jpp consulting
Civil & Structural Engineers

Proposed Keyline Unit
Land at Harts Farm Way
Havant
Hampshire

Flood Risk Assessment

Revision 0: January 2017
R-FRA-KLHAV1YY-01-0

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Revision	Date	Description	Prepared	Reviewed
0	22nd November 2016	Draft Report	Katherine Rose	Martin Andrews
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1.0 Introduction

1.1 Background

1.1.1 This report is a Flood Risk Assessment which has been prepared by JPP Consulting Limited on behalf of Travis Perkins for a proposed Keyline unit. The benefit of this report is to our instructing Client.

1.1.2 The proposed Keyline unit is located at land off Harts Farm Way, Havant, as shown in Figure 1.1 below. Havant is located to the north-east of Portsmouth and west of Chichester. The National Grid Reference for the site is E470710 N105910. The proposed development has a total development area of 0.868ha (8,679m^2).

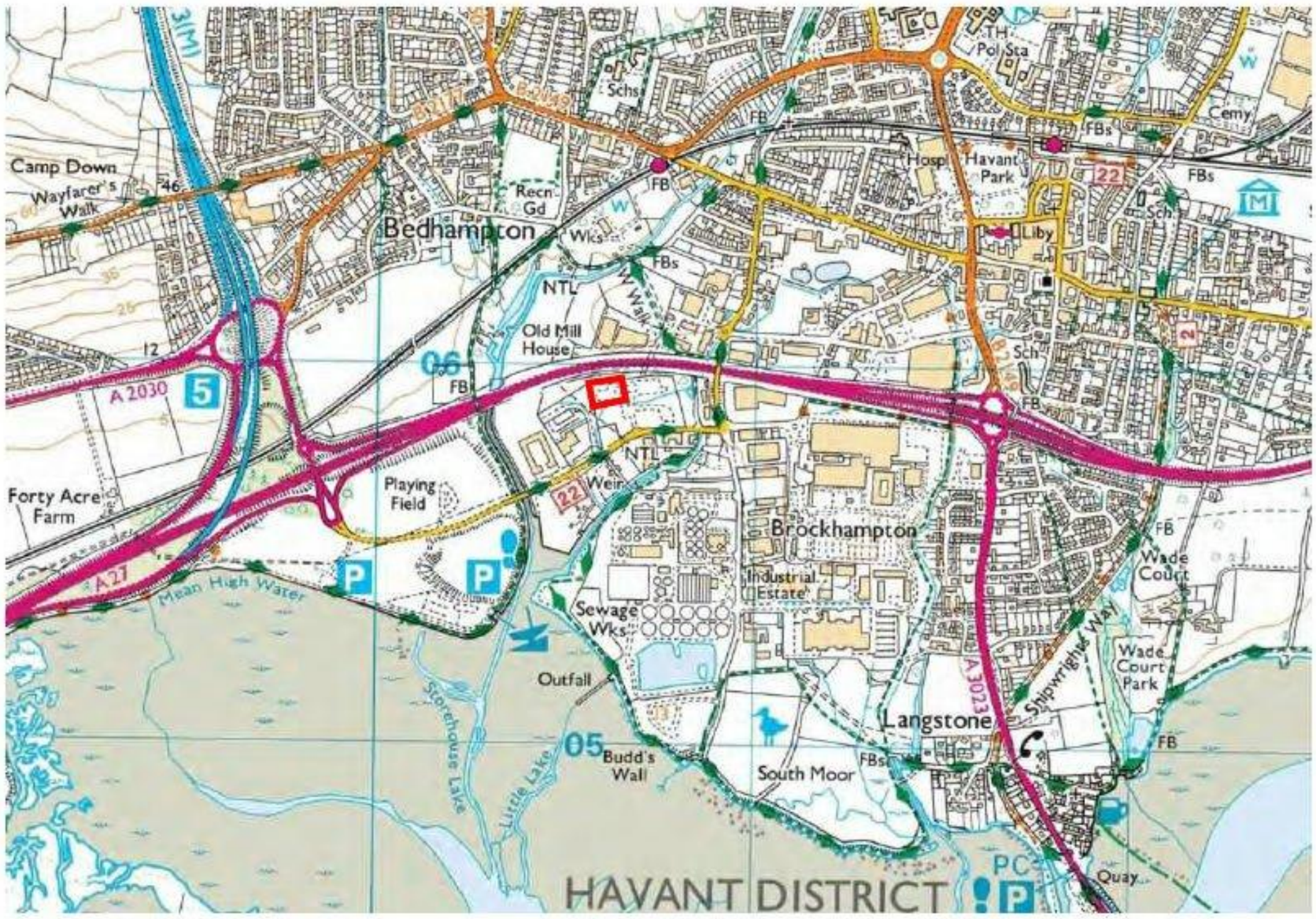


Figure 1.1 Site Location Plan

1.2 Objectives

1.2.1 The objective of this report is to advise interested parties in the development to the potential risk of flooding and the management of surface water from a drainage perspective.

1.2.2 This report has been prepared to support a full planning application.

1.3 Reference documents

1.3.1 This report has been prepared with reference to the following publications:-

- Department for Communities and Local Government (March 2012), National Planning Policy Framework
- Department for Communities and Local Government (March 2014),
- Planning Practice Guidance 'Flood Risk and Coastal Change'
- Department for Environment, Food and Rural Affairs (March 2015), Non-statutory technical standards for sustainable drainage systems
- Environment Agency (September 2013), Climate Change Allowances for Planners: Guidance to support the National Planning Policy Framework
- Environment Agency (October 2013), Delivering benefits through evidence: Rainfall runoff management for developments
- HM Government (2010), The Building Regulations (2010), Drainage and Waste Disposal, Approved Document H, The NBS, Newcastle Upon Tyne
- Wilson, Bray, Cooper (2004), Sustainable drainage systems: Hydraulic, structural and water quality advise,C609, CIRIA, London
- Woods-Ballard et al (2015), The SUDS Manual, C753, CIRIA, London
- CIRIA Report C624 Development and flood risk
- National SUDS Working Group (2004), Interim Code of Practice for Sustainable Drainage Systems,
- Institute of Hydrology (1999), Flood Estimation Handbook, Institute of Hydrology, Wallingford
- BS EN 752:2008 Drain and sewer systems outside buildings. Hydraulic design and environmental considerations
- BS 8533:2011 Assessing and managing flood risk in development – Code of Practice
- CIRIA Report C635 Designing for exceedance in urban drainage – good practice

2.0 Description and history of the site and development proposals

2.1 Location and description of the site

2.1.1 The proposed Keyline unit is located at and off Harts Farm Way, Havant, as shown in Figure 1.1 above. The site is bound by the A27, vacant brownfield sites to the east and south, and a household waste recycling centre to the west.

2.2 History of the site

2.2.1 The site has previously been developed, but is currently vacant.

2.3 Proposed development

2.3.1 The planning description of the proposed development is as follows:

> Construction of 1 no. storage and distribution building (use class: sui generis) with trade counter; and with access and servicing arrangements, car parking, structural landscaping and associated works.

2.3.2 The proposed development layout is shown on the plan enclosed in Appendix A.

2.4 Geology of the site and ground investigation data

2.4.1 Soiltechnics have completed a geotechnical investigation on the site; an extract of their report is enclosed in Appendix B. Their investigation encountered Made Ground to depths of 1.4m to 2.0m underlain by Alluvium. Groundwater was generally encountered from depths of between 1.90m and 2.30m. The ground conditions encountered are summarised in Table 2.1 below.

Summary of Ground Conditions									
Ground Condition	Depth (m)								
	TP01	TP02	TP03	TP04	TP05	TP06	TP07	DTS07/ DP05	DTS08
Made Ground	1.40	1.70	2.00	1.75	1.80	1.45	1.80	2.00	1.70
Groundwater	*2.15*	*1.90*	*2.15*	*2.00*	*2.30*	*2.00*	*2.15*	*N/A*	*N/A*
Alluvium	2.80	2.60	2.60	3.50	3.20	3.00	2.60	4.00	3.00
	Extent of Borehole								
Source: Soiltechnics report ref. STN3703G-G01									

Table 2.1

2.4.2 With respect to the use of infiltration techniques, the Ground Investigation Report states:

> "Although, it is possible that the predominantly granular deposits of the Alluvium could dispose of stormwater using infiltration systems, laboratory testing undertaken on two groundwater samples indicates presence of contaminants above their respective guideline values. While the respective leachate testing did not show presence of contaminants which could potentially be derived from leachate concentrations within the Made Ground deposits. Considering a worst-case scenario in which soakaways will discharge rainwater through Made Ground, this would promote leaching of chemical contaminants in the soil sufficient to cause concern. On this basis, the use of soakaway systems would only be recommended if design allows for discharge within the naturally deposits Alluvium avoiding any discharge within the Made Ground deposits."

2.4.3 The base of any infiltration device should be located at least 1.0m above the groundwater level. This would locate the base of any infiltration device within the Made Ground, which is not considered advisable. Therefore, we would consider that infiltration is not viable.

2.5 Development proposals and flood risk vulnerability

2.5.1 With reference to Table 2 of the Planning Practice Guidance (PPG) to the National Planning Policy Framework (NPPF), the proposed Keyline unit would be classed as Less Vulnerable development.

2.5.2 An extract from Table 2 of the PPG for Flood Risk and Coastal Change is replicated below in Table 2.2 with the proposed development type highlighted.

Flood Risk Vulnerability Classification	
Vulnerability	**Development Types**
Less Vulnerable	Police, ambulance and fire stations which are not required to be operational during flooding.
	Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, **storage and distribution**; non-residential institutions not included in the 'More Vulnerable' class; and assembly and leisure.
	Land and buildings used for agriculture and forestry.
	Waste treatment (except landfill and hazardous waste facilities).
	Minerals working and processing (except for sand and gravel working).
	Water treatment works which do not need to remain operational during times of flood.
	Sewage treatment works, if adequate measures to control pollution and manage sewage during flood events are in place.
Source: Planning Practice Guidance - 2014	

Table 2.2

3.0 Flood risk

3.1 Fluvial / Tidal flooding

3.1.1 An extract of the Environment Agency's Flood Map for Planning (Rivers and Sea) is provided below in Figure 3.1. The flood map was extracted from the Environment Agency's website on 16th November 2016. The approximate application site boundary is shown in red. The map indicates that the development site is located within Flood Zone 1 (Low Probability) and as such, the report considers the development to be in Flood Zone 1 and at a low risk of flooding from rivers or the sea.

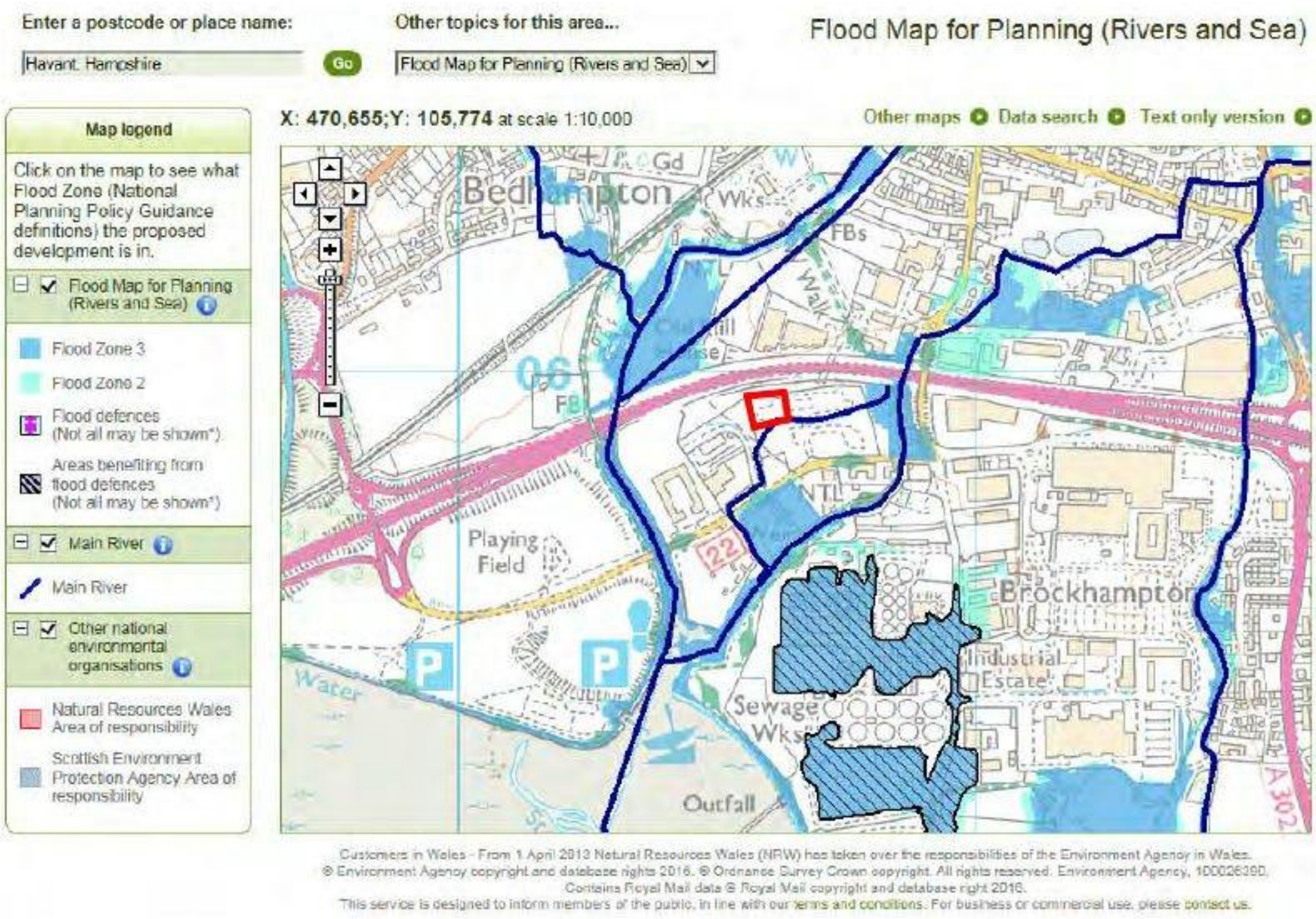


Figure 3.1 Flood Map for Planning (Rivers and Sea)
Source: Environment Agency website – 16th November 2016

3.1.2 It should be noted that an Environment Agency designated Main River runs adjacent to the site's southern boundary.

3.1.3 Table 3.1 below is a copy of Table 1 from Planning Practice Guidance for *'Flood Risk and Coastal Change'* to the National Planning Policy Framework which defines Flood Zones. The proposed development, which is located within Flood Zone 1, is defined as having a less than 1 in 1,000 annual probability of river or sea flooding in any year.

