PROPOSED RESIDENTIAL DEVELOPMENT AT COLLEGE ROAD, HAVANT

FLOOD RISK ASSESSMENT INCORPORATING SURFACE WATER AND FOUL DRAINAGE STRATEGY ON BEHALF OF PERSIMMON HOMES

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EXECUTIVE SUMMARY

Odyssey was commissioned by Persimmon Homes to undertake a Flood Risk Assessment, incorporating a surface water and foul drainage strategy in support of a planning application for residential development at College Road, Havant.

The site is located within Flood Zone 1 and is not situated within any historic flood extents. The majority of the site lies in an area at 'very low' risk of surface water flooding, however there is an apparent surface water flow route across the north west and south west of the site, originating from offsite.

To mitigate the impacts of the flow route to the south west of the site, it is proposed that a diversion channel in the form of a swale will redirect the overland flow away from the development. The other spur of the flow route will be accommodated within the site layout to mitigate flood risk.

Surface water runoff generated by the development will be managed through the implementation of ponds/wetlands and cellular storage tanks. The results of soakage testing undertaken indicate that infiltration will not be feasible on site and therefore flows will be discharged to the ditch located along the southern boundary of the site, restricted to Q_{BAR} rates based on the developable area of the site. The SuDS features have been sized to attenuate flows up to the 1 in 100 year plus 40% climate change storm event, which incorporates an urban creep allowance of 10% on impermeable roof areas.

Foul flows will be conveyed by gravity to the east of the site, and where this is not possible, flows will be pumped to this location. It is proposed to connect to the existing Southern Water network, subject to approval.

Hampshire County Council was consulted in their role as the Lead Local Flood Authority at the pre-planning application stage and a copy of the Flood Risk Assessment submitted to them. Their comments have been incorporated into this latest report.

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1.0 INTRODUCTION

1.1 Odyssey has been commissioned by Persimmon Homes to undertake a Flood Risk Assessment (FRA), incorporating a surface water and foul water drainage strategy to support a planning application for a proposed residential development at College Road, Havant.

1.2 The 26.2 ha site is located to the west of Havant and is bounded by Havant and South Downs College to the north, the A3(M) motorway to the east, Portsmouth Golf Course to the south, and College Road to the west. A site location plan is presented below in **Figure 1**.



Figure 1: Site Location Plan

1.3 This report comprises the following elements:

- Review of existing legislation, policy and supporting documents in relation to flood risk, surface water and foul water;

- Review all elements which may cause or increase the risk of flooding to the development and the local vicinity including fluvial, pluvial, groundwater and sewers. The assessment also identifies and examines the residual flood risk to the proposed development and neighbouring property from these sources;

- Demonstrate through the use of Sustainable Drainage Systems (SuDS) that any potential flooding on this site can be safely mitigated;

- Prepare a surface and foul water drainage strategy illustrating that the site can be drained effectively and in accordance with Hampshire County Council (HCC), Havant Borough Council (HBC), the Environment Agency (EA) and Southern Water Services Ltd (SWSL) requirements.

1.4 This FRA has been prepared in accordance with the requirements set out in the National Planning Policy Framework (NPPF), Planning Practice Guidance (PPG), EA guidance, The SuDS Manual (CIRIA C753), Non-Statutory Technical Standards for Sustainable Drainage, and SWSL requirements.

2.0 DEVELOPMENT PROPOSALS

2.1 A hybrid planning application is proposed, comprising; full planning application for the erection of 130 dwellings with the creation of new access onto College Road, landscape, drainage, car parking and associated works; and outline planning application for up to 650 dwellings, community and nursery facility (use class D1 and D2), retail unit (use class A1), public open space, landscaping, diversion of public right of way and associated works and infrastructure. The proposed site masterplan is shown in **Appendix A**.

2.2 The proposed access to the development will be from College Road, to the north west of the site.

2.3 Surface water runoff will be managed through the implementation of SuDS, in the form of ponds/wetlands and cellular storage tanks. The surface water drainage strategy is discussed in detail in **Section 10** of this report.

2.4 A foul water drainage system for the development will be designed in accordance with Sewers for Adoption 8th Edition (SfA), the Building Regulations Part H and to SWSL requirements. The proposed foul water drainage will connect to the existing SWSL public foul sewer, subject to a S106 agreement with SWSL. The foul drainage strategy is discussed in detail in **Section 11** of this report.

3.0 BASELINE CONDITIONS

3.1 Sources of Information

3.1.1 The baseline conditions for the site have been established using the following sources and references:

- British Geological Survey (BGS) online mapping (data obtained in August 2019);
- Geo-Environmental Site Assessment; RSK Environment Ltd, October 2016;
- EA mapping;
- SWSL asset location plans.

3.2 Site Description

3.2.1 The site is located to the west of Havant in Hampshire. The approximate centre of the site is Ordnance Survey (OS) Grid Reference 469075E, 107000N and the nearest postcode is PO7 8AA.

3.2.2 The site is bounded by Havant and South Downs College to the north, the A3(M) motorway to the east, Portsmouth Golf Course to the south, and College Road to the west. The site currently consists of undeveloped fields.

3.3 Topography

3.3.1 A study of the topography shows that levels fall towards the south east of the site. Levels range from approximately 57.5m AOD to 25.5m AOD. A topographical survey is presented in **Appendix B**.

3.4 Geology

3.4.1 BGS mapping indicates that the bedrock beneath the site comprises: Wittering Formation - sand, silt and clay; London Clay Formation - clay, silt and sand; Bognor Sand Member - sand; and Lambeth Group - clay, silt and sand.

3.4.2 The mapping shows the presence of superficial deposits towards the south and south east of the site, which consist of clay, silt, sand and gravel.

