Borough.

Across Havant Borough, gaps in available fluvial flood risk data exist, which are being addressed by the Environment Agency's ongoing Strategic Flood Risk Mapping programme. Therefore, for the purposes of this SFRA, Flood Zone 3b (defined by PPS25 as the 'functional floodplain') has been defined as the entire extent of Flood Zone 3, as recommended by the PPS25 Draft Practice Guide. This is a precautionary approach and should be tested by site specific FRAs, where required.

Unlike the tidal Flood Zones, flood levels associated with the fluvial Flood Zones have not been identified as part of this SFRA. The variations in previous modelling approaches (some of which are awaiting EA approval) for the rivers within the PUSH sub-region, coupled with the spatial variation on flood levels along the river valleys, meant that it was not possible to provide a consistent approach to identifying fluvial flood levels without re-

modelling a number of rivers. Such detailed assessments were outside the scope of this SFRA. Developers undertaking a FRA for a site within the fluvial Flood Zones should obtain the most up to date flood risk data from the Environment Agency. If no further information is available then a site specific FRA may need to include a numerical assessment to refine the understanding of fluvial flood risk, and agree the form of this assessment with the Environment Agency.

The impacts of climate change on fluvial flooding are likely to result in a 10% increase in flows up to 2025 and 20% from 2025 to 2115. Again due to current gaps in available data that are being addressed by the Environment Agency's ongoing flood mapping programme, there are no consistent estimates for Havant Borough of the extreme fluvial flood extent taking climate change into account. Based on Environment Agency guidance, this SFRA has assumed that the present day Flood Zone 2 (medium probability) becomes Flood Zone 3 (high probability) by 2025. This is a conservative assumption which should be tested by site specific FRAs, where required. This also means that there is no data available to estimate Flood Zone 2 after the present day. Therefore, the fluvial climate change outline shown in Map Set 1E only shows a Flood Zone 3.

Undefended flood hazard information, shown in Map Set 1B, has also been developed for the fluvial Flood Zones 2 and 3. This information can provide developers with an indication of the varying degree of flood hazard within the Flood Zones which can facilitate the design and layout of development sites to avoid areas of high hazard. As with the tidal flood hazard data, it is recommended that FRAs for sites located within the flood hazard zones undertake a more detailed quantitative assessment of flood hazard based on an improved understanding of defences and flow routes.

Surface Water/Overland Flow Flooding

Map Set 1F-4 shows the variation in the potential source of overland flow across the PUSH sub-region. The areas shown in red and orange relate to areas of very high and high potential for generating overland flow. Notably, the urban areas are indicated as red or orange due to the high runoff potential from urban land uses. Within Havant Borough there is a large area of the mainland which has a high to very high potential for generating overland flow. FRAs for sites that are found to be within or in the vicinity of these areas, especially if the local topography places the site at a lower elevation than the surrounding land and hence downstream of the source, should consider the impacts and management of flooding due to overland flow.

In addition to the information provided in relation to the source of overland flow flooding, Map Set 1F-3 provides information to inform Local Authorities of the potential impacts of land use changes on the local surface water runoff regime. The areas showing diagonal hatching represent the urban areas, where a change in land use is unlikely to significantly affect the existing surface water runoff rates and volumes. This representation is a high level assessment across the PUSH sub-region and would therefore need to be confirmed when undertaking a site specific FRA. The areas outside of the hatching represent the effect that changes in land use are likely to have on the surface runoff rates and volumes from Greenfield sites. The data shows that new development located on the majority of the Greenfield Land in Havant Borough is likely to have a moderate impact on the surface water runoff regime. Site specific FRAs should therefore carefully consider the impact of development on the local surface water runoff regime and should investigate SUDS options to manage surface water where achievable.

Groundwater Flooding

Within the PUSH region the key areas at risk of groundwater flooding are north of Havant Borough in East Hampshire, Winchester, Eastleigh and Test Valley where highly permeable geology meets lower permeability geology as shown by Map Set 1F-2, which has been verified by inspection of the historical incident records. The key risks to new development in the Havant Borough come from increases in flows in the Lavant Stream as a result of high groundwater levels emerging in East Hampshire District. It is therefore recommended that site specific FRAs for sites located within the Flood Zone of the upper reaches of the Lavant Stream consider the joint effects of high groundwater flows in the Lavant Stream combined with rapid runoff from intense rainfall events.

Flooding from Infrastructure

Historically, the mainland part of Havant Borough has recorded the most incidents of flooding caused by problems relating to the drainage infrastructure as shown by Map Set 1F-5. The majority of these incidents have occurred in the vicinity of Havant Town Centre, Purbrook, Cowplain and Emsworth. When undertaking a site specific FRA for a large development site, consultation with Southern Water should always be undertaken to investigate whether the proposed development will have an adverse impact on the local drainage system.