Flood Zone Definitions	
Flood Zone	**Definition**
Zone 1: Low Probability	**Land having a less than 1 in 1,000 annual probability of river or sea flooding.**
Zone 2: Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or Land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.
Zone 3a: High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding.
Zone 3b: The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency.
Source: Planning Practice Guidance - 2014	

Table 3.1

3.2 Flooding from surface water

3.2.1 An extract of the Environment Agency map 'Risk of Flooding from Surface Water' is provided below in Figure 3.2. The approximate application site boundary is shown in red. The site is shown to be located in an area of very low (less than 1 in 1000), low (1 in 100 to 1 in 1000) and medium (1 in 30 to 1 in 100) risk of surface water flooding in a given year.

3.2.2 The Finished Floor Levels of the proposed building will be designed such that it will not be at risk of surface water flooding.

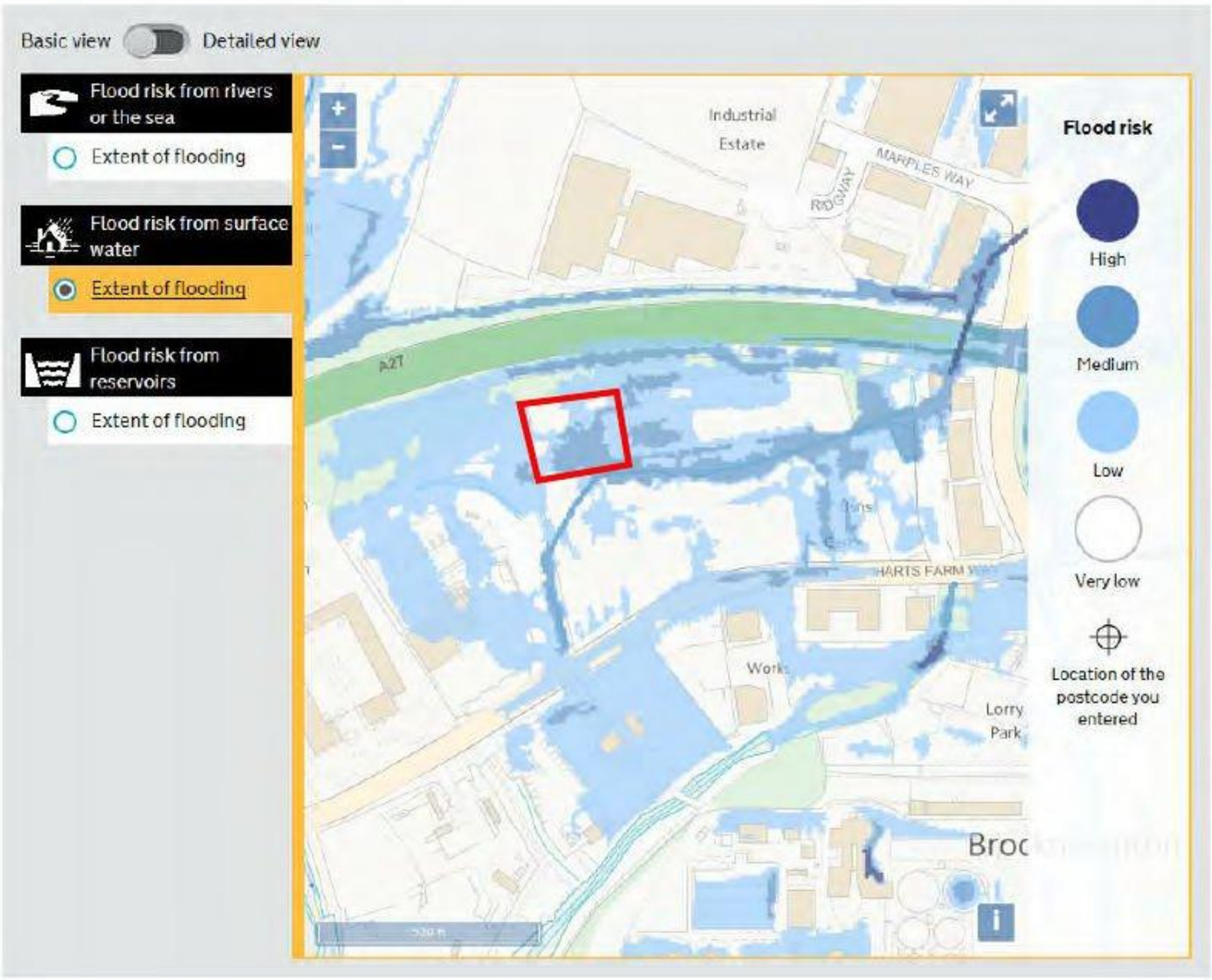


Figure 3.2 Risk of Flooding from Surface Water
Source: Environment Agency website – 16th November 2016

3.3 Flooding from groundwater

3.3.1 From information provided on the Environment Agency's website, see Figure 3.3 and Figure 3.4 below, the site appears to be underlain by a Secondary A aquifer in the superficial deposits and by a Principal aquifer in the bedrock layer. We are not aware of any flooding on the site caused by groundwater. We would therefore consider the probability of flooding on the site from groundwater as low.

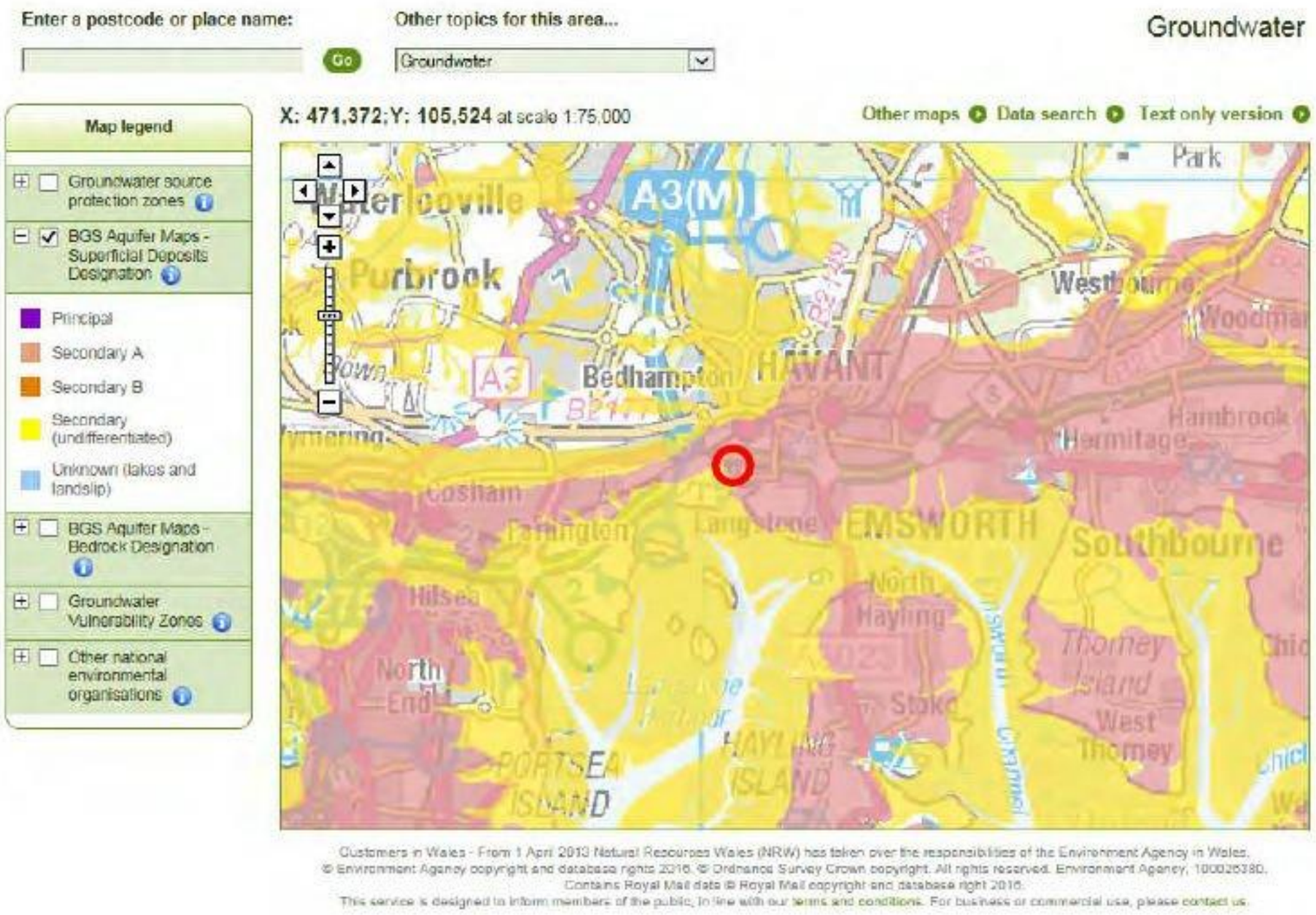


Figure 3.3 Groundwater – Superficial Deposits
Source: Environment Agency website – 16th November 2016

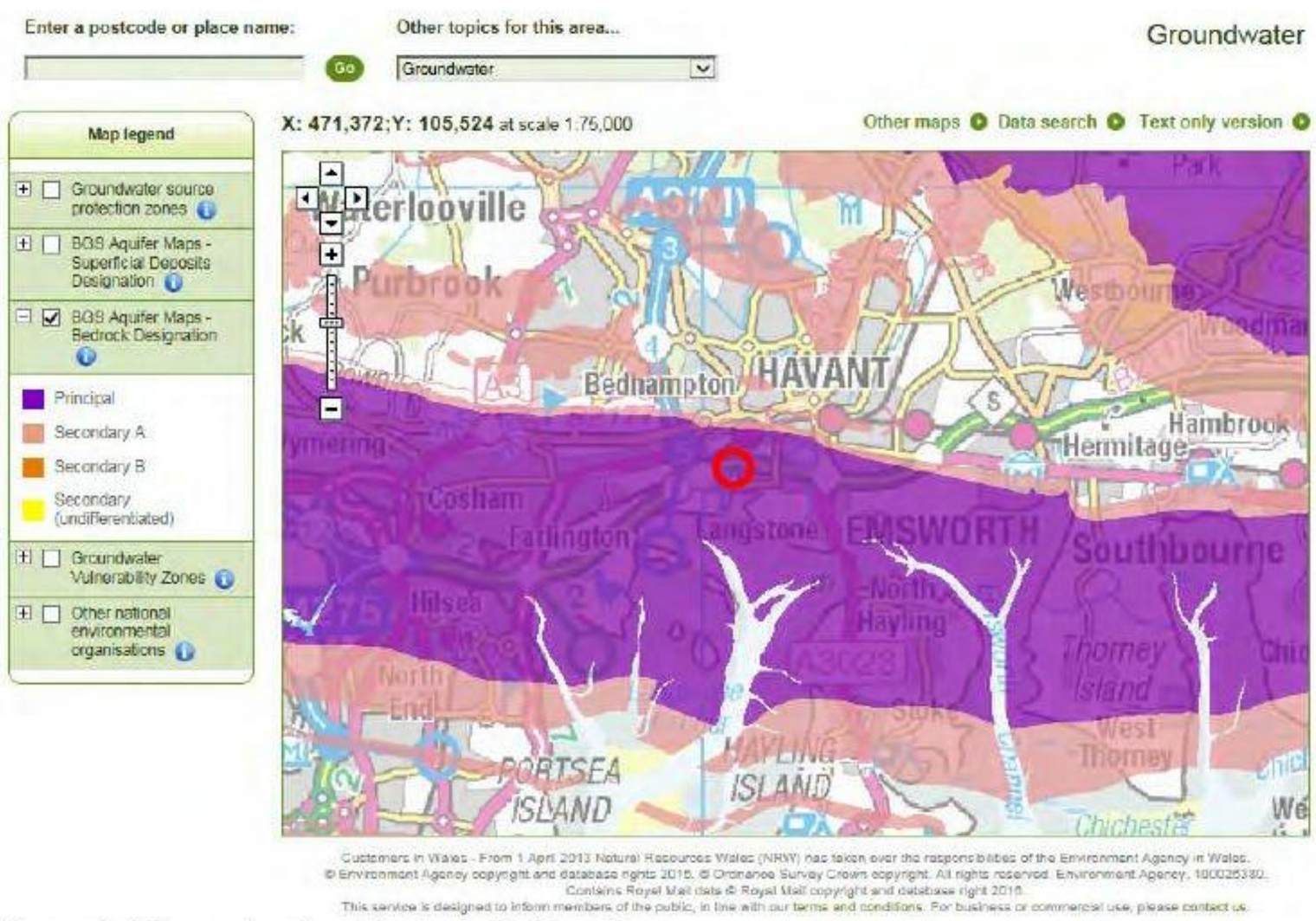


Figure 3.4 Groundwater – Bedrock Designation
Source: Environment Agency website – 16th November 2016

3.4 Flooding from sewers

3.4.1 We are not aware of any sewers located within the site application boundary. We do not have any records of sewer flooding within the vicinity of the proposed development.

3.4.2 We therefore do not consider the risk of flooding from sewers to be a significant risk to the proposed development.

3.5 Flooding from reservoirs, canals and other artificial sources

3.5.1 We are not aware of any canals or artificial water sources that may result in flooding of this site.

3.5.2 An extract of the Environment Agency map 'Risk of Flooding from Reservoirs' is provided below in Figure 3.5. It can be seen that the proposed development site, shown in red, is not at a risk of flooding from reservoirs.