3.4.3 BGS information is shown in **Appendix C**.

3.4.4 Intrusive ground investigations undertaken by RSK largely correspond with the BGS mapping, as topsoil, made ground, head deposits, Bognor Sand Member and Lambeth Group strata were encountered.

3.4.5 The ground investigation logs are shown in **Appendix D**.

3.5 Hydrology

3.5.1 The nearest EA designated Main River to the site is located to the east of the site, just beyond the A3(M) motorway. There is also an ordinary watercourse located to the south of the site, which flows along part of the southern boundary.

3.6 Hydrogeology

3.6.1 According to the BGS hydrogeological mapping, the northern part of the site is located within the Bracklesham Group and Barton Group, which is described as a moderately productive aquifer. The remaining area of the site is located within the Thames Group, described as rocks with essentially no groundwater. The hydrogeological mapping is included within **Appendix C**.

3.6.2 Groundwater mapping published by the EA indicates that the site is situated within the Groundwater Source Protection Zone described as 'inner zone - subsurface activity only (Zone 1c)'. The south east of the site is designated as 'inner zone (Zone 1)'. This is shown in **Appendix E**.

3.6.3 The results of the borehole soakage tests indicated that infiltration rates ranged from 5.37 x 10^{-6} m/s and 4.05 x 10^{-8} m/s, as shown in **Appendix D**.

3.7 Existing Surface and Foul Water Drainage Regime

3.7.1 According to maps provided by SWSL, there are no public surface water sewers currently located within the site boundary, however the records show the presence of SWSL surface water infrastructure beyond the western boundary of the site.

3.7.2 It is anticipated that surface water runoff from the existing site currently infiltrates into the underlying strata, with any excess discharged towards the watercourse to the south of the site.

3.7.3 The SWSL mapping shows that there is a 375mm diameter public foul sewer which runs across the site from west to east.

3.7.4 A copy of the SWSL sewer records is presented in **Appendix F**.

4.0 FLOOD RISK LEGISLATION AND POLICY REVIEW

Legislation

4.1 Flood and Water Management Act 2010

4.1.1 The Flood and Water Management Act 2010 (FWMA) received Royal Assent on 8th April 2010. The FWMA was introduced to enforce some of the key proposals set out within UK Government flood and water strategies, along with the Government's response to Sir Michael Pitt's review of the summer 2007 floods.

4.1.2 Relevant to development sites, the FWMA is intended to encourage the uptake of SuDS by removing the automatic right to connect to sewers.

4.1.3 The development proposals will adhere to the FWMA through the provision of SuDS as a fundamental element of the surface water drainage system. Furthermore, Persimmon Homes are committed to working with the relevant stakeholders, such as the EA and HBC, in implementing the requirements of the FWMA where applicable.

4.2 Flood Directive - The Flood Risk Regulations 2009

4.2.1 The Flood Risk Regulations 2009 came into force on 10th December 2009, transposing the European Floods Directive into domestic law. In essence, the Regulations require the EA to prepare FRAs, maps and plans for sea, Main River and reservoir flood risk and will require Lead Local Flood Authorities (LLFAs - unitary and county councils) to do the same for all other forms of flooding.

National Policy

4.3 National Planning Policy Framework 2019

4.3.1 The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England, and how these policies should be applied. Planning practice guidance is available online and provides additional guidance to the NPPF, as well as links to relevant current detail documents.

4.3.2 Paragraph 155 of the NPPF states that 'inappropriate development in areas at risk of flooding should be avoided by directing development away from areas of highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere'.

4.3.3 Paragraph 163 states that 'when determining planning applications, Local Planning Authorities (LPAs) should only consider appropriate development in areas at risk of flooding where, following application of the Sequential Test (and if required, the Exception Test), it can be demonstrated that:

- Within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location;
- The development is appropriately flood resistant and resilient;
- It incorporates Sustainable Drainage Systems, unless there is clear evidence that this would be inappropriate;
- Any residual risk can be safely managed; and,
- Safe access and escape routes are included where appropriate, as part of an agreed emergency plan.'

4.3.4 All land in England is classified into three main Flood Zones which refer to the probability of river of sea flooding, ignoring the existence of defences. The PPG identifies and describes the EA Flood Zones as:

- Flood Zone 1: Low Probability, defined as land assessed as having less than a 1 in 1,000 annual probability of river or sea flooding (<0.1%);
- Flood Zone 2: Medium Probability, defined as land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% - 0.1%), or between 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% - 0.1%);
- Flood Zone 3a: High Probability, defined as land assessed as having a 1 in 100 or greater annual probability of river flooding (≥1%), or a 1 in 200 or greater annual probability of sea flooding (≥0.5%);
- Flood Zone 3b: The Functional Floodplain, defined as land where water has to flow or be stored in times of flood (as identified by local planning authorities in their Strategic Flood Risk Assessments).

4.3.5 In accordance with the NPPF, a site specific FRA is required for:

- Proposals of 1 hectare or greater in Flood Zone 1,
- All proposals for development in Flood Zones 2 and 3,
- Land identified as having critical drainage problems,
- Land identified in a strategic flood risk assessment as being at increased flood risk in future,
- Land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.

4.3.6 The site is entirely situated within Flood Zone 1, and due to the site being larger than 1 hectare, a site specific FRA is required in accordance with the NPPF.

4.3.7 Greenfield sites would rely on natural drainage to convey or absorb rainfall. In general, development can reduce the permeability of the site if not well designed, increasing the volume and rate of water running off the site and potentially increasing flood risk to downstream areas.

4.4 Non-Statutory Technical Standards for Sustainable Drainage Systems 2015

4.4.1 The Non-Statutory Technical Standards for Sustainable Drainage Systems was published by the Department for Environment, Food and Rural Affairs (DEFRA) in March 2015.