Furthermore, a parallel study being undertaken on behalf of PUSH, 'Hampshire Integrated Water Management Study', is investigating the issues relating to the future management of surface water within the region with respect to the anticipated increases in housing as indicated in the draft South East Plan. It is recommended that those undertaking a site specific FRA within the urban areas of Havant Borough make reference to the findings of this study.

Sustainable Urban Drainage Systems (SUDS)

Conventional surface water drainage systems have traditionally used underground pipe networks to efficiently convey water away from sites. In the past this has led to problems of downstream flooding, reductions in groundwater recharge and waste pollution incidents associated with surface water overwhelming combined sewers. Both '*Making Space for Water*' and the '*Water Framework Directive*' have highlighted the need for an improved understanding and better management of how our urban environments are drained. The SUDS management train approach, as shown in Figure 2, is the principle that a range of SUDS which feed into each other can often offer benefits to the delivery of a successful surface water system/strategy.

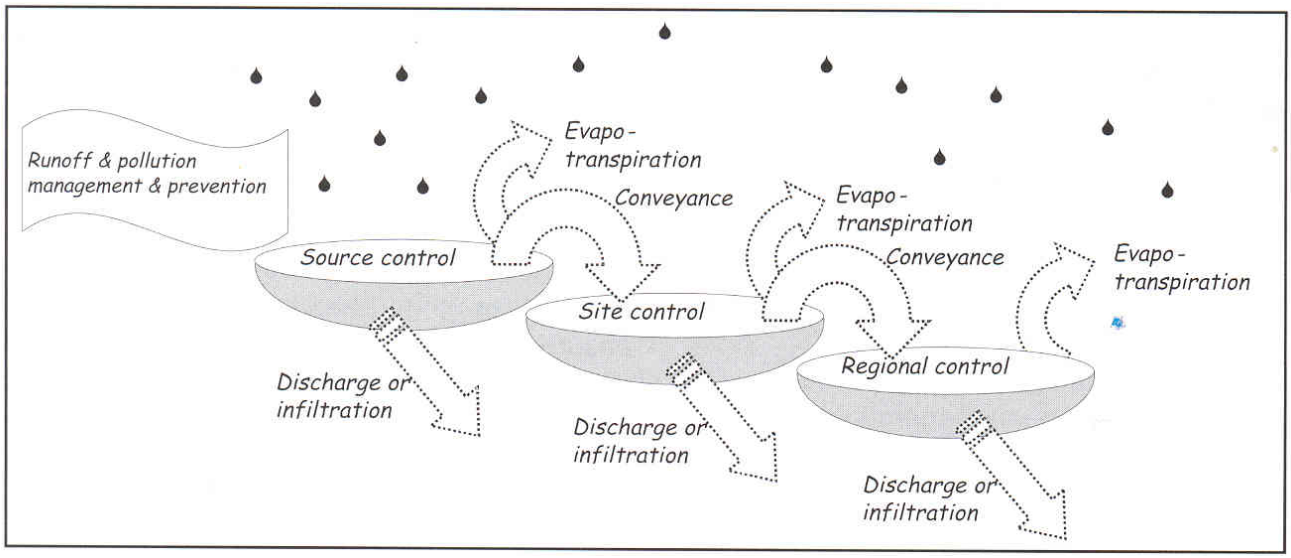


Figure 2: SUDS Management Train Approach

PPS25 states that Local Authorities should prepare and implement planning strategies that help to deliver sustainable development, by using opportunities offered by new development to reduce the causes and impacts of surface water flooding. By implementing polices to encourage developers to incorporate SUDS wherever possible, Local Authorities can help to mitigate the impacts that development has on surface water runoff rates and volumes. Appendix F of PPS25 states:

'the surface water drainage arrangements for any development site should be such that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates/volumes prior to the proposed development, unless specific off-site arrangements are made and result in the same net affect.'

Map set 1F-2 provides information relating to the spatial variation of permeability across Havant Borough. This information can be used as a first estimate of the suitability of different types of SUDS within the Borough as shown in Table 3.

Permeability	Indicative Suitability of SUDS Techniques
High Permeability	Infiltration and Combined Systems
Moderate Permeability	Infiltration and Combined Systems
Low Permeability	Attenuation Systems

Table 3: Suitability of SUDS

It is important to note that the above assessment of the spatial suitability of SUDS is an indicative estimate and should be confirmed at the site specific level, using ground investigation data.