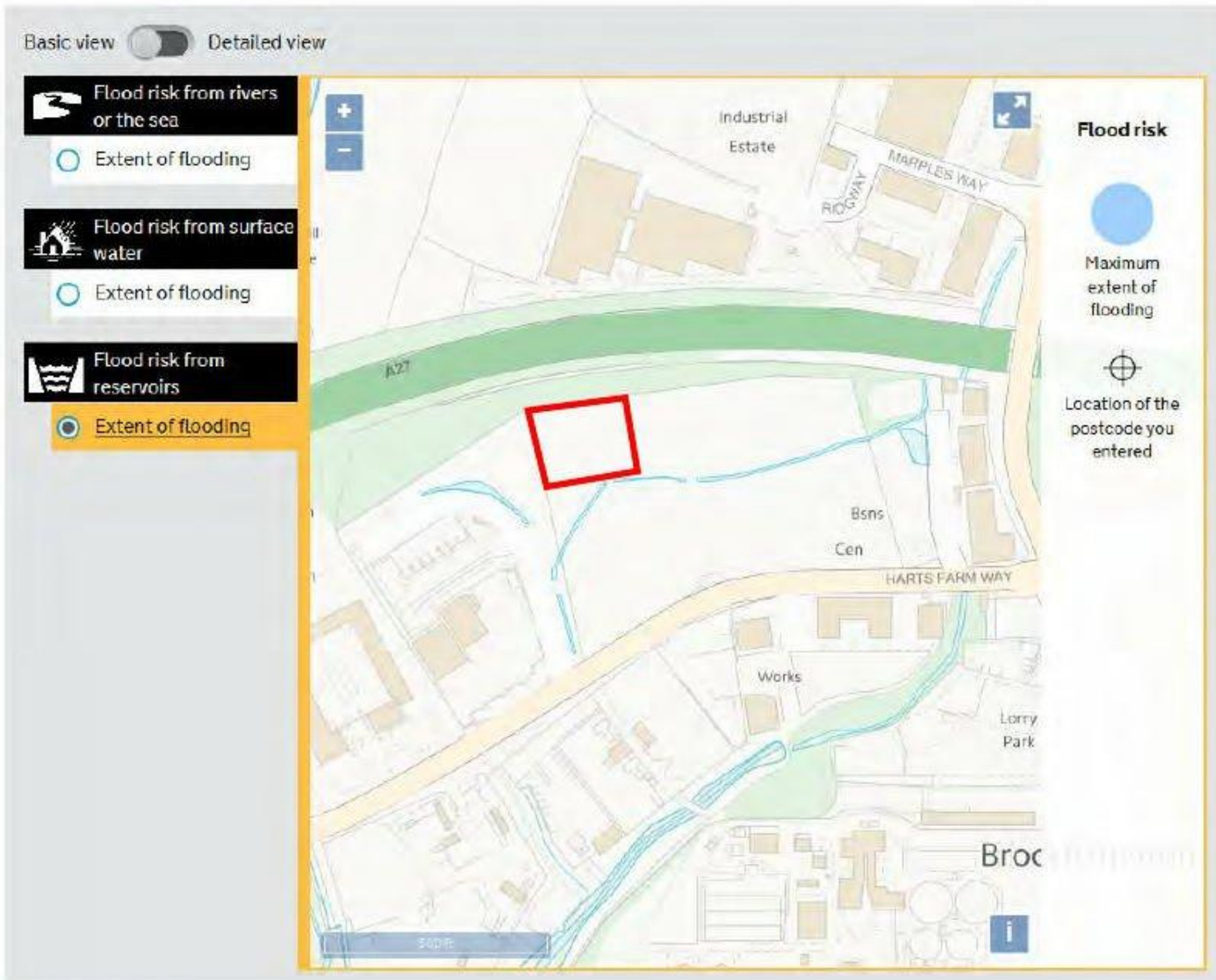


Figure 3.5 Risk of Flooding from Reservoirs
Source: Environment Agency website – 16th November 2016

3.6 Historic flooding

3.6.1 We do not have any records showing historic flood events within the vicinity of the site.

3.7 Flood risk vulnerability and flood zone compatibility

3.7.1 Based on the above assessment of the site being located within Flood Zone 1 and classified as a Less Vulnerable development, and with reference to Table 3.2 below (Planning Practice Guidance for 'Flood Risk and Coastal Change' to the National Planning Policy Framework, Table 3), the proposed development of this site would be considered "appropriate". A copy of Table 3 is presented below highlighting the above. Neither a sequential or exception test will be required.

Table 3 – Flood Risk Vulnerability and Flood Zone Compatibility

Flood Risk Vulnerability Classification	Essential Infrastructure	Water Compatibility	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception test required	✓	✓
Zone 3a	Exception test required	✓	X	Exception test required	✓
Zone 3b	Exception test required	✓	X	X	X

✓ = Development is appropriate X = Development should not be permitted

Source: Planning Practice Guidance - 2014

Table 3.2

3.8 Flood compensation

3.8.1 Flood compensation measures will not be required for this site as it is located within Flood Zone 1.

3.9 Access and egress

3.9.1 Access and egress to and from this site in the event of flooding will be via the proposed development's access road which will allow users of the development to move to higher ground.

4.0 Management of surface water

4.1 Current conditions

4.1.1 The site is currently a brownfield site. In line with best practice guidance, the design of drainage will assume that the site is greenfield and allowable discharge rates will be calculated in line with this assumption.

4.2 Surface water drainage outfalls

4.2.1 It is a requirement of the The Building Regulations (2010), Drainage and Waste Disposal, Approved Document H, to dispose of surface water collected by a development in the following list of priorities:-

1. Infiltration systems where ground condition permit
2. To watercourses
3. To sewers

4.2.2 Each of these is considered separately below:

4.2.2 Infiltration systems

4.2.2.1 The geology of the site is described in Section 2.4 above. Due to the groundwater depth and the contamination within the Made Ground, the use of infiltration techniques will not be considered further.

4.2.3 Watercourses / Main River

4.2.3.1 Brockhampton Stream is located along the site's southern boundary. Therefore, surface water from the proposed development will drain to Brockhampton Stream.

4.2.4 Sewers

4.2.4.1 Draining the site via to an existing watercourse is a viable option, therefore the use of surface water sewers will not be considered further.

4.3 Surface water drainage strategy

4.3.1 Surface water discharge rates will be restricted to minimum viable discharge rates. The proposed drainage strategy will comprise a piped network with attenuation provided in the permeable subbase beneath the road. Surface water will outfall to Brockhampton Stream located along the site's southern boundary.

4.3.2 An indicative surface water layout plan is enclosed in Appendix C. The drawing shows that surface water attenuation can be accommodated on the site and the method of discharge assuming that infiltration techniques are not viable. The detail design parameters of the drainage are described in detail in Section 4.4.

4.4 Surface water drainage design and management

4.4.1 Proposals are to design the surface water drainage system to accommodate storms up to the 1 in 100 year event plus an allowance of 40% for climate change. Should the 40% climate change event result in surface water flooding, this will be contained within the development site and will not flood any buildings on site.

4.5 Existing runoff rates

4.5.1 To reflect the changes in the near surface geology across the site the greenfield runoff rates have been calculated. The method used to calculate the greenfield run off rates is the ICP SUDS and the calculations are presented in Appendix D.

4.5.2 The greenfield run off rate, for the application site is:

Soil type	= 0.37 – obtained from HR Wallingford online tool
SAAR	= 783mm – obtained from the FEH parameters
Urban	= 0.000
Region number	= 7
Proposed Imp Area	= 0.239ha
Q_1	= 0.7 l/s
Q_{bar}	= 0.8 l/s
Q_{30}	= 1.8 l/s
Q_{100}	= 2.5 l/s

4.5.3 The Q_{bar} equivalent rate for the proposed development is 0.8 l/s. A restriction of 0.8 l/s could potentially result in a small aperture at the outfall which could increase the risk of blockage. To reduce the risk of blockage, a minimum aperture size of 75mm will be used. As such, surface water will be restricted to a runoff rate of 2.5 l/s.

4.6 Attenuation requirements

4.6.1 Surface water will discharge into Brockhampton Stream located along the site's southern boundary and will be attenuated to a runoff rate of 2.5 l/s. To achieve this, surface water will be attenuated within the permeable subbase under the road to accommodate a 1 in 100 year event plus an allowance of 40% for climate change.

4.6.2 The proposed impermeable area of the development is 0.239ha as shown on the plan enclosed in Appendix E. Based on the proposed impermeable area and allowable discharge rate of 2.5 l/s the storage requirement for the 1 in 100 year plus climate change event has been calculated utilising the following parameters. Full calculations are enclosed in Appendix F.

Rainfall profile	= Flood Estimation Handbook
Return Period	= 100 year
Durations	= 15 to 10080 minutes
Climate change	= 40%
System	= Porous car park
Porosity	= 30%
Drained area	= 0.239 ha
Limiting flow to SW Sewer	= 2.5 l/s
Area of subbase attenuation	= 1521.6m^2
Depth of permeable material	= 0.360m
Total volume of storage	= 164.4m^3

4.6.3 The indicative surface water drainage layout incorporating the attenuation is shown on the plan enclosed in Appendix C.

4.7 Overland flows

4.7.1 Proposals are to design the surface water drainage to accommodate the 1 in 100 year storm event taking into account the predicted future effects of climate. Clearly there is a risk of this storm event being exceeded, albeit this risk is considered very low. In such an event the proposed drainage systems will become overwhelmed and overland flows could occur. Overland flows will be directed to follow the path that overland flows currently follow.

4.8 Foul water drainage strategy

4.8.1 We understand that foul water will discharge to Southern Water's sewer.

5.0 Maintenance

5.1 Surface drainage maintenance

5.1.1 The drainage system will be designed to minimise maintenance requirements, however, a full maintenance scheme will be established for those elements not being offered for adoption. The various areas will be maintained as set out in Table 5.1 below.

Maintenance Areas – Surface Water	
Aspect	**Maintainer**
Private Drains / Sewers	Keyline
SUDS	Keyline

Table 5.1

5.2 Foul drainage maintenance

5.2.1 The drainage system will be designed to minimise maintenance requirements, however, a full maintenance scheme will be established for those elements not being offered for adoption. The various areas will be maintained as set out in Table 5.2 below.

Maintenance Areas – Foul Water	
Aspect	**Maintainer**
Private Drains / Sewers	Keyline
Adopted Sewers	Southern Water

Table 5.2

6.0 Conclusions and flood risk from site drainage proposals

6.1 The proposed Keyline unit is located at and off Harts Farm Way, Havant. The site is bound by the A27, vacant brownfield sites to the east and south, and a household waste recycling centre to the west. The site has previously been developed, but is currently vacant.

6.2 The planning description of the proposed development is as follows:

> Construction of 1 no. storage and distribution building (use class: sui generis) with trade counter; and with access and servicing arrangements, car parking, structural landscaping and associated works.

6.3 The site is located within Flood Zone 1 and is shown to be at a low risk of flooding from groundwater, sewers and artificial sources such as reservoirs. The site is shown to be located in an area of very low, low and medium risk of surface water flooding. Therefore, the Finished Floor Levels of the proposed building will be designed such that it is not at risk of surface water flooding.

6.4 The proposed drainage strategy will comprise a piped network with attenuation provided within the permeable subbase beneath the road. Surface water will discharge into Brockhampton Stream located along the site's southern boundary and will be attenuated to a runoff rate of 2.5 l/s. To achieve this, surface water will be attenuated within the permeable subbase beneath the road to accommodate a 1 in 100 year event plus an allowance of 40% for climate change. The depth of permeable subbase required to provide the surface water storage volume is 0.360m.

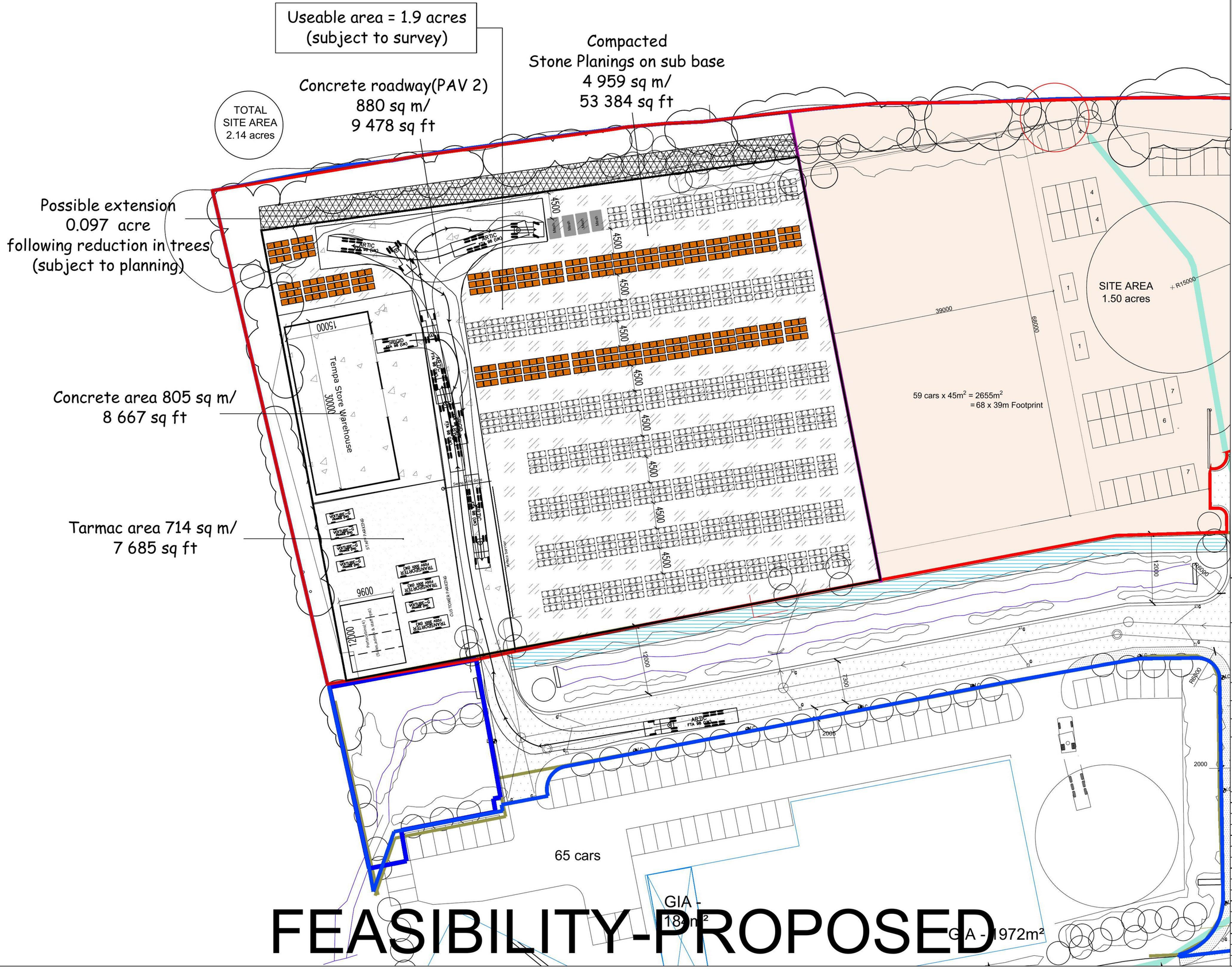
6.5 We understand that foul water will discharge to Southern Water's sewer.

6.6 The surface water drainage from this site, post development, is such that the surface water will be managed and disposed of within the site boundary, thus complying with the Planning Practice Guidance for *'Flood Risk and Climate Change'* to the National Planning Policy Framework. Based on the above, providing the above strategies are adopted the developed site will not contribute further to flood risk thus satisfying the principles of the National Planning Policy Framework.

Appendix A

Feasibility Layout

Travis Perkins drawing Keyline Havant-site2-feasibility Rev 1.3



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Drawn By	Checked by
JJM	N/A

Scale	Drawing Size	Date
N/A	A1	13.10.16

Drawing Title	Revision
Keyline Havant-site2-feasibility	1.3

ALL FIGURED DIMENSIONS MUST BE CHECKED ON SITE PRIOR TO WORKS COMMENCING ON SITE.
DO NOT SCALE FROM THIS DRAWING.
ANY CONFLICTING INFORMATION FOUND ON THE DRAWING MUST BE REPORTED FOR CLARIFICATION.
ALL MATERIALS AND WORKMANSHIP TO BE IN ACCORDANCE WITH RELEVANT AND CURRENT BRITISH STANDARDS AND CODES OF PRACTICE.