4.4.2 The standards are to be used in order to manage surface water runoff in accordance with Schedule 3 of the FWMA.

4.4.3 The standards state that runoff destination should be considered in the following order of preference:

1. Discharge into the ground (infiltration); or, where not reasonably practicable,
2. Discharge to a surface water body; or, where not reasonably practicable,
3. Discharge to a surface water sewer; or, where not reasonably practicable,
4. Discharge to a combined sewer.

4.4.4 The document provides guidance on runoff destination, peak flow rate, volume and control of water quality and function.

4.4.5 The local planning authority may set local requirements for planning permission that have the effect of more stringent requirements than that of the standards.

4.5 The Water Industry Act 1991

4.5.1 The Water Industry Act 1991 (WIA) (HMSO, 1991) was introduced to consolidate previous water supply and wastewater services enactments in the UK. Section 94 sets out the principal duties and standards of performance to sewerage undertakers which includes the duty '*to provide, improve and extend such a system of public sewers (whether inside its area or elsewhere) and so to cleanse and maintain those sewers so as to ensure that the area is, and continues to be, effectually drained*'.

4.5.2 Relevant to new developments, Section 104 and Section 106 of the WIA provide the framework for the adoption of private sewers, subject to an agreement with the sewerage undertaker, who in this case is SWSL.

4.5.3 Section 98 of the WIA provides the legal mechanism through which the appropriate infrastructure can be requested (by the developer) and provided to drain a specific location.

4.5.4 Section 106 allows the sewerage undertaker a 21 day notice period prior to the works being undertaken. During this time the application may be refused if the undertaker considers that the connection mode or condition of the connecting sewer does not satisfy the required standards. The undertaker cannot refuse the connection based on inadequate capacity.

4.6 Transfer of Private Sewers

4.6.1 It should be noted that the Water Industry (Schemes for Adoption of Private Sewers) Regulations 2011 has transferred private sewers into the ownership of the statutory sewerage companies in England since October 2011. The government are also taking steps to stem the proliferation of newly built sewers in order to prevent the recurrence of existing ownership / maintenance problems in the future.

4.7 The Pitt Review

4.7.1 In response to the severe flooding in the UK during the summer of 2007, the government commissioned an independent review on lessons to be learned. The Pitt Review was comprehensive and considered all stages of flooding - preparedness, response and recovery - as well as the coordination, responsibilities and legislation necessary to ensure the UK can advance in the area of flood risk management.

4.8 Sewers for Adoption 8th Edition

4.8.1 The SfA places responsibility for existing and future private sewers and lateral drains that connect to the public sewer system, to the water and sewerage companies.

4.8.2 The SfA will provide detailed guidance to support the Mandatory Build Standard, whereby it will be mandatory for new sewers and lateral drains (between the sewer and the serviced property boundary) to be adopted to public status by the sewerage undertaker.

4.8.3 The guidance for foul sewer design in SfA states; '*The design of flows for gravity sewers for residential developments should be 4,000 litres / unit dwelling / per 24 hours*.'

4.9 Building Regulations

4.9.1 Where drainage within a development is not to be adopted by the sewerage undertakers, the so-called private sewers will be required to meet the standards as set out in the Building Regulations 2015, Part H 'Drainage and Waste Disposal' guidance on the design of private sewers.

4.9.2 Specific guidance can be found within the aforementioned section of the Building Regulations:

- H1 - Foul water drainage
- H2 - Wastewater treatment systems and cesspools
- H3 - Rainwater drainage
- H4 - Building over sewers
- H5 - Separate systems of drainage
- H6 - Solid waste storage.

Local Policy

4.10 Havant Borough Core Strategy - March 2011

4.10.1 The Core Strategy is one of the documents within the Havant Borough Local Development Framework. The Core Strategy sets out the Council's long term vision and objectives for the Borough up to 2026, and also specifies how the Council believes the Borough should develop.

4.10.2 Policy CS15 - Flood and Coastal Erosion Risk states, in part, that development in areas at risk of flooding now and in the future as identified on the latest EA flood risk maps will only be permitted where:

- A site-specific FRA demonstrates that the development will be safe, including the access, without increasing flood risk elsewhere and, where possible, will reduce flood risk overall;
- The scheme incorporates flood protection, resilience and resistance measures appropriate to the character and biodiversity of the area and the specific requirements of the site;
- New site drainage systems are designed, taking account of events which exceed the normal design standard.

4.10.3 Policy CS15 also states that all development will be required to ensure that there is no net increase in surface water runoff. Priority should be given to incorporating SuDS to manage surface water drainage, unless it is proven that SuDS are not appropriate. Where SuDS are provided, arrangements must be put in place for their whole life management and maintenance.

4.11 South East Hampshire Catchment Flood Management Plan

4.11.1 The South East Hampshire Catchment Flood Management Plan (CFMP) (published in December 2009) is a formal planning document which sets out the EA's preferred plan for sustainable flood risk management for the next 50 to 100 years. It identifies flood risk management policies to assist all key decision makers in the catchment.

4.11.2 The CFMP indicates that the site lies within the Havant and Denmead sub-area, and it is recommended that Policy Option 4 be applied to this sub-area, described as;

- Areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change.

4.11.3 It is stated that the most sustainable approach to managing future flood risk will be to bring about long-term adaptation of the urban environment. One key message relevant to the site is that new developments are expected to manage drainage so that there is no net increase in flood risk.

5.0 THE SEQUENTIAL TEST AND THE EXCEPTION TEST

5.1 The Sequential Test

5.1.1 The EA Flood Zones are the starting point for the sequential approach promoted by the NPPF, and are shown on the EA flood mapping. The PPG identifies that the overall aim of the Sequential Test is to steer new development to Flood Zone 1.

5.1.2 As stated by the NPPF, development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with lower probability of flooding. The Strategic Flood Risk Assessment (SFRA) will provide the basis for applying this test.