Infiltration Systems

Infiltration systems allow surface water to discharge directly into the ground. These systems are only appropriate 1) where ground conditions permit a suitable water acceptance potential and 2) in locations where groundwater recharge will not adversely affect drinking water aquifers as identified by the Environment Agency's source protection zones, available on their website http://www.environment-agency.gov.uk. Such systems may include:

- Permeable surfaces
  - Gravel
  - Permeable Paving
  - Block Paving with voids
  - Grassed areas
- Sub Surface Infiltration
  - Filter Drains
  - Geocellular Systems
  - Soakaways

Infiltration systems may not be appropriate in areas of potentially contaminated land. In such circumstances, other systems, such as contained attenuation systems, that avoid mobilisation of contaminants may be more appropriate.

Attenuation Systems

If ground conditions cannot support infiltration systems, surface water may need to be attenuated using measures to store surface water. Attenuation systems, if designed above ground, have the potential to take up large areas of development sites. Early consideration of such constraints is therefore essential. Attenuation systems may include:

- Landscaped
  - Detention Basins
  - Balancing Ponds
  - Retention Ponds
  - Wetlands
  - Lagoons
- Engineered
  - Underground Tanks
  - Ornate Water Features
  - Rainwater Harvesting
  - Green Roofs
  - Oversized Pipes

Combined Systems

SUDS designs for most sites can include a combination of infiltration and attenuation systems and they have

been categorised above according to the dominant process. Other forms of SUDS which can provide more balanced benefits of infiltration and attenuation include:

- Swales
- Filter Strips

Emergency Planning

As well as informing the development control process, the outputs of the SFRA can also be used by the Local Authority to inform their Emergency Planning Polices. Map Sets 1A, 1B, 1C, 1D and 1E are particularly useful when considering the feasibility and sustainability of key access routes within their administrative boundaries. The benefit of producing such outputs on a sub-regional scale mean that the Local Authority can also consider access to the Borough beyond their administrative boundary where key access routes (e.g. M27) cross a number of Local Authorities.

Additional Guidance

In addition to the guidance provided by the Environment Agency http://www.pipernetworking.com/floodrisk/, there are a number of other documents that provide detailed advice and guidance for undertaking site specific FRAs:

- Planning Policy Statement 25: Development and Flood Risk, (2006), Communities and Local Government.
- Development and Flood Risk: A Practice Guide Companion to PPS25 - 'Living Draft', (2007), Communities and Local Government
- Development and Flood Risk: Guidance for the Construction Industry, (2004), CIRIA (Based on PPG25)
- Flood Risk Assessment Guidance for New Development: FD2320/TR2, (2005), Defra (Based on PPG25)
- Sustainable Urban Drainage Systems: Best Practice Manual, (2001), CIRIA

Annex 1 – Data Source for Havant Borough Council

Further to the general technical details provided in the main SFRA Stage 2 report, this annex includes data issues specific to Havant Borough Council.

Defence Data

The majority of Havant Borough Council defence data in is provided by the Havant Asset Database which holds details of most of the Borough's coastal defences from recent surveys. Surveys recorded in the database were undertaken between 2002 and 2003. The defence database for Havant was supplemented with data from the Eastoke Sectoral Strategy Study (2005) and Portchester Castle to Emsworth Coastal Defence Strategy Study (2006). Coastal defence works in other parts of Havant's coastline undertaken since 2003 may supersede records in the SFRA Defence Database.

No information on fluvial defences in Havant was available.

Topographic Data

95% of the topographic grid in Havant Borough is composed of LiDAR data. Areas where LiDAR was not available are the northern slope of Portsdown Hill to the west of Bedhampton and to the north of the Borough between Lovedean and Cowplain. In these areas, NextMap data was used to fill in the gaps in the LiDAR.

Fluvial Flood Zone 3b

In Havant Borough, fluvial Flood Zone 3b was represented as the whole of Flood Zone 3. In the absence of data to prove otherwise (i.e. detailed 1 in 20 year modelling or observed historic flood extents), this approach is in accordance with PPS25 practice guide section 3.17 and was recommended by the Environment Agency.

Fluvial Climate Change Outlines

In Havant Borough, the fluvial outlines after the present day were represented by assuming that Flood Zone 3 will expand to fill the current area of Flood Zone 2. This means there is no estimate of fluvial Flood Zone 2 after the present day for the Borough. This approach was recommended by the Environment Agency.

APPENDIX G

EXTRACT GEOTECHNICAL REPORT



'optimising development potential'

THE BRITISH ASSESSMENT BUREAU ISO9001

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