No.	Revision	Date

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Appendix B

Extract of Ground Investigation
Soiltechnics report ref. STN3703G-G01

4 Fieldwork

4.1	General
4.2	Site restrictions
4.3	Exploratory trial pits
4.4	Driven tube sampling
4.5	Dynamic probing
4.6	Measurement of landfill type gases in gas monitoring standpipes
4.7	Sampling strategies

4.1 General

4.1.1 Fieldwork activities were carried out between 15th and 16th September 2016 and comprised of the following activities:-

- Excavation of nine exploratory trial pits
- Excavation of eight exploratory boreholes formed using driven tube sampling equipment
- Dynamic probing testing in five locations

4.1.2 The above mentioned exploratory locations were undertaken in the "Plot 4"area as well as adjacent areas to the east. The distribution of the exploratory points is presented in the following table;

Table location of exploratory points

Exploratory point	Date of excavation	Western area- "Plot 4"	Eastern area
TP01	16/09/16	✓	
TP02			
TP03			
TP04			
TP05			
TP06			
TP07			
DTS05			
DTS06			
DTS07			
DTS08			
TP08	15/09/16		✓
TP09			
DTS01			
DTS02			
DTS03			
DTS04			

Table 4.1.2

4.1.3 The position of exploratory points relative to site development proposals is presented on Drawing 03. The position of exploratory points shown on these plans is approximate only and confirmation of these positions is subject to dimensional surveys, which is considered outside our brief. It should be noted that although some of the investigatory points are outside of the development area we have presented all data from the wider site.

4.1.4 The extent of fieldwork activities and position of exploratory points were determined by Soiltechnics in agreement with Travis Perkins plc.

4.1.5 Exploratory points were positioned to avoid known locations of underground services, to avoid possible location of proposed foundations but were also positioned to provide a reasonable coverage of the site. Prior to commencement of exploratory excavations an electronic cable locating tool was used to scan the area of the excavation. If we received a response to this equipment, then the excavation would be relocated.

4.1.6 All soils exposed in excavations were described in accordance with BS EN ISO 14688 *'Identification and Classification of soil'*.

4.2 Site restrictions

4.2.1 Care was taken to avoid buried services such as main sewers and electricity cables predominantly located to the east of the area denominated as "Plot 4".

4.3 Exploratory trial pits

4.3.1 Surface concrete/bituminous bound materials were initially broken out using hydraulic breaking equipment fixed to the rubber tyred excavator. Once broken, excavation continued using normal excavation techniques.

4.3.2 Trial pits TP01 to TP09 were excavated to a maximum depth of 3.5m. The excavations were backfilled with excavated material compacted using the back of the excavator bucket. Whilst we attempted to reinstate the excavation to its original condition the soils could not be fully compacted into the trial pit and thus the soils were left proud of the ground surrounding the pit to allow for short-term settlement of the backfill. A Geotechnical Engineer supervised the excavations.

4.3.3 Sampling and logging was carried out as trial pit excavations proceeded but were not entered at depths exceeding 1.2m, or where trial pit sides were deemed unstable. The density of granular soils encountered in excavations was gauged by the ease of excavation.

4.3.4 Soil samples for subsequent laboratory determination of concentration of chemical contaminants were taken from the sides of trial pits using clean stainless steel equipment and stored in new plastic containers, which were labelled and sealed. Samples from below access depth into trial pits were taken as a sub sample from soil contained in the excavator bucket, discarding any soil, which may have been in contact with the bucket. If as a consequence of visual or olfactory evidence, a sample was suspected to be contaminated by organic material, the sample was stored in an amber glass jar with a PTFE sealing washer.

4.3.5 Soil samples for subsequent classification laboratory testing were taken from the side of trial pits or from bulk samples taken from the excavator bucket. The sample was placed in a plastic bag and subsequently sealed and labelled. Samples for moisture content determination were placed in sealable tubs and appropriately labelled.

4.3.6 Sample sizes were appropriate for the laboratory test being considered.

4.3.7 A pocket penetrometer was used in the fine soils encountered. This tool is deemed to measure the apparent ultimate bearing capacity of the soil under test. The pocket penetrometer is calibrated in kg/cm^2. The reading can be approximately converted to equivalent undrained shear strength by multiplying the results by a factor of 50. Pocket penetrometer testing was carried out in the sides of trial pits when access could be safely achieved otherwise testing was carried out on excavated intact clods. The results are reported in columns to the right of trial pit results. The pocket penetrometer is not covered by British Standards. This tool has the advantage that it can be used to determine the approximate in-situ undrained shear strength of stony cohesive soils.

4.3.8 A summary of pocket penetrometer results obtained from the fine soils encountered in exploratory excavations are presented in graphical format on Drawing 04.

4.3.9 Trial pit records are presented in Appendix C.

4.4 Driven tube sampling

4.4.1 Boreholes DTS01 to DTS08 were formed using driven tube sampling equipment. Driven tube sampling comprises driving 1m long steel sample tubes which are screw coupled together or coupled to extension rods and fitted with a screw on cutting edge. The sample tubes are of various diameters, generally commencing with 100mm and reducing, with depth, to 50mm and include a disposable plastic liner which is changed between sampling locations to limit the risk of cross contamination. On completion of excavation the liner containing the sample is cut open and the soil sample logged by a geo-environmental engineer.

4.4.2 Samples for determination concentration of chemical contaminants are taken from samples obtained in the disposable tubes as sub-samples using stainless steel sampling equipment.

4.4.3 In some locations, surface concrete was either broken out or cored prior to excavation of the borehole. The concrete surface was reinstated on completion.

4.4.4 A pocket penetrometer was used in the fine soils retrieved from the borehole. This tool is deemed to measure the apparent ultimate bearing capacity of the soil under test. The pocket penetrometer is calibrated in kg/cm^2. The reading can be approximately converted to an equivalent undrained shear strength by multiplying the results by a factor of 50. The results are reported on borehole records. The pocket penetrometer is not covered by British Standards.

4.4.5 A summary of pocket penetrometer results obtained from the fine soils retrieved from the boreholes are presented in graphical format on Drawing 04.

4.4.6 Combined gas and groundwater monitoring standpipes were installed in DTS02, DTS03, DTS07 and DTS08. The standpipes were installed following the recommendations of BS EN ISO 22475-1:2006 *'Geotechnical Investigation and Testing – Sampling methods and groundwater measurements – Part 1: Technical Principles for execution'* and *BS8576:2013 'Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs)'.* Details of the standpipe installation are recorded on Drawing 05.

4.4.7 Water levels in the standpipes have been measured during a return visit to the site. The water level was measured using a measuring tape calibrated in 1mm intervals with an electronic end piece, which emits an alarm sound in contact with water. Water levels are measured from ground levels at the borehole position.

4.4.8 Records of boreholes formed using driven tube sampling techniques are presented in Appendix D.

4.5 Dynamic probing

4.5.1 Dynamic probing (DP) testing was carried out in five locations. Dynamic probing consists of driving a 50mm diameter, 90° cone into the ground, via an anvil and extension rods with successive blows of a freefall hammer. The number of blows required to drive the cone each successive 100mm (N_{10}) is recorded.

4.5.2 Dynamic probing was carried out following BS EN ISO 22476-2:2005 and the apparatus used was categorised as 'Super heavy' (DPSH-B) in accordance with the standard.

4.5.3 Dynamic probing data is presented in graphical format on Appendix E.

5 Ground conditions encountered

5.1	Soils
5.2	Groundwater
5.3	Evidence of contamination
5.4	Obstructions and instability

5.1 Soils

5.1.1 The exploratory excavations encountered a similar profile of soils considered to be Made Ground overlying Alluvium.

5.1.2 Made Ground was encountered in all locations and observed between depths of 0.75m to 2.0m and comprised a chaotic mixture of fine, coarse and chalk soils.

5.1.3 The coarse Made Ground soils comprised brown to dark brown and orange brown slightly clayey to clayey sand and gravel with occasional cobbles of brick and concrete and occasional boulders of concrete. Gravel consisted of flint, limestone, fragments of brick, concrete, occasional bituminous coated material, rare plastic, timber and metal.

5.1.4 The fine Made Ground soils comprised firm to stiff medium to high strength brown, dark brown and orange brown sandy gravelly to very gravelly clay. Gravels consisted of flint occasional limestone, chalk, and fragments of brick, concrete rare metal, timber and plastic. Occasional rootlets and roots (up to 50mm in diameter) and generally were observed throughout.

5.1.5 Made Ground deposits observed in exploratory locations TP01, TP05, TP02 and DTS06, DTS07 and DTS08 comprised a layer of chalk at depths in a range of 0.3m to 1.5m. The Chalky Made Ground deposits comprised medium strong white slightly sandy gravel and cobbles of angular chalk.

5.1.6 Alluvial deposits were encountered in all exploratory locations at depths below 1.4m Alluvial deposits comprised loose to dense light cream and orange brown slightly clayey slightly sandy gravel with local boulder-sized lenses of sandy gravelly clay observed at depths below 2m. Gravel consisted of fine to coarse angular to rounded flint and extended beyond the termination depths of the boreholes and trial pits.

5.1.7 The following table summarises the geology encountered;

Table summarising soil types				
Strata	**Depth to top (m)**	**Depth to bottom (m)**	**Thickness (m)**	**Summary description**
Made Ground	0.0m	1.3-2.0	1.3-2.0	Mixture of fine, coarse and chalky soils comprising anthropogenic fragments
Alluvium	1.3-2.0	Beyond depth of termination	N/A	Light cream clayey sandy gravels and cobbles of flint

Table 5.1.7

5.2 Groundwater

5.2.1 Groundwater inflows were observed in many of the exploratory excavations. A summary of our observations is tabulated below:

Table summarising groundwater observations			
Exploratory point	**Date of observation**	**Depth (m) below ground levels**	**Observations**
TP01	16/09/16	2.15	Groundwater inflows from 2.15m. Groundwater level at 2.3 on completion
TP02	16/09/16	1.9	Groundwater inflows from 1.9m. Groundwater level at 1.9 on completion
TP03	16/09/16	2.15	Groundwater inflows from 2.15m. Groundwater level at 2.25m on completion
TP04	16/09/16	2.0	Groundwater inflows from 2.0m. Groundwater level at 2.8m on completion
TP05	16/09/16	2.3	Groundwater inflows from 2.3m promoting collapse of trial pit from 1.8m
TP06	16/09/16	2.0	Groundwater seepages from 2.0m promoting collapse of trial pit.
TP07	16/09/16	2.15	Groundwater inflows from 2.15m. Groundwater level at 2.2m on completion promoting collapse from this depth.
TP08*	15/09/16	1.4	Groundwater inflows from 1.4m. Groundwater level at 2.0m on completion, collapse of trial pit from 1.8m
TP09*	15/09/16	1.1	Groundwater inflows from 1.1m. Groundwater level at 2.1m 5 minutes after completion, collapse of trial pit from 1.5m
DTS01*	15/09/16	1.25	Groundwater strike at 1.25m.
DTS02*	15/09/16	0.95	Groundwater strike at 0.95m
	30/09/16	1.93	Monitoring observation
	10/10/16	2.05	Monitoring observation
	28/10/16	1.56	Monitoring observation
DTS03*	15/09/16	1.25	Groundwater measured at 1.25m
	30/09/16	1.88	Monitoring observation
	10/10/16	1.98	Monitoring observation
	28/10/16	1.34	Monitoring observation
DTS04*	15/09/16	1.54	Groundwater strike at 1.54m remained stable on completion
DTS05	16/09/16	1.5	Groundwater strike at 1.5m, remained stable 5 minutes after completion
DTS06	16/09/16	1.8	Groundwater strike at 1.8m

Table summarising groundwater observations			
Exploratory point	**Date of observation**	**Depth (m) below ground levels**	**Observations**
DTS07	16/09/16	1.7	Groundwater strike at 1.75m
	30/09/16	1.05	Monitoring observation
	10/10/16	1.08	Monitoring observation
	28/10/16	2.65	Monitoring observation
DTS08	16/09/16	-	No groundwater observed on completion
	30/09/16	1.08	Monitoring observation
	10/10/16	0.73	Monitoring observation
	28/10/16	2.94	Monitoring observation

Table 5.2.1
***Exploratory locations undertaken outside the proposed site boundaries**

5.2.2 It should be noted that water levels will vary depending generally on recent weather conditions and only long term monitoring of levels in standpipes will provide a measure of seasonal variations in groundwater levels.

5.3 Evidence of contamination

5.3.1 During the excavation of our exploratory points, evidence of potential contamination was identified; however, specific contaminant observations are presented below;

Table summarising contamination observations			
Exploratory point	**Depth of contamination**	**Strata**	**Description**
TP01	0.45-0.50	Made Ground	Greyish blue coloured sand and gravel soils which exposed a slight hydrocarbon contamination odour

Table 5.3.1

5.4 Obstructions and instability

5.4.1 No in-ground obstructions were identified during our site investigations. Generally trial pit excavations were terminated prematurely when excavations extended beyond the level of groundwater as it promoted the collapse of the pit. Where driven tube samplers encountered groundwater levels, the use of casing allowed drilling to achieve depths below groundwater table.

7.3 Influence of trees and other major vegetation

7.3.1 Soil classification and new foundation design

7.3.1.1 The results of plastic and liquid limit determinations performed on near surface samples of the Made Ground and Alluvium indicate the deposits vary between non-shrinkable to medium volume change potential when classified in accordance with National House Building Council (NHBC) Standards, Chapter 4.2. Adopting a worst case medium volume change then foundations taken down onto a depth of 0.9m will penetrate the zone of shrinkage and swelling caused by seasonal wetting and drying. Trees and other major vegetation extend this zone and will require deeper foundations. A good guide to this subject is provided in NHBC Standards, Chapter 4.2.

7.3.2 Tree species identification

7.3.2.1 There are a number of trees and other major vegetation at the site. We recommend a qualified Arboriculturist (listed in the Arboricultural Association Directory of Consultants – www.trees.org.uk) be appointed to determine the location, height (and mature height) and water demand of all trees/major hedgerows at the site, information, which will be necessary to design foundations in accordance with NHBC Standards, Chapter 4.2.

7.4 Service Trench Excavations

7.4.1 Generally, the sides of trench excavations will remain stable in the short term. As described in Section 7.2.10 above, groundwater will likely be encountered from 1.9m, with water standing around 1m based on return monitoring visits. Groundwater inflows will promote progressive instability in trench sides requiring continuous trench sheet shoring to maintain an open excavation. We anticipate water will be controlled with nominal pumping techniques.

7.4.2 We recommend any trench excavation requiring human entry is shored as necessary to conform with current best practice, and accepted by the Health and safety Executive (HSE) and in particular, following guidance provided in the HSE publication 'Health and safety in construction (HSG 150)' (www.hse.gov.uk).

7.5 Infiltration Potential

7.5.1 Requirements for use of infiltration systems

7.5.1.1 It is a requirement under H3 (3) of the current building regulations to discharge stormwater collected by a development to soakaways as a priority (as opposed to water courses and sewers).