5.1.3 Following application of the Sequential Test, if it is not possible for the development to be located in zones with a lower probability of flooding (Flood Zone 1), proposed sites should take into account the flood risk vulnerability of land uses (Table 2, PPG) and consider reasonable sites in Flood Zone 2, and apply the Exception Test if required (Table 3, PPG). Only where there are no reasonably available sites in Flood Zones 1 and 2 should the suitability of sites in Flood Zone 3 be considered, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required.

5.1.4 The development footprints are entirely situated within Flood Zone 1 and the site is therefore suitable for the proposed residential development in accordance with the NPPF and PPG. The Sequential Test is therefore not required.

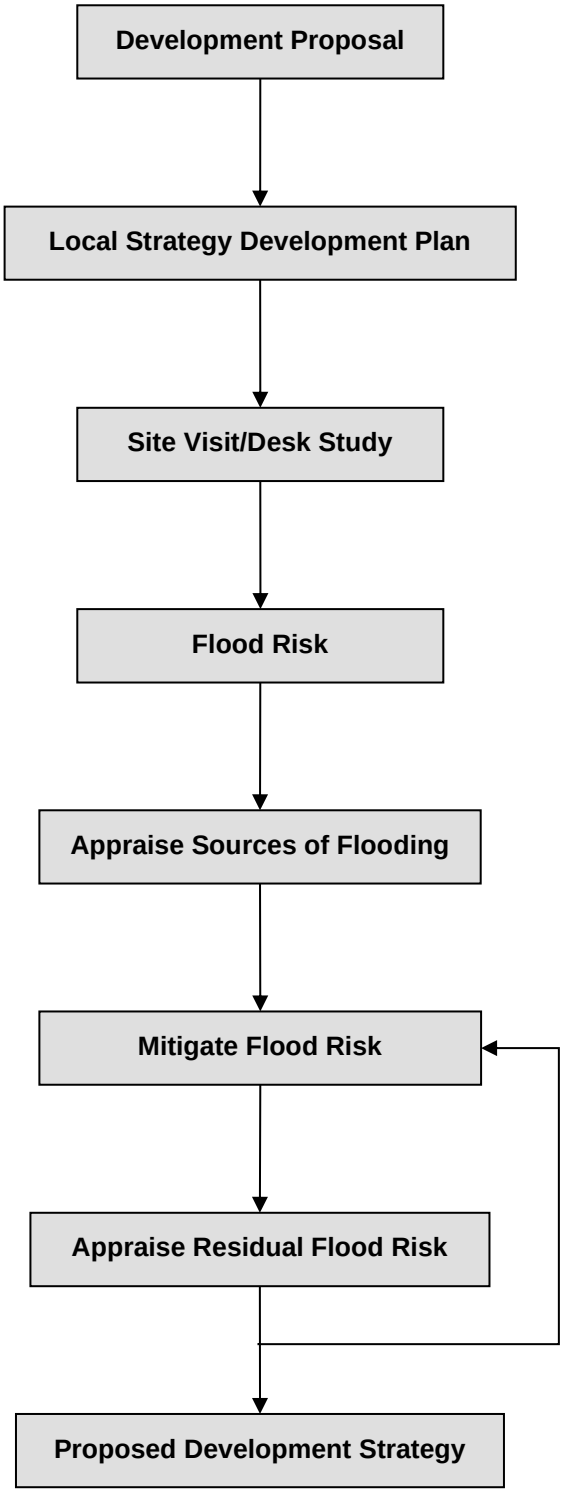
5.2 The Exception Test

5.2.1 For the Exception Test to be passed, a development proposal:

- Must demonstrate that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA;
- The development should be on developable brownfield land or, if not, it must be demonstrated that there is no such alternative land available; and
- An FRA must demonstrate that the development will be safe for its lifetime, taking into account the vulnerability of its users, without increasing flood risk elsewhere, and where possible, reducing flood risk overall.

5.2.2 The development footprints are entirely situated within Flood Zone 1, and so the Exception Test is not required.

6.0 FLOOD RISK METHODOLOGY



6.1 The assessment methodology is based on the requirements of the NPPF.

7.0 APPRAISE KEY SOURCES OF FLOOD RISK

7.1 Introduction

7.1.1 In accordance with NPPF requirements, all forms of flooding must be considered within a site-specific FRA. The following is a review of all types of flooding and an overview of their risks to the site, if any.

7.2 Flooding from Rivers (Fluvial)

7.2.1 Fluvial flooding is caused by high flows in rivers or streams exceeding the capacity of the river channel and spilling into the floodplain, or in some cases non-designated floodplain, which can occur after a period of heavy rainfall.

7.2.2 The EA's Flood Map for Planning indicates that the entire site is located within Flood Zone 1: land having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%) in any given year.

7.2.3 The Partnership for Urban South Hampshire (PUSH) SFRA indicates that the site is not shown to be located within any historic flood extents.

7.3 Surface Water Flooding / Overland Flows (Pluvial)

7.3.1 Surface water flooding is caused by rainfall levels exceeding the natural infiltration properties of the surrounding soils. It occurs where there is a lack of a formalised drainage system, as a result of poorly designed or maintained sewer systems, or due to no natural method of drainage such as watercourses or ditches, or where soil infiltration rates are low. It often results in ponding of water at low points or backing up behind obstructions.

7.3.2 The EA's Risk of flooding from Surface Water mapping shows that the majority of the site lies within an area at 'very low risk' of surface water flooding. This is an area which has a less than 1 in 1,000 annual probability of surface water flooding (<0.1%). The mapping is shown in **Appendix E**.

7.3.3 The mapping shows that there is an apparent surface water flow route across the north west and the south west of the site, originating offsite. The mapping shows that this flow route has low, medium and high risk areas of surface water flooding.