7.5.2 Contamination considerations

7.5.2.1 With reference to Environment Agency (EA) publication '*Groundwater protection: Policy and practice (GP3) Section G,* 2012, outside of SPZ1, the EA will support sustainable drainage systems for new discharges to ground. This is subject to an appropriate risk assessment to demonstrate that ground conditions are suitable and infiltration systems do not present an unacceptable risk of promoting mobilisation of contaminants or creating new pathways for contaminant migration.

7.5.3 Assessment following fieldwork investigations

7.5.3.1 Although, it is possible that the predominantly granular deposits of the Alluvium could dispose of stormwater using infiltration systems, laboratory testing undertaken on two groundwater samples indicates presence of contaminants above their respective guideline values. While the respective leachate testing did not show presence of contaminants which could potentially be derived from leachable concentrations within the Made ground deposits. Considering a worst-case scenario in which soakaways will discharge rainwater through Made Ground, this would promote leaching of chemical contaminants in the soil sufficient to cause concern. On this basis, the use of soakways systems would be only recommended if design allows for discharge within the naturally deposits Alluvium avoiding any discharge within the Made Ground deposits.

7.5.3.2 Whilst groundwater was recorded to be standing at a depth as shallow as 1m, it is possible that permeable paving could be used, with any chamber sealed through Made Ground. In addition, Brockhampton Stream flows along the southern boundary of the site, it may be possible to discharge rainwater into the stream. This may be preferential to percolating through a permeable paving.

7.5.3.3 If either of these solutions are sought, advice and permission from the Environmental Agency will be required.

7.6 Pavement Foundations

7.6.1 It is anticipated that the proposed access road and associated hardstanding areas will be located at or about existing ground levels with formation located on Made Ground soils.

7.6.2 Equilibrium CBR (California Bearing Ratio) values (with reference to Transport and Road Research Laboratory (TRRL) Report LR1132 '*Structural design of Bituminous Roads*') are derived from knowledge of soil classification data (plasticity index for soils exhibiting cohesion (clay type) and particle size distribution for granular soils), the location of the water table pavement thickness, and weather conditions at the time of construction. It is anticipated that excavations to formation levels will encounter a mixture of both granular and cohesive soils. Granular soils will provide numerically high CBR values, but cohesive soils will typically provide significantly lower values. Assuming an average plasticity index of 30 for cohesive soils, a low water table, a 'thin' pavement the following equilibrium CBR values are derived for varying construction conditions.

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Key

- DTS — Approximate location of borehole formed by Driven Tube Sampling techniques
- DTS/ DP — Approximate location of borehole formed by Driven Tube Sampling techniques and Dynamic Penetration testing
- DTS — Approximate location of borehole formed by Driven Tube Sampling techniques with standpipe installation
- TP — Approximate location of trial pit excavation
- P1 — Approximate location and orientation of photographic record
- Approximate location of former features taken from a topographical survey dated October 2014

Notes

Base drawing provided by Travis Perkins

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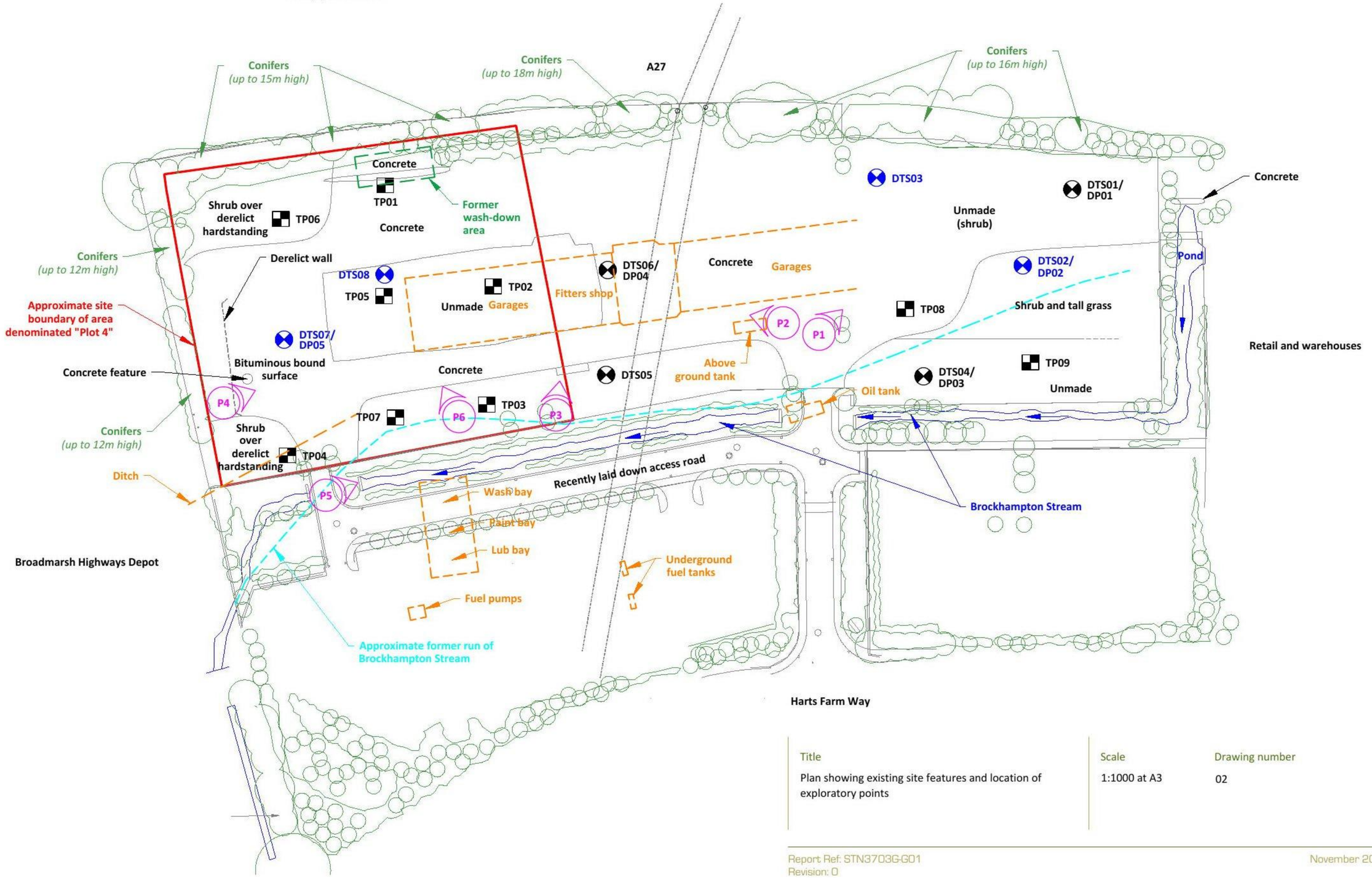

Title	Scale	Drawing number
Plan showing existing site features and location of exploratory points	1:1000 at A3	02

Commercial development
Harts Farm Way, Havant

Key

- DTS — Approximate location of borehole formed by Driven Tube Sampling techniques
- DTS/ DP — Approximate location of borehole formed by Driven Tube Sampling techniques and Dynamic Penetration testing
- DTS — Approximate location of borehole formed by Driven Tube Sampling techniques with standpipe installation
- TP — Approximate location of trial pit excavation

Notes

Base drawing provided by Travis Perkins

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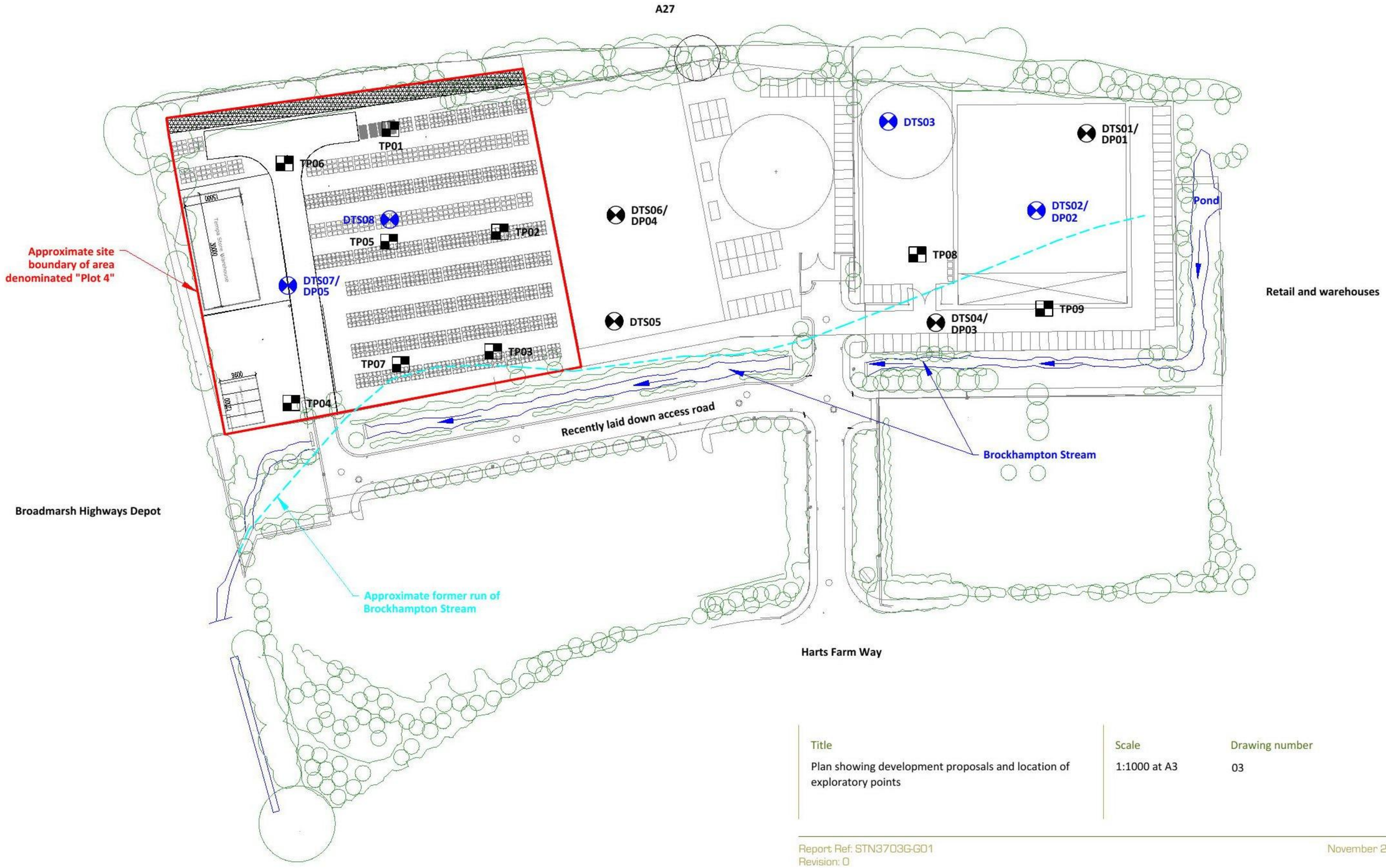

Title	Scale	Drawing number
Plan showing development proposals and location of exploratory points	1:1000 at A3	03

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DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS TYPE/ DEPTH (m)	TEST RESULTS RESULT	SAMPLING FROM (m)	SAMPLING TO (m)	SAMPLING TYPE
BITUMINOUS BOUND MATERIAL. (MADE GROUND)		0.10						
Dense orange brown SAND and GRAVEL. Gravel consists of flint. Slight TPH odour noted. (MADE GROUND)						0.20		D
...band of greyish blue SAND and GRAVEL on northern side of trial pit between 0.45m and 0.5m depth.						0.50		ES
White mottled cream and orange brown slightly clayey slightly sandy GRAVEL. Gravel consists of chalk. Clasts are angular medium strong. (MADE GROUND)		0.55						
Stiff high strength dark brown to greyish brown slightly sandy gravelly CLAY. Gravel consists of flint and chalk. (MADE GROUND)		0.90		PP 1.00	PP=142	1.00		D
...becoming lighter in colour and very sandy from 1.2m depth.				PP 1.20 PP 1.30	PP=117 PP=92			
Dense cream slightly clayey to clayey very sandy GRAVEL with occasional cobbles of flint. Gravel consists of fine to coarse angular to sub-rounded flint. (ALLUVIUM)		1.40	▼			1.60		D
...becoming orange brown in colour from 2.25m depth.								
TRIAL PIT TERMINATED AT 2.80m		2.80						

Notes: Collapse of trial pits sides by approximately 0.4m from 1.5m depth. Trial pit terminated at 2.8m due to collapse of sides promoted by groundwater inflows. Density of coarse soils gauged by the ease of excavation.

Ground level (mAOD)

Co-ordinates
470676, 105930

Title
Trial pit record

Surface breaking
Yes

Groundwater observations
Groundwater inflows at 2.15m depth.
Groundwater level at 2.3m upon completion.

Dimensions (W x L)
0.60m x 2.30m

Date of excavation (range if applicable)
16/09/2016

Appendix
C

Method of excavation
JCB 3CX

Location plan on drawing number
02

TP01

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DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS TYPE/ DEPTH (m)	TEST RESULTS RESULT	SAMPLING FROM (m)	SAMPLING TO (m)	SAMPLING TYPE
Grass and construction debris onto dark brown slightly clayey very gravelly SAND. Gravel consists of brick, flint, concrete, occasional fragments of plastic, timber, charcoal and rare ash. (MADE GROUND)		0.30				0.10		D
						0.20		D
Cream to white slightly sandy GRAVEL. Gravel consists of chalk. Clasts are angular medium strong and very frequent cobbles of chalk (MADE GROUND)						0.60		B
Stiff dark brown slightly sandy gravelly to very gravelly CLAY. Gravel consists of fine to coarse angular to sub-rounded flint. (MADE GROUND)		1.30				1.40		B
Medium dense light greyish brown slightly clayey slightly sandy to sandy GRAVEL. Gravel consists of fine to coarse angular to sub-rounded flint. (ALLUVIUM)		1.70	▼			2.00		B
						2.40		B
TRIAL PIT TERMINATED AT 2.60m		2.60						

Notes: Trial pit collapsed from 1.8m depth, widening pit by 0.3m each side. Unable to excavate further due to collapse promoted by groundwater inflows.

Ground level (mAOD)

Co-ordinates
470676, 105930

Title
Trial pit record

Surface breaking
No

Groundwater observations
Groundwater strike at 1.9m depth.
Groundwater level at 1.9m upon completion.