7.4 Groundwater Flooding

7.4.1 Groundwater flooding is caused by the emergence of water originating from sub-surface permeable strata. A groundwater flood event results from a rise in groundwater level sufficient for the water table to intersect the ground surface and inundate low lying land. Periods of prolonged rainfall may also be a cause of groundwater flooding, with aquifers and soils becoming saturated.

7.4.2 During the site investigation, groundwater was encountered at two of the boreholes. The deepest strike was at 2.50m below ground level.

7.5 Sewer Infrastructure Flooding

7.5.1 Flooding can occur due to the failure of existing foul or surface water drainage infrastructure. If flows within the drainage system exceed the designed capacity or foreign matter causes blockages, overflow to the surface can occur, leading to flooding.

7.5.2 The PUSH SFRA data indicates that there have been no sewer flooding incidents within the site boundaries.

8.0 FLOOD RISK MITIGATION MEASURES

8.1 Mitigation against Flood Risk from the Proposed Development

8.1.1 To mitigate against the risk from localised overland flooding from the proposed development, surface water runoff will be managed through the implementation of SuDS in the form of ponds/wetlands and cellular storage tanks.

8.1.2 The proposed development will alter the drainage regime of the site by increasing impermeable surface area and therefore increasing the rate, volume and potential contamination of surface runoff, it is necessary to provide mitigation measures to offset the potential impacts. It is proposed to manage the surface water runoff by utilising SuDS which will remove heavy metals, hydrocarbons, rubber dust, and silts prior to discharging to the ditch along the southern boundary of the site.

8.1.3 The proposed on-site drainage system will be designed to cater for the 1 in 30 year storm, providing attenuation to store flood waters on-site during flood events up to and including the 1 in 100 year plus 40% climate change rainfall event. An additional 10% impermeable roof area has been included to account for urban creep.

8.1.4 In order to manage the residual risk of blockage to all on-site drainage features, the drainage system will be maintained in line with the manufacturers' recommendations by the production of a maintenance management plan. This will ensure that over the lifetime of the proposed development, the drainage system will be maintained to ensure continuing functionality. Maintenance and ownership details are discussed further in **Section 10**.

8.2 Mitigation against Flood Risk to the Development

Surface Water Flooding

8.2.1 As previously mentioned, there is a surface water flow route to the south west of the site, originating offsite. It is proposed that a diversion channel in the form of a swale will redirect this flow route so as to not impact the development; the site layout has been developed to avoid the area most at risk of surface water flooding, and dwellings will therefore be located outside of the flow route.

8.2.2 The other spur of the overland flow route has been considered within the site layout and will be accommodated within the highway areas, so as to manage flood risk to the proposed houses.

8.2.3 To mitigate any overland flow, as previously mentioned, a formalised surface water drainage system will be designed to accommodate storm water runoff for all events up to 1 in 100 year plus 40% climate change, as well as accounting for urban creep. Detailed information of the drainage strategy for the site is set out in **Section 10**.

8.2.4 A pluvial study report (report ref. 17-239-02) contains detailed hydraulic modelling that was undertaken of all the overland flows draining to the proposed residential development.

8.2.5 A mitigation model was designed which includes diverting the overland flood routes through the site by raising areas situated along the overland flood routes. The diversion channel to the south west of the site manages the overland flows from the catchment upstream and was included in the mitigation model.

8.2.6 The hydraulic model results show that proposed mitigation measures will not impede the overland flood routes upstream and downstream of the site and the site will be protected from the overland flood routes without increasing the risk offsite.

8.2.7 Detailed information on the hydraulic modelling report is shown in **Appendix G**.

Groundwater Flooding

8.2.8 Finished floor levels will usually be set 150mm above existing levels, and ground levels manipulated in order to ensure that in the unlikely event of groundwater flooding occurring, flood flows will be conveyed away from the houses and discharged into the surface water drainage system.

8.3 Contamination from Construction

8.3.1 Contractors are to make reference to current legislation and EA guidelines in respect of construction pollution prevention. All procedures will be in effect to prevent pollution of the ground prior to, during, and post construction in order to maintain water quality.

8.3.2 All stocks of materials, oils and fuels are to be stored in a manner preventing spillage and seepage to the ground or drainage network. Wastewater will not be freely discharged to the ground or sewers. All hydrocarbons and chemical spillages will be thoroughly cleaned by excavation of the polluted ground and disposed of at a licensed waste depot.

8.3.3 The contractor would be required to report any pipework encountered during the construction works, trace the system to establish if it is live and maintain its operation whilst a diversion or protection to the system is established.

9.0 APPRAISAL OF RESIDUAL FLOOD RISK

9.1 Introduction

9.1.1 When undertaking an FRA it is essential to put into perspective any theoretical analysis with the reality of the physical system in place. It is impossible (both practically and economically) to design a system which will never fail. However, good design, controlled construction and regular maintenance can reduce the likelihood of failure during its design life.

9.1.2 The assessment has shown that the site generally offers low risk to users of the proposed residential development based on the following:

- There are no historic flood events recorded within the site boundaries;
- The proposals are for a residential scheme with all built development to be located in Flood Zone 1, which is deemed appropriate as per the recommendations of the NPPF;
- The proposed development will utilise SuDS techniques to provide treatment of surface water runoff, up to and including that arising from the 1 in 100 year plus 40% climate change storm;
- The foul drainage system will be designed in accordance with best practice.

9.1.3 All flood advice given is based on literature, mapping and historic records produced by the EA, HBC and SWSL.

10.0 PRELIMINARY SURFACE WATER DRAINAGE STRATEGY

10.1 Surface Water Management Strategy Requirements

10.1.1 Any surface water drainage strategy must demonstrate that the proposed development can be drained in a sustainable manner, commensurate with local and national policy. The NPPF requires that flood risk to land and property is not increased as a result of new development.

10.1.2 A fundamental principle of sustainable development in terms of flood defence is the reduction of surface water runoff from new developments. The Non-Statutory Technical Standards for Sustainable Drainage state that peak runoff rates should be limited to the greenfield runoff rates, and long term storage should be provided. Exceedance routes should be shown to not impact the safety of property.

10.1.3 The Non-Statutory Technical Standards for Sustainable Drainage and Part H of the Building Regulations: Drainage and Waste Disposal establish a hierarchy for surface water disposal, which also encourages a SuDS approach. This hierarchy stipulates that surface water runoff not collected for reuse must be discharged to one or more of the following in order of priority:

1. Discharge into the ground (infiltration); or, where not reasonably practicable;
2. Discharge to a surface water body; or, where not reasonably practicable;
3. Discharge to a surface water sewer, highway drain, or another drainage system; or, where not reasonably practicable;
4. Discharge to a combined sewer.

10.1.4 The peak runoff rates and volumes leaving the site must not be greater than those currently discharged during the following events;

- 1:1 year rainfall event;
- 1:30 year rainfall event;
- 1:100 year rainfall event; and
- 1:100 year plus climate change.

10.2 Proposed Surface Water Drainage Strategy

10.2.1 The proposed surface water management strategy described below is outlined in Drawings 17-239/002-004 in **Appendix H**. A plan showing the catchment boundaries for the SuDS features is also included in **Appendix H**.

10.2.2 The use of infiltrating SuDS at the site is not practicable due to the poor infiltration rates encountered during the intrusive site investigation. In accordance with the above drainage hierarchy, it is therefore proposed that surface water runoff will drain to non-infiltrating ponds/wetlands and non-infiltrating cellular storage tanks, prior to restricted discharge to the ditch located to the south of the site.

10.2.3 As the proposed development area is less than 50ha, the Institute of Hydrology (IoH) Report 124 Flood Estimation for Small Catchments (1994) method has been used to estimate the site greenfield peak flow rate, which is an approved methodology specified within the EA's Rainfall Runoff Management for Developments Report[1], using the parameters detailed in Table 10.1 below.

Table 10.1: ICP SuDS Parameters

Parameter	Value	Unit
SAAR	746	mm
Soil Index	0.4	-
Region	7	-
Urban	0	-

10.2.4 Table 10.2 below shows the existing surface water discharge rate from the entire site. The proposed discharge rate has been calculated by applying the Q_{BAR} rate of 3.67 l/s/ha to the developable areas of the site.

Table 10.2: Existing and Proposed Surface Water Discharge Rates

Return Period	Total Site Greenfield Discharge Rate (l/s)	Proposed Discharge Rate (l/s)
Q_{BAR}	96.2	68.1
Q1	81.8	68.1

[1] R Kellagher (2013) *Rainfall Runoff Management for Development Report SC030219*, Environment Agency, Bristol.

Q30	218.0	68.1
Q100	306.8	68.1
Q100 + 40% climate change	-	68.1

10.2.5 The proposed on-site surface water drainage system is to be designed to accommodate flows from the 1 in 30 year storm event, and all surface water attenuation systems will be designed to accommodate the 1 in 100 year plus 40% climate change storm. An additional 10% impermeable roof area has been included to account for urban creep. The Micro Drainage calculations are presented in **Appendix H**.

10.2.6 The ditch will have sufficient capacity for the diversion channel and the development drainage, as the runoff from the site will be less than existing, and the topographical survey and surface water flood map indicate that the overland flow route currently discharges to the ditch. Ordinary Watercourse Consent will be sought from HCC if required.

10.2.7 Due to the proximity of the A3(M), an inspection of the ditch culvert will be undertaken to establish its condition, to ensure its suitability for the flows from the site.

10.2.8 The proposed development is residential with a local road network, and the *pollution hazard indices for different land use classifications* table has been extracted in Table 10.3 below (CIRIA C753 The SuDS Manual, Table 26.2).

Table 10.3: Pollution Mitigation Indices

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very Low	0.2	0.2	0.05
Individual property driveways, residential car parks, low traffic roads (e.g. cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (e.g. schools, offices) i.e. < 300 traffic movements per day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent	Medium	0.7	0.6	0.7

change (e.g. hospitals, retail), all roads except low traffic roads and trunk roads / motorways				

10.2.9 The pollution hazard level for the proposed development is 'Medium' due to the number of traffic movements per day. It is proposed that the ponds/wetlands will provide treatment for surface water runoff, and a proprietary device will treat the remaining flows. The indicative SuDS mitigation indices for the proposed SuDS devices are detailed in Table 10.4 below.

Table 10.4: Pollution Hazard Indices

Type of SuDS	Mitigation Indices		
	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Ponds/Wetlands	0.8	0.8	0.8
Hydro-BioCell™ Bioretention System	0.8	0.8	0.8

10.3 Maintenance of SuDS Features

10.3.1 The onsite drainage system maintenance will be carried out by a private recognised management company through the implementation of an approved maintenance management plan to minimise the residual risk of drainage system blockage.

10.3.2 The operation and maintenance requirements for the SuDS features are shown in Table 10.5 and Table 10.6 below, in accordance with the CIRIA SuDS Manual C753.