Dimensions (W x L)
0.60m x 2.20m

Date of excavation (range if applicable)
16/09/2016

Appendix
C

Method of excavation
JCB 3CX

Location plan on drawing number
02

TP02

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DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS TYPE/ DEPTH (m)	TEST RESULTS RESULT	SAMPLING FROM (m)	SAMPLING TO (m)	SAMPLING TYPE
Gravels of flint, chalk, limestone and granite over brown mottled white slightly clayey SAND and GRAVEL with occasional rootlets up to 2mm in diameter. Gravel consists of flint, occasional brick, concrete, chalk, plastic and metal. (MADE GROUND)						0.10		D
						0.30		D
Firm high strength dark brown slightly sandy gravelly CLAY. Gravel consists of fine to coarse flint, occasional chalk and organic remains. Slight organic odour noted. (MADE GROUND)		0.60		PP 0.80	PP=75			
				PP 1.00	PP=83	1.00		D
Soft to firm light bluish grey sandy very gravelly CLAY. Gravel consists of fine to coarse angular to sub-rounded flint. (MADE GROUND)		1.30						
						1.80		B
Medium dense light grey clayey very sandy GRAVEL. Gravel consists of fine to coarse flint. (ALLUVIUM)		2.00						
						2.30		B
...becoming slightly sandy GRAVEL with occasional boulder-sized lenses of clayey gravelly sand from 2.5m depth.		2.60						
TRIAL PIT TERMINATED AT 2.60m								

Notes: Unable to excavate further due to collapse of trial pit sides by 0.5m from 1.5m depth promoted by groundwater inflows.

Ground level (mAOD)

Co-ordinates
470649, 105913

Title
Trial pit record

Surface breaking
No

Groundwater observations
Groundwater at 2.25m depth upon completion, inflow from 2.15m depth.

Dimensions (W x L)
0.60m x 2.40m

Date of excavation (range if applicable)
16/09/2016

Appendix
C

Method of excavation
JCB 3CX

Location plan on drawing number
02

TP03

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DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS TYPE/ DEPTH (m)	TEST RESULTS RESULT	SAMPLING FROM (m)	SAMPLING TO (m)	SAMPLING TYPE
Gravels of brick, concrete and flint onto BITUMINOUS BOUND MATERIAL. (MADE GROUND)		0.10						
Dark brown mottled brown and black slightly clayey SAND and GRAVEL with frequent cobbles and boulders of brick and concrete. Gravel consists of bituminous coated material, fragments of metal, plastic, flint, limestone and pottery. (MADE GROUND)		0.50				0.20		D
						0.30		D
Loose brown to light brown slightly clayey SAND and GRAVEL. Gravel consists of brick, concrete and flint. (MADE GROUND)						0.60		D
Firm medium to high strength dark brown and dark grey slightly sandy gravelly CLAY with occasional rootlets up to 10mm in diameter. Gravel consists of fine to coarse flint. (MADE GROUND)		1.40		PP 1.50	PP=58	1.50		D
				PP 1.50	PP=83			
				PP 1.70	PP=75			
...roots up to 50mm in diameter between 1.7m and 2.2m depth.		1.75				1.80		B
Medium dense to dense dark bluish grey slightly sandy to sandy clayey GRAVEL. Gravel consists of fine to coarse angular to sub-rounded flint. (ALLUVIUM)			▼					
...becoming lighter in colour from 1.9m depth.						2.20		B
...becoming white in colour from 3.0m depth.			▼			3.20		B
TRIAL PIT TERMINATED AT 3.50m		3.50						

Notes: Trial pit collapsed from 1.8m depth, widening pit by 0.3-0.4m each side

Ground level (mAOD)

Co-ordinates
470588, 105889

Title
Trial pit record

Surface breaking
Yes

Groundwater observations
Groundwater inflows 2.0m depth. Groundwater level at 2.8m upon completion.

Dimensions (W x L)
0.60m x m

Date of excavation (range if applicable)
16/09/2016

Appendix
C

Method of excavation
JCB 3CX

Location plan on drawing number
02

TP04

Commercial development

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DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS		SAMPLING		
				TYPE/ DEPTH (m)	RESULT	FROM (m)	TO (m)	TYPE
Grass and construction debris onto dark brown slightly clayey gravelly SAND with roots up to 2mm in diameter. Gravel consists of flint, brick, concrete, occasional plastic and timber. (MADE GROUND)						0.10 0.20		D D
Medium dense to dense brown slightly clayey slightly sandy GRAVEL. Gravel consists of chalk and occasional fragments of brick. (MADE GROUND)		0.40				1.00		D
Firm to stiff medium strength orange brown slightly sandy gravelly to very gravelly CLAY. Gravel consists of fine to coarse flint. (MADE GROUND)		1.50		PP 1.60	PP=67	1.50		D
Medium dense to dense orange brown clayey very sandy GRAVEL with frequent cobbles of flint and occasional cobble to boulder-sized lenses of bluish grey clayey fine to medium sand. Gravel consists of fine to coarse flint. (ALLUVIUM)		1.80				2.50		B
TRIAL PIT TERMINATED AT 3.20m		3.20						

Notes: Trial pit collapsed from 1.8m depth (due to groundwater inflows), widening pit 0.4m each side.

Ground level (mAOD)	**Co-ordinates** 470624, 105940	**Title** Trial pit record	**Surface breaking** No
Groundwater observations Groundwater inflows from 2.3m depth.	**Dimensions (W x L)** 0.60m x 2.20m	**Date of excavation (range if applicable)** 16/09/2016	**Appendix** C
	Method of excavation JCB 3CX	**Location plan on drawing number** 02	**TP05**

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DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS TYPE/ DEPTH (m)	TEST RESULTS RESULT	SAMPLING FROM (m)	SAMPLING TO (m)	SAMPLING TYPE
Grass onto derelict BITUMINOUS BOUND MATERIAL. (MADE GROUND)								
Loose dark grey mottled orange brown and black SAND and GRAVEL with rootlets up to 2mm in diameter. Gravel consists of bituminous coated material, flint, brick, rare fragments of plastic and metal. (MADE GROUND)		0.20				0.20		D
						0.30		D
		0.45						
Firm to stiff dark greenish brown slightly sandy to sandy slightly gravelly CLAY. Gravel consists of fine to coarse flint. (MADE GROUND)				PP 0.60	PP=108			
						0.70		D
				PP 0.80	PP=100			
...becoming gravelly from 1.0m depth.								
				PP 1.20	PP=108	1.20		B
		1.45						
Medium dense to dense light grey to cream and orange brown clayey sandy GRAVEL with occasional boulder-sized lenses of firm orange brown sandy very gravelly clay. Gravel consists of fine to coarse angular to sub-rounded flint. (ALLUVIUM)						1.60		B
						2.60		B
TRIAL PIT TERMINATED AT 3.00m		3.00						

Notes: Trial pit collapsed due to groundwater seepage promoting instability from 1.8m depth, widening pit by 0.5m each side.

Ground level (mAOD)	**Co-ordinates** 470599, 105953	**Title** Trial pit record	**Surface breaking** Yes
Groundwater observations Minor groundwater seepages from 2.0m depth.	**Dimensions (W x L)** 0.60m x 2.60m	**Date of excavation (range if applicable)** 16/09/2016	**Appendix** C
	Method of excavation JCB 3CX	**Location plan on drawing number** 02	**TP06**

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DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS TYPE/ DEPTH (m)	TEST RESULTS RESULT	SAMPLING FROM (m)	SAMPLING TO (m)	SAMPLING TYPE
Loose dark brown slightly clayey very gravelly SAND with rootlets up to 2mm in diameter and occasional boulders of concrete. Gravel consists of flint, brick, concrete, limestone and occasional bituminous coated material. (MADE GROUND)						0.10		D
						0.20		ES
						0.30		D
Firm to stiff dark brown sandy gravelly CLAY with occasional rootlets up to 5mm in diameter. Gravel consists of fine to coarse angular to sub-rounded flint. (MADE GROUND)		0.50						
						0.80		D
Soft very sandy very gravelly CLAY. Gravel consists of fine to coarse angular to sub-rounded flint. (MADE GROUND)		1.40				1.50		D
Medium dense light grey slightly clayey sandy GRAVEL. Gravel consists of fine to coarse angular to sub-rounded flint. (ALLUVIUM)		1.80				2.00		D
...becoming orange brown in colour from 2.4m depth.								
TRIAL PIT TERMINATED AT 2.60m		2.60						

Notes: Trial pit collapsed from 2.2m depth, widening pit by 0.4m each side. Trial pit terminated at 2.6m due to collapse promoted by groundwater inflows.

Ground level (mAOD)

Co-ordinates
470622, 105901

Title
Trial pit record

Surface breaking
No

Groundwater observations
Groundwater inflows from 2.15m depth.
Groundwater level at 2.2m upon completion.

Dimensions (W x L)
0.60m x 2.50m

Date of excavation (range if applicable)
16/09/2016

Appendix
C

Method of excavation
JCB 3CX

Location plan on drawing number
02

TP07

Commercial development

Harts Farm Way, Havant

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DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS TYPE/ DEPTH (m)	TEST RESULTS RESULT	SAMPLING FROM (m)	SAMPLING TO (m)	SAMPLING TYPE
Unreinforced grey CONCRETE. (MADE GROUND)								
Medium dense orange brown SAND and GRAVEL. Gravel consists of fine to coarse flint, occasional chalk and concrete fragments. (MADE GROUND)		0.20				0.20		D
Medium dense to dense cream to white slightly clayey slightly sandy GRAVEL. Gravel consists of chalk. Chalk clasts are weak to medium strong medium density and angular. (ALLUVIUM)		0.45				0.50		D
Firm dark brown mottled white and orange brown slightly sandy very gravelly CLAY. Gravel consists of fine to coarse angular to sub-rounded flint and occasional chalk. (ALLUVIUM)		0.70				0.70		ES
Medium dense cream slightly silty slightly sandy GRAVEL with frequent cobbles of flint. Gravel consists of fine to coarse angular to sub-rounded flint. (ALLUVIUM)		1.00				0.90		D
...becoming orange brown in colour from 1.5m depth.						1.50		B
...occasional boulder-sized lenses of clayey sandy gravel from 2.0m depth.						2.00		B
TRIAL PIT TERMINATED AT 2.50m		2.50						

Notes: Collapse of trial pits sides by approximately >0.5m from 1.8m depth. Unable to excavated further due to collapsed promoted by groundwater inflows.

Ground level (mAOD)

Co-ordinates
470758, 105933

Title
Trial pit record

Surface breaking
Yes

Groundwater observations
Grounfwater inflows from 1.4m depth.
Groundwater level at 2.0m upon completion.

Dimensions (W x L)
0.60m x 2.90m

Date of excavation (range if applicable)
16/09/2016

Appendix
C

Method of excavation
JCB 3CX

Location plan on drawing number
02

TP08

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DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS TYPE/ DEPTH (m)	TEST RESULTS RESULT	SAMPLING FROM (m)	SAMPLING TO (m)	SAMPLING TYPE
Shrub onto brown to dark brown slightly clayey SAND and GRAVEL with occasional boulders of concrete up to 250x300x250mm in size and with frequent rootlets and roots up to 5mm in diameter. Gravel consists of brick, concrete, bituminous coated material, timber, occasional plastic, flint and limestone. (MADE GROUND)						0.20		D
						0.40		D
						0.50		ES
						0.80		B
Medium dense to dense cream to light grey slightly clayey sandy GRAVEL with frequent cobbles of flint. Gravel consists of fine to coarse angular to sub-rounded flint. (ALLUVIUM)		1.10	▼					
						1.40		B
Medium dense cream and orange brown slightly silty slightly sandy to sandy GRAVEL with occasional cobbles of flint. Gravel consists of fine to coarse angular to sub-rounded flint. (ALLUVIUM)		2.00						
						2.20		B
Firm orange brown slightly silty slightly sandy very gravelly CLAY with frequent cobbles of flint. Gravel consists of flint. (ALLUVIUM)		2.50				2.50		B
TRIAL PIT TERMINATED AT 2.80m		2.80						

Notes: Collapse of trial pit sides from 1.5m depth. Unable to excavate further due to collapse of trial pit sides by >0.5m caused by groundwater inflows.

Ground level (mAOD)

Co-ordinates
470496, 105926

Title
Trial pit record

Surface breaking
No

Groundwater observations
Groundwater inflows at 1.15m depth.Groundwater level at 2.5m, 5 minutes upon completion.

Dimensions (W x L)
0.60m x 3.00m

Date of excavation (range if applicable)
16/09/2016

Appendix
C

Method of excavation
JCB 3CX

Location plan on drawing number
02

TP09

soiltechnics
environmental and geotechnical consultants

WELL	DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS				SAMPLING		
					TYPE/ DEPTH (m)	RESULT	CASING DEPTH (m)	WATER LEVEL (m)	FROM (m)	TO (m)	TYPE
	Dark brown slightly clayey SAND and GRAVEL with rare rootlets up to 2mm in diameter. Gravel consists of fine to coarse angular to sub-angular limestone, concrete, brick and flint. (MADE GROUND)		0.30						0.20		D
									0.30		ES
									0.40		D
	[Medium dense] dark brown slightly sandy clayey GRAVEL in a clayey matrix. Gravel consists of flint and rare brick. (MADE GROUND)								0.60		D
			0.80						0.80		D
	Soft light greyish brown sandy very gravelly CLAY. Gravel consists of fine to coarse flint. (MADE GROUND)		1.00						1.00	1.70	D
	[Loose] orange brown slightly silty slightly sandy GRAVEL. Gravel consists of fine to coarse angular flint. (MADE GROUND)										
			1.80								
	Soft to firm orange brown to dark brown slightly sandy very gravelly CLAY. Gravel consists of fine to coarse angular to sub-rounded flint. (MADE GROUND)		2.00						2.00	2.60	B
	[Loose to medium dense] light brown and grey slightly clayey to clayey sandy GRAVEL. Gravel consists of fine to coarse angular to sub-rounded flint. (ALLUVIUM)										
	BOREHOLE TERMINATED AT 3.00m		3.00								

Notes: Borehole collapsed from 1.7m depth. 50% recovery between 1.0m to 2.5m depth. Density of coarse soils inferred from nearest dynamic probing. For dynamic probing, refer to DP01.

Ground level (mAOD)

Co-ordinates
470820, 105964

Title
Driven tube sampler borehole record

Surface breaking
No

Groundwater observations
Groundwater encountered at 1.25m depth, rising to 0.95m after collapse of borehole.