Table 10.5: Maintenance of Ponds/Wetlands

Maintenance Schedule	Required Action	Typical Frequency
Regular maintenance	Remove litter and debris	Monthly or as required
	Cut the grass – public areas	Monthly during growing season
	Cut the meadow grass	Half yearly
	Inspect marginal and bankside vegetation and remove	Monthly (at start, then as

	nuisance plants (for first three years)	required)
	Inspect inlets, outlets, banksides, structures, pipework etc. for evidence of blockage and/or physical damage	Monthly
	Inspect water body for signs of poor water quality	Monthly (May – October)
	Inspect silt accumulation rates in any forebay and in main body of the pond and establish appropriate removal frequencies; undertake contamination testing once some build-up has occurred, to inform management and disposal options	Half yearly
	Check any mechanical devices, e.g. penstocks	Half yearly
	Hand cut submerged and emergent aquatic plants	Annually
	Remove 25% of bank vegetation from water's edge to a minimum of 1m above water level	Annually
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from any forebay	Every one to five years, or as required
	Remove sediment and planting from one quadrant of the main body of ponds without sediment forebays	Every five years
Occasional maintenance	Remove sediment from the main body of big ponds when pool volume is reduced by 20%	With effective pre-treatment, this will only be required rarely
Remedial actions	Repair erosion or other damage	As required
	Replant, where necessary	As required
	Aerate pond when signs of eutrophication are detected	As required
	Realign rip-rap or repair other damage	As required
	Repair/rehabilitate inlets, outlets and overflows	As required

Table 10.6: Maintenance of Cellular Storage Tanks

Maintenance Schedule	Required Action	Typical Frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for three months, then annually

	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	Remove sediment from pre-treatment structures	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, overflows and vents to ensure they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every five years or as required

11.0 PRELIMINARY FOUL DRAINAGE STRATEGY

11.1 SWSL are the governing water authority for the area. Any proposed connections or changes to the existing discharge rates must be approved by SWSL prior to commencement of any construction works. A copy of the SWSL records is presented in **Appendix F**.

11.2 The proposed system will convey the foul flows to the east of the site, and connect to the existing SWSL public foul network. Where flows to the south cannot be conveyed to the network by gravity, flows will be conveyed to the proposed pumping station and will be pumped in a northern direction towards the SWSL network. The new connection from the site must be approved by SWSL under a Section 106 agreement.

11.3 The hydraulic design for the discharge rate for the foul wastewater design will be calculated in accordance with SfA which states peak design flow rates for dwellings should be 4000l/day.

12.0 CONCLUSIONS

12.1 Odyssey has been commissioned by Persimmon Homes to undertake a Flood Risk Assessment (FRA), incorporating a surface water and foul water drainage strategy to support a planning application for a proposed residential development at College Road, Havant.

12.2 The EA flood mapping shows that the site lies entirely within Flood Zone 1, an area with a low probability of flooding. Residential (more vulnerable) development is appropriate within Flood Zone 1 and there are no records of historic flooding within the site boundaries.

12.3 The surface water mapping shows that there is a surface flow route across the north west and south west of the site, originating offsite. However, the masterplan has been laid out such that the flow route is not impeded by development, and the proposed diversion channel redirects surface water to the watercourse without impacting the development.

12.4 The results of the soakage testing indicate that infiltrating SuDS features may not be suitable for the site. It is proposed that surface water will be discharged to the watercourse to the south of the site, via ponds/wetlands and non-infiltrating cellular storage tanks.

12.5 The SuDS features shown on the proposed drainage strategy have been sized to attenuate flows for all rainfall events up to the 1 in 100 year event plus climate change (40%).

12.6 It is proposed that foul flows will be conveyed to the east of the site and connect into the existing SWSL foul sewerage network. Section 106 applications will be made in accordance with the Water Industries Act with SWSL.

12.7 This FRA has demonstrated that the proposed development is fully compliant with the requirements of the NPPF. Issues relating to flood risk and drainage do not represent an obstruction to the development and therefore should not hinder an approval for planning permission of the proposed development.

APPENDIX A

Indicative Site Masterplan

Site Entrance

Retail Unit

Emergency vehicle access

High pressure gas easment

SUDS basin

ROMAN VILLA
(site of)

Allotments

Scheduled monument

Community Hall / Nursery

Pedestrian bridge

LEAP

SUDS basin

SUDS basin

Allotments

SuDS 1 (BASIN)

SuDS 3 (BASIN)

SuDS 4 (BASIN)

Rev	Date	Revision Details	Dr	Ch
D	02.10.19	Community building relocated	br	db
C	02.09.19	Allotment boundary amended	br	db

PERSIMMON
Together, we make a home

Job Title
Campdown, College Road.
Purbrook

Drawing Title
Masterplan Layout

Job No	Drawing No	Rev
536	A-02-200-MP	D

Drawn	Checked	Date
br		26.03.19

Scale
1:1000 @ A0 / 1:2000 @ A2
metres 20 40 60 80 100

Status
INFORMATION

Persimmon Homes. No dimensions to be scaled from drawing except for the purposes of Planning Applications. The contractor should check all dimensions on site. It is the contractors responsibility to ensure compliance with Building Regulations.

File Location: s:\technical\current sites\campdown college road\drawings\architectural\planning\drawings