Date of excavation (range if applicable)
15/09/2016

Appendix
D

Location plan on drawing number
02

DTS01

Commercial development

Harts Farm Way, Havant

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WELL	DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS				SAMPLING		
					TYPE/ DEPTH (m)	RESULT	CASING DEPTH (m)	WATER LEVEL (m)	FROM (m)	TO (m)	TYPE
	[Medium dense] dark brown slightly sandy GRAVEL. Gravel consists of angular to sub-angular brick, bituminous coated material and limestone. (MADE GROUND)		0.25						0.20		D
									0.40		D
	Firm to stiff dark brown slightly sandy slightly gravelly CLAY. Gravel consists of flint, decaying organic material and chalk. (MADE GROUND)		0.70						0.40		ES
									0.60		D
	...becoming very gravelly from 0.5m depth.										
	Soft dark brown slightly sandy very gravelly CLAY. Gravel consists sub-angular to angular flint. (MADE GROUND)		1.00	▼					1.00	1.70	B
	Medium dense to loose brown and grey GRAVEL. Gravel consists of medium to coarse angular to sub-rounded flint. (MADE GROUND)		1.50								
	Loose light brown slightly silty slightly sandy GRAVEL. Gravel consists of fine to coarse angular to sub-rounded flint. (ALLUVIUM)		1.80								
	Loose to medium dense cream and light brown slightly clayey slightly sandy GRAVEL. Gravel consists of fine to coarse angular to sub-rounded flint. (ALLUVIUM)										
	...becoming clayey and very sandy from 2.2m depth.										
	Soft light brown to orange brown slightly sandy to sandy very gravelly CLAY with occasional gravels of angular to sub-angular fine to coarse chalk. Gravel consists of fine to coarse angular to sub-rounded flint. (ALLUVIUM)		2.50						2.60	2.80	B
									3.50	4.00	B
	BOREHOLE TERMINATED AT 4.00m		4.00								

Notes: Standpipe installed to 3m depth. Standpipe 0.85m above ground level. For dynamic probing, refer to DP02.

Ground level (mAOD)

Co-ordinates
470802, 105944

Title
Driven tube sampler borehole record

Surface breaking
No

Groundwater observations
Groundwater encountered at 0.95m depth.

Date of excavation (range if applicable)
15/09/2016

Appendix
D

Location plan on drawing number
02

DTS02

Commercial development

Harts Farm Way, Havant

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WELL	DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS				SAMPLING		
					TYPE/ DEPTH (m)	RESULT	CASING DEPTH (m)	WATER LEVEL (m)	FROM (m)	TO (m)	TYPE
	Firm to stiff brown to dark brown gravelly very sandy CLAY. Gravel consists of fine to medium flint, occasional fragments of brick and bituminous coated material. (MADE GROUND)		0.30						0.10		D
	becoming dark brown in colour from 0.25m depth.								0.40		ES
	Stiff becoming firm high to low strength dark brown slightly sandy gravelly to very gravelly CLAY with occasional rootlets up to 2mm in diameter and decayed fragments of organic matter. Gravel consists of fine to coarse flint, occasional chalk and brick. (MADE GROUND)		1.00		PP 0.50	PP=75			0.50		D
					PP 0.70	PP=92					
					PP 0.90	PP=33			0.90		D
	Very soft light bluish grey slightly sandy silty very gravelly CLAY. Sand is fine. Gravel consists of fine to coarse angular to sub-rounded flint. (ALLUVIUM)								1.40		D
	[Loose to medium dense] light grey slightly clayey sandy GRAVEL. Sand is medium to coarse. Gravel consists of fine to coarse angular to sub-rounded flint. (ALLUVIUM)		1.90						2.50	3.00	B
	(NO RECOVERY)		3.00								
	BOREHOLE TERMINATED AT 4.00m		4.00								

Notes: Standpipe installed to 3m depth. Standpipe 0.3m above ground level. Borehole collapsed from 3.0m depth. Density of coarse soils inferred from nearest dynamic probing.

Ground level (mAOD)

Co-ordinates
470745, 105970

Title
Driven tube sampler borehole record

Surface breaking
No

Groundwater observations
Groundwater measured at 1.15m depth 2 minutes after completion.

Date of excavation (range if applicable)
15/09/2016

Appendix
D

Location plan on drawing number
02

DTS03

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WELL	DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS				SAMPLING		
					TYPE/ DEPTH (m)	RESULT	CASING DEPTH (m)	WATER LEVEL (m)	FROM (m)	TO (m)	TYPE
	Light brown gravelly SAND. Gravel consists of rounded to angular fine to coarse flint and limestone. (MADE GROUND)		0.30						0.20		D
	Firm dark brown clayey sandy GRAVEL with rare rootlets up to 2mm in diameter and occasional organic remains. Gravel consists of sub-rounded to angular medium to coarse limestone, angular fine to coarse flint and brick. (MADE GROUND)		0.60						0.50		D
	Stiff dark brown mottled white slightly sandy very gravelly CLAY. Gravel consists of fine to coarse flint and chalk. (MADE GROUND)		0.90						0.70		D
	...cobble of chalk at 0.75m depth.										
	Medium dense dark brown clayey sandy GRAVEL. Gravel consists of angular to sub-rounded fine to coarse flint. (ALLUVIUM)		1.50	▼					1.50	2.00	B
	Medium dense light brown mottled orange brown slightly silty slightly sandy GRAVEL. Gravel consists of angular to sub-rounded fine to coarse flint. (ALLUVIUM)								2.00	3.00	B
	...becoming slightly clayey with occasional cobbles of flint at 3.8m depth.										
	BOREHOLE TERMINATED AT 4.00m		4.00								

Notes: For dynamic probing, refer to DP03.

Ground level (mAOD)

Co-ordinates
470763, 105911

Title
Driven tube sampler borehole record

Surface breaking
No

Groundwater observations
Groundwater strike at 1.54m depth. Level remained stale on completion.

Date of excavation (range if applicable)
15/09/2016

Appendix
D

Location plan on drawing number
02

DTS04

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WELL	DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS				SAMPLING		
					TYPE/ DEPTH (m)	RESULT	CASING DEPTH (m)	WATER LEVEL (m)	FROM (m)	TO (m)	TYPE
	Dark brown slightly silty clayey gravelly SAND with occasional rootlets up to 2mm in diameter. Gravel consists of bituminous coated material and angular to rounded fine to coarse flint. (MADE GROUND)		0.30						0.10		ES
									0.20		D
	Firm grey brown and white slightly sandy gravelly CLAY. Gravel consists of sub-rounded to angular fine to coarse chalk. (MADE GROUND)								0.50		D
	...cobble of chalk at 0.6m depth.		0.80		PP 0.80	PP=83					
	Stiff high strength dark brown slightly sandy slightly gravelly CLAY. Gravel consists of angular to rounded fine to coarse flint. (MADE GROUND)				PP 1.00	PP=117					
	...increase in flint between 1.1m and 1.2m depth.										
	Firm grey brown slightly sandy slightly gravelly clayey SILT. Gravel consists of angular to sub-rounded fine to coarse flint. (ALLUVIUM)		1.30	▼					1.30	1.40	D
	...increase in gravels at 1.7m depth.										
	...organic material between 1.8m and 2m depth.								2.30	2.60	D
	[Loose to medium dense] grey slightly clayey gravelly SAND. Gravel consists of angular to sub-rounded fine to coarse flint. (ALLUVIUM)		2.40								
	[Loose to medium dense] light brown slightly silty slightly sandy GRAVEL. Gravel consist of angular to sub-angular fine to coarse flint. (ALLUVIUM)		2.75								
	BOREHOLE TERMINATED AT 3.00m		3.00								

Notes: Density of coarse soils inferred from nearest dynamic probing.

Ground level (mAOD)

Co-ordinates
470694, 105910

Title
Driven tube sampler borehole record

Surface breaking
No

Groundwater observations
Groundwater encountered at 1.5m depth. Groundwater level remained stable 5 minutes after completion.

Date of excavation (range if applicable)
16/09/2016

Appendix
D

Location plan on drawing number
02

DTS05

Commercial development

Harts Farm Way, Havant

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WELL	DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS				SAMPLING		
					TYPE/ DEPTH (m)	RESULT	CASING DEPTH (m)	WATER LEVEL (m)	FROM (m)	TO (m)	TYPE
	BITUMINOUS BOUND MATERIAL. (MADE GROUND)		0.10						0.10		D
	Medium dense light brown gravelly SAND. Gravel consists of sub-angular to sub-rounded fine to coarse flint and bituminous coated material. (MADE GROUND)		0.50								
	Dense white to light grey slightly sandy GRAVEL. Gravel consists of chalk. Clasts are fine to coarse angular medium strong with very frequent angular cobbles. (MADE GROUND)								0.80	1.00	D
	Light brown gravelly SAND. Gravel consists of sub-angular to sub-rounded fine to coarse flint and bituminous coated material. (MADE GROUND)		1.00								
	..cobble of chalk between 1.25m to 1.35m depth.		1.35								
	Firm dark brown and grey slightly silty slightly sandy gravelly CLAY. Gravel consists of angular to sub-angular fine to coarse flint. (ALLUVIUM)		1.70						1.50		D
	Loose to medium dense light brown to grey slightly clayey gravelly SAND. Gravel consists of sub-angular to rounded fine to coarse flint. (ALLUVIUM)		2.00	▼					1.75	2.00	D
	BOREHOLE TERMINATED AT 2.00m										

Notes: For dynamic probing, refer to DP04.

Ground level (mAOD)

Co-ordinates
470698, 105945

Title
Driven tube sampler borehole record

Surface breaking
Yes

Groundwater observations
Groundwater encountered at 1.8m depth.

Date of excavation (range if applicable)
16/09/2016

Appendix
D

Location plan on drawing number
02

DTS06

Commercial development

Harts Farm Way, Havant

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WELL	DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS				SAMPLING		
					TYPE/ DEPTH (m)	RESULT	CASING DEPTH (m)	WATER LEVEL (m)	FROM (m)	TO (m)	TYPE
	BITUMINOUS BOUND MATERIAL. (MADE GROUND)		0.10								
	Light brown gravelly SAND. Gravel consists of sub-angular to rounded fine to coarse flint and bituminous coated material. (MADE GROUND)		0.50						0.20		D
	Dense white to light grey slightly sandy GRAVEL. Gravel consists of chalk. Clasts are fine to coarse angular medium strong with very frequent angular cobbles. (MADE GROUND)		0.95						0.60	0.90	D
	Firm medium strength dark brown slightly silty slightly sandy CLAY. Gravel consists of angular to rounded fine to coarse flint and occasional decaying organic material. (MADE GROUND)		1.50		PP 1.00	PP=50			1.10		D
	Stiff light brown and grey mottled orange brown slightly silty sandy very gravelly CLAY. Gravel consists of occasional chalk and angular to sub-rounded fine to coarse flint. (MADE GROUND)		1.80	▼					1.50	1.60	D
	Stiff light brown, light grey and white sandy gravelly CLAY. Gravel consists of angular to sub-rounded fine to coarse flint and rounded to sub-rounded fine to coarse chalk. (MADE GROUND)		2.00								
	Medium dense to loose light brown sandy clayey GRAVEL. Gravel consists of sub-angular to rounded fine to coarse flint and sub-rounded fine to medium chalk. (ALLUVIUM)		2.65								
	Firm brown sandy gravelly CLAY. Gravel consists of angular to sub-rounded fine to coarse flint and sub-rounded to rounded fine to medium chalk. (ALLUVIUM)		2.80								
	Loose to medium dense light brown sandy clayey GRAVEL. Gravel consists of sub-angular to rounded fine to coarse flint and sub-rounded fine to medium chalk. (ALLUVIUM)								3.40	4.00	D
	BOREHOLE TERMINATED AT 4.00m		4.00								

Notes: Borehole collapsed to 3.5m depth. Standpipe installed to 0.9m depth. Standpipe 1m above ground level. For dynamic probing, refer to DP05.

Ground level (mAOD)

Co-ordinates
470598, 105919

Title
Driven tube sampler borehole record

Surface breaking
Yes

Groundwater observations
Groundwater encountered at 1.75m depth.

Date of excavation (range if applicable)
16/09/2016

Appendix
D

Location plan on drawing number
02

DTS07

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WELL	DESCRIPTION	LEGEND	DEPTH (m)	WATER STRIKE	TEST RESULTS				SAMPLING		
					TYPE/ DEPTH (m)	RESULT	CASING DEPTH (m)	WATER LEVEL (m)	FROM (m)	TO (m)	TYPE
	Brown gravelly SAND with rootlets up to 5mm in diameter. Gravel consists of brick, bituminous coated material, organic material, fabric sheeting and chalk. (MADE GROUND)		0.30						0.10		D
	[Dense] white to light grey slightly sandy GRAVEL. Gravel consists of chalk. Clasts are fine to coarse angular medium strong with very frequent angular cobbles. (MADE GROUND)		1.30						1.20		D
	Firm brown slightly sandy very gravelly CLAY. Gravel consists of angular to sub-rounded fine to coarse flint. (MADE GROUND)		1.70						1.50		D
	Light brown slightly sandy clayey GRAVEL in a clayey matrix. Gravel consists of angular to sub-rounded fine to coarse flint. (ALLUVIUM)		2.55								
	Firm orange brown slightly sandy gravelly CLAY. Gravel consists of sub-angular to sub-rounded fine to coarse flint and sub-rounded to rounded fine to medium chalk. (ALLUVIUM)		2.70						2.90		D
	[Loose to medium dense] light brown clayey sandy GRAVEL. Gravel consists of angular to sub-rounded flint and sub-rounded fine to medium chalk. (ALLUVIUM)		3.00						2.90		D
	BOREHOLE TERMINATED AT 3.00m										

Notes: Standpipe installed to 3m depth. Standpipe 0.93m above ground level. Density of coarse soils inferred from nearest dynamic probing.

Ground level (mAOD)

Co-ordinates
470636, 105946

Title
Driven tube sampler borehole record

Surface breaking
No

Groundwater observations
No groundwater encountered.

Date of excavation (range if applicable)
16/09/2016

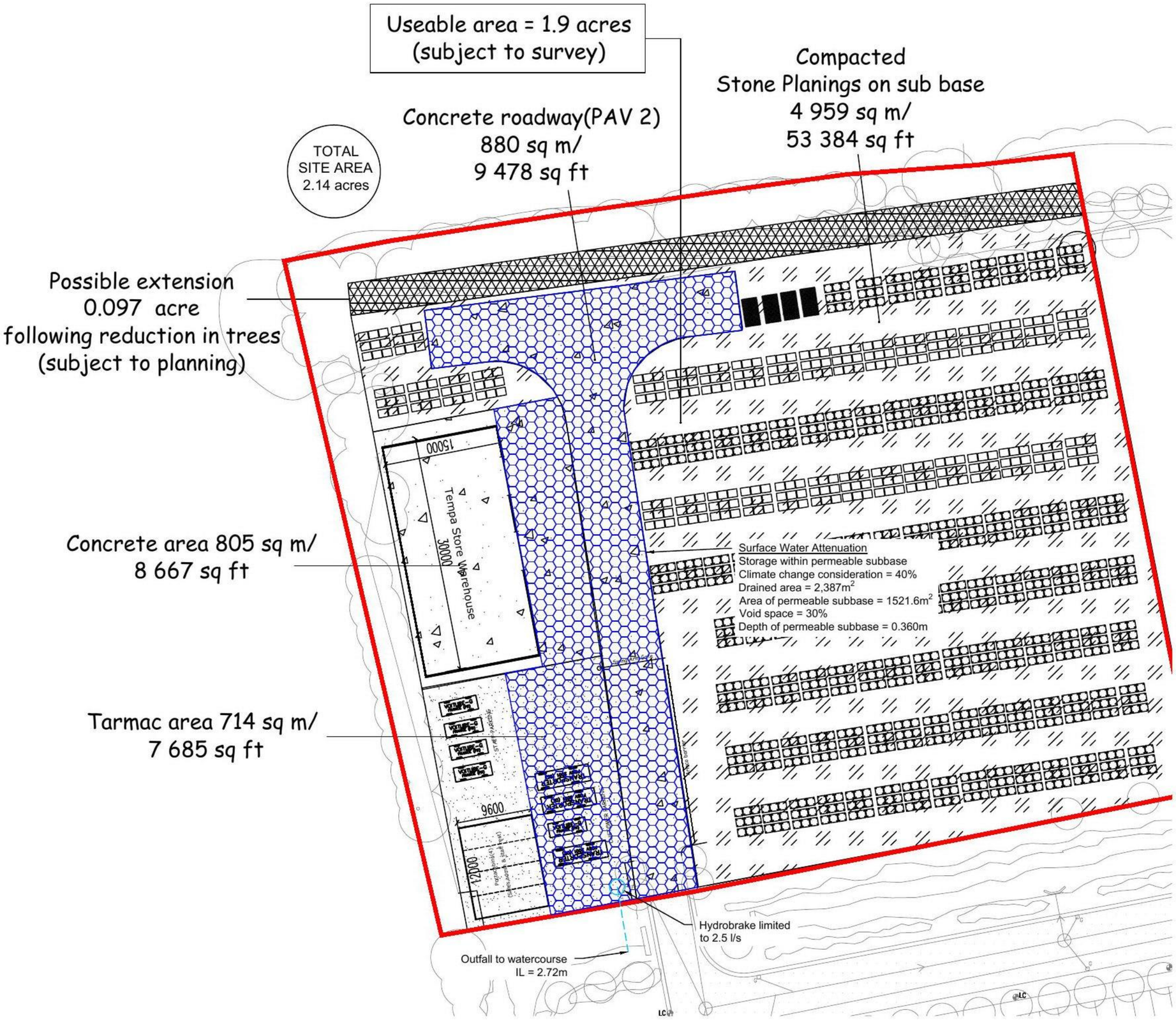
Appendix
D

Location plan on drawing number
02

DTS08

Appendix C

Proposed Drainage Strategy
JPP drawing no. KLHAV1YY-FRA03



KEY

Site Boundary = 8,679m^2

Proposed Impermeable Area = 2,387m^2

Proposed Surface Water Drainage

NOTES

1. Based on Travis Perkins drawing 'Keyline Havant-site2-feasibility' Revision 1.3, dated 13.10.2016.
2. Outfall to watercourse will require permission from Environment Agency to contract the new outfall.
3. It is assumed that Keyline have riparian rights to discharge to the watercourse.

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Client	TRAVIS PERKINS
Project	KEYLINE HAVANT HARTS FARM WAY HAVANT, HAMPSHIRE
Title	PROPOSED SURFACE WATER DRAINAGE STRATEGY

Scale at A3	1:500	Drawn by	KER	Checked by	MJA	Date	17.11.2016

Status	Project ref	Drawing no.	Revision
FOR INFORMATION	KLHAV1YY	FRA03	

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Appendix D
Greenfield Calculations

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.370
Area (ha)	0.239	Urban	0.000
SAAR (mm)	783	Region Number	Region 7

Results	**l/s**
QBAR Rural	0.8
QBAR Urban	0.8
Q100 years	2.5
Q1 year	0.7
Q30 years	1.8
Q100 years	2.5

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Appendix E

Proposed Impermeable Area
JPP drawing no. KLHAV1YY-FRA02

Useable area = 1.9 acres
(subject to survey)

TOTAL
SITE AREA
2.14 acres

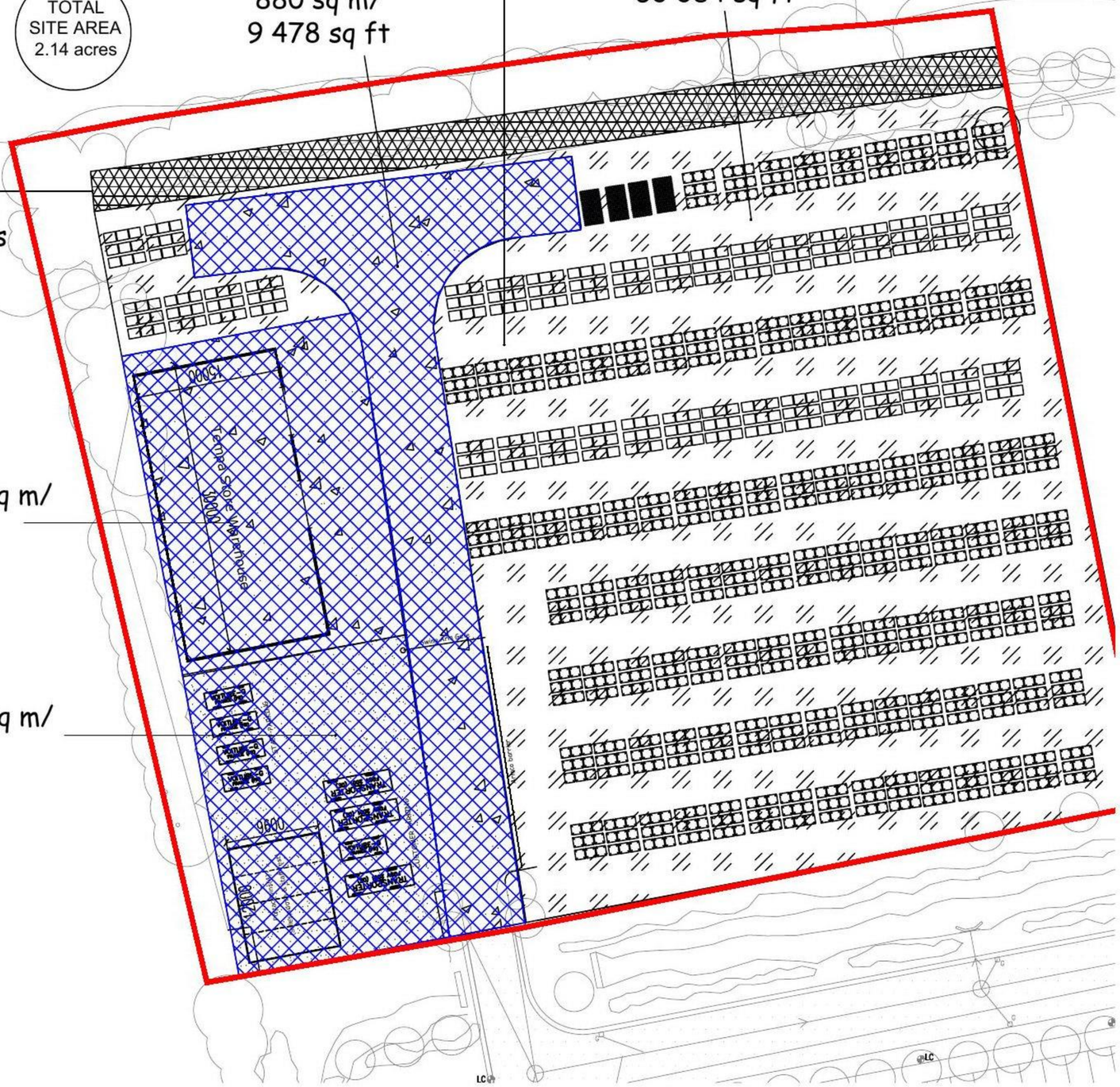
Concrete roadway(PAV 2)
880 sq m/
9 478 sq ft

Compacted
Stone Planings on sub base
4 959 sq m/
53 384 sq ft

Possible extension
0.097 acre
following reduction in trees
(subject to planning)

Concrete area 805 sq m/
8 667 sq ft

Tarmac area 714 sq m/
7 685 sq ft



KEY

Site Boundary = 8,679m^2

Proposed Impermeable Area = 2,387m^2

NOTES

1. Based on Travis Perkins drawing 'Keyline Havant-site2-feasibility' Revision 1.3, dated 13.10.2016

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Client TRAVIS PERKINS

Project KEYLINE HAVANT
HARTS FARM WAY
HAVANT, HAMPSHIRE

Title PROPOSED IMPERMEABLE AREA

Scale at A3 1:500	Drawn by KER	Checked by MJA	Date 17.11.2016

Status	Project ref	Drawing no.	Revision
FOR INFORMATION	KLHAV1YY	FRA02	

jpp consulting
Civil & Structural Engineers

Appendix F
Attenuation Calculations

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 580 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	98.115	0.115	0.0	2.1	2.1	52.6	O K
30 min Summer	98.147	0.147	0.0	2.3	2.3	66.9	O K
60 min Summer	98.184	0.184	0.0	2.4	2.4	83.8	O K
120 min Summer	98.225	0.225	0.0	2.4	2.4	102.8	O K
180 min Summer	98.250	0.250	0.0	2.4	2.4	114.2	O K
240 min Summer	98.267	0.267	0.0	2.4	2.4	121.9	O K
360 min Summer	98.288	0.288	0.0	2.5	2.5	131.4	O K
480 min Summer	98.300	0.300	0.0	2.5	2.5	136.9	O K
600 min Summer	98.309	0.309	0.0	2.5	2.5	141.0	O K
720 min Summer	98.315	0.315	0.0	2.5	2.5	144.0	O K
960 min Summer	98.304	0.304	0.0	2.5	2.5	139.0	O K
1440 min Summer	98.282	0.282	0.0	2.5	2.5	128.5	O K
2160 min Summer	98.248	0.248	0.0	2.4	2.4	113.1	O K
2880 min Summer	98.217	0.217	0.0	2.4	2.4	99.1	O K
4320 min Summer	98.177	0.177	0.0	2.3	2.3	80.9	O K
5760 min Summer	98.146	0.146	0.0	2.3	2.3	66.8	O K
7200 min Summer	98.124	0.124	0.0	2.2	2.2	56.4	O K
8640 min Summer	98.107	0.107	0.0	2.1	2.1	48.7	O K
10080 min Summer	98.096	0.096	0.0	2.0	2.0	43.6	O K
15 min Winter	98.131	0.131	0.0	2.2	2.2	59.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	137.063	0.0	48.4	19
30 min Summer	85.882	0.0	63.4	33
60 min Summer	53.813	0.0	85.8	62
120 min Summer	33.719	0.0	109.8	122
180 min Summer	25.652	0.0	126.5	182
240 min Summer	21.128	0.0	139.7	242
360 min Summer	16.073	0.0	160.3	360
480 min Summer	13.239	0.0	176.6	422
600 min Summer	11.389	0.0	190.2	490
720 min Summer	10.071	0.0	201.9	556
960 min Summer	7.908	0.0	210.8	682
1440 min Summer	5.625	0.0	223.1	952
2160 min Summer	4.000	0.0	241.7	1344
2880 min Summer	3.141	0.0	251.3	1732
4320 min Summer	2.312	0.0	273.3	2504
5760 min Summer	1.860	0.0	293.0	3224
7200 min Summer	1.571	0.0	306.0	3896
8640 min Summer	1.368	0.0	316.3	4584
10080 min Summer	1.218	0.0	324.0	5248
15 min Winter	137.063	0.0	55.6	19

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Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	98.167	0.167	0.0	2.3	2.3	76.1	O K
60 min Winter	98.209	0.209	0.0	2.4	2.4	95.2	O K
120 min Winter	98.256	0.256	0.0	2.4	2.4	116.9	O K
180 min Winter	98.285	0.285	0.0	2.5	2.5	130.1	O K
240 min Winter	98.305	0.305	0.0	2.5	2.5	139.3	O K
360 min Winter	98.331	0.331	0.0	2.5	2.5	151.2	O K
480 min Winter	98.346	0.346	0.0	2.5	2.5	158.1	O K
600 min Winter	98.355	0.355	0.0	2.5	2.5	162.2	O K
720 min Winter	98.360	0.360	0.0	2.5	2.5	164.4	O K
960 min Winter	98.345	0.345	0.0	2.5	2.5	157.5	O K
1440 min Winter	98.312	0.312	0.0	2.5	2.5	142.3	O K
2160 min Winter	98.261	0.261	0.0	2.4	2.4	119.3	O K
2880 min Winter	98.217	0.217	0.0	2.4	2.4	98.9	O K
4320 min Winter	98.159	0.159	0.0	2.3	2.3	72.6	O K
5760 min Winter	98.120	0.120	0.0	2.1	2.1	54.6	O K
7200 min Winter	98.096	0.096	0.0	2.0	2.0	44.0	O K
8640 min Winter	98.084	0.084	0.0	1.8	1.8	38.4	O K
10080 min Winter	98.076	0.076	0.0	1.6	1.6	34.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	85.882	0.0	72.3	33
60 min Winter	53.813	0.0	97.3	62
120 min Winter	33.719	0.0	124.2	120
180 min Winter	25.652	0.0	142.9	178
240 min Winter	21.128	0.0	157.6	236
360 min Winter	16.073	0.0	180.8	348
480 min Winter	13.239	0.0	199.0	458
600 min Winter	11.389	0.0	214.2	562
720 min Winter	10.071	0.0	227.3	644
960 min Winter	7.908	0.0	237.3	738
1440 min Winter	5.625	0.0	251.1	1038
2160 min Winter	4.000	0.0	272.6	1452
2880 min Winter	3.141	0.0	283.7	1848
4320 min Winter	2.312	0.0	309.2	2596
5760 min Winter	1.860	0.0	331.6	3288
7200 min Winter	1.571	0.0	346.8	3896
8640 min Winter	1.368	0.0	359.0	4592
10080 min Winter	1.218	0.0	368.6	5336

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Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
Site Location	470600 106250 SU 70600 06250
C (1km)	-0.029
D1 (1km)	0.459
D2 (1km)	0.293
D3 (1km)	0.377
E (1km)	0.310
F (1km)	2.223
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.239

Time (mins) From:	To:	Area (ha)
0	4	0.239

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Model Details

Storage is Online Cover Level (m) 100.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	16.0
Membrane Percolation (mm/hr)	1000	Length (m)	95.1
Max Percolation (l/s)	422.7	Slope (1:X)	0.0
Safety Factor	1.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	98.000	Cap Volume Depth (m)	0.000

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0075-2500-1000-2500
Design Head (m)	1.000
Design Flow (l/s)	2.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	75
Invert Level (m)	98.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.000	2.5
Flush-Flo™	0.301	2.5
Kick-Flo®	0.620	2.0
Mean Flow over Head Range	-	2.2

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	2.0	1.200	2.7	3.000	4.1	7.000	6.1
0.200	2.4	1.400	2.9	3.500	4.4	7.500	6.3
0.300	2.5	1.600	3.1	4.000	4.7	8.000	6.5
0.400	2.4	1.800	3.2	4.500	4.9	8.500	6.7
0.500	2.3	2.000	3.4	5.000	5.2	9.000	6.9
0.600	2.1	2.200	3.5	5.500	5.4	9.500	7.0
0.800	2.2	2.400	3.7	6.000	5.7		
1.000	2.5	2.600	3.8	6.500	5.9		

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