APPENDIX B

Topographical Survey

Tree schedule

Tree No	Species	Height (m)	Category	RPA Radius
T1	Hawthorn	4	C	4.8
G2	Pine, hazel, birch, ash, maple	4	C	3.6
G3	Oak	12	B	5.4
G4	Oak, ash	8	C	3.6
T5	Ash	20	B	9.6
G6	Hazel, cherry, goat willow	6	C	3.6
T7	Oak	15	U	5.4
T8	Ash	18	U	15.0
T9	Ash	18	U	6.6
T10	Oak	18	A	9.6
T11	Oak	18	B	10.8
G12	Hawthorn	6	C	3.6
T13	Ash	20	A	9.0
T14	Ash	15	C	4.8
T15	Ash	20	B	12.0
T16	Ash	18	U	7.2
G17	Hawthorn, ash, oak	8	C	4.8
G18	Bramble, ash, hawthorn	3	C	2.4
G19	Oak, ash, hawthorn, goat willow	8	C	3.6
G20	Goat willow	8	C	3.6
T21	Lombardy poplar	25	B	9.0
T22	Lombardy poplar	20	B	7.2
T23	Oak	20	B	10.8
T24	Sycamore	14	C	3.6
T25	Scots pine	18	B	7.2
T26	Oak	20	A	9.3
T27	Oak	20	A	12.9
G28	Oak	22	A	11.4
T29	Ash	22	A	9.6
G30	Goat willow	10	C	6.0
T31	Oak	18	A	8.4
T32	Oak	16	A	8.4
T33	Oak	18	A	9.6
T34	Oak	18	A	10.8
T35	Ash	18	B	7.8
G36	Oak	18	B	7.2
H37	Hawthorn, blackthorn	4	C	3.0
T38	Oak	12	U	9.6
G39	Goat willow	8	C	4.8
T40	Oak	18	A	10.2
T41	Oak	16	A	5.4
H42	Hawthorn, field maple, hazel	5	C	3.6
T43	Field maple	8	B	5.4
T44	Oak	8	B	5.4
T45	Oak	20	A	13.2
H46	Hazel, blackthorn, hawthorn, ash	4	C	2.4
T47	Oak	12	B	7.2
T48	Ash	18	C	9.6
T49	Oak	20	B	7.8
T50	Oak	22	A	11.4
T51	Oak	18	B	9.0
T52	Field maple	15	A	7.8
T53	Oak	20	A	9.0
T54	Oak	20	A	12.0
G55	Oak	20	A	10.5
T56	Oak	20	A	9.6
G57	Ash, hazel, goat willow	8	C	3.6
T58	Ash	20	U	10.8
T59	Ash	22	B	9.6
T60	Oak	20	A	7.2
T61	Field maple	15	B	8.4
T62	Oak	18	B	8.4
G63	Ash, aspen, oak	18	B	7.2
T64	Oak	20	A	7.2
T65	Oak	18	B	5.4
T66	Oak	22	A	10.8
G67	Oak	15	B	4.8
G68	Cypress, elder, scrub	10	C	3.6
T69	White poplar	15	B	5.4
G70	Oak, ash	10	C	3.6
T71	Goat willow	12	C	9.3
T72	Poplar	16	C	9.6
G73	Ash, cypress	14	C	4.8
T74	White poplar	18	B	8.4
T75	Turkey oak	10	B	3.0
H76	Hawthorn, blackthorn, white poplar	3	C	2.4
T77	Cypress	6	C	3.6



Tree constraints plan

Location of trees, categorisation and development constraints at College Road, Campdown, Purbrook, Portsmouth

Permission is granted to scale from this drawing for Local Authority Planning Approval purposes relating to tree protection measures only. Where applicable this drawing is to be read in conjunction with the arboricultural report. This drawing is the copyright of Barrell Tree Consultancy 2016. ©

This drawing to be reproduced in colour only.

Barrell Plan Ref: 16248-BT2

Provided Plan Refs: 340CD01.dwg

barrell TREE CONSULTANCY

Field House, Fordingbridge Business Park, Ashford Road, Fordingbridge SP6 1BY
Tel: 01425 651470 Fax: 01425 653449
www.barrelltreecare.co.uk

BS category A — Trees of high quality

BS category B — Trees of moderate quality

BS category C — Trees of low quality

BS category U — Trees unsuitable for retention

Estimated tree positions not included on original land survey and adjusted crown spreads

Purpose of this plan and its annotation

This constraints plan provides sufficient information to interpret the tree constraints when designing a new layout. This guidance must be carefully reviewed with the individual tree information provided in the schedule on this plan. If there is any doubt about how to interpret this information, you must check it out with Barrell Tree Consultancy (BTC) on 01425 651470 or info@barrelltreecare.co.uk.

The number of each tree, hedge and group is highlighted in colour to enable quick identification of tree categories. Category A and B trees are green; category C and U trees are blue. The number of each A and B tree is set inside a green triangle; the number of each C and U tree is set inside a blue rectangle. Category A trees are shown with double triangles and U trees are shown with double rectangles. Zone 1, indicating the RPA where no ground disturbance should occur, is annotated with dark shading. Zone 2, indicating where shading, dominance and/or future growth may be an issue, is annotated with light shading.

How to use the constraints information

Our interpretation of the starting-point recommendations of BS 5837(2012) is that only category A and B trees are sufficiently important to influence a layout, so the category C and U trees are discounted in this constraints advice. The constraints that the A and B trees are likely to impose have been assessed as follows:

Zone 1 (dense coloured shading): This is called the root protection area (RPA) where ground disturbance must be carefully controlled. If encroachment is planned within the RPA, then this must be assessed on a tree-by-tree basis by BTC. If important trees are to be successfully retained, no significant disturbance should occur within the RPA and a high level of care is needed when working within it.

Zone 2 (light coloured shading): The second constraint is where shading/dominance/future growth may be an issue and is our estimate of how much space may be needed to retain trees after the development activity when the pressures of residential occupation come to bear. Factors such as crown density, future growth potential, orientation in relation to the sun and the number of trees in groups are considered to arrive at this second, less restrictive, constraints zone. Zone 2 is not normally suitable for occupied buildings, but uninhabited structures and hard surfacing may be acceptable within it.

Zone 3 Nominal RPA radii for category C trees:
Low quality only to be considered for retention if there is scope within the layout and they do not compromise the potential to establish new trees of higher future sustainability.

Designers should try to avoid the loss of category A and B trees because the LPA will consider them important in determining the full impact of the proposal. Category C trees can be considered for retention if there is scope within the scheme. However, their loss should not be a material constraint and layouts do not have to be designed around keeping them. As a starting point in the design process, no significant disturbance should occur within the RPA of any category A and B trees shown as zone 1. There is sometimes scope to reduce this slightly in some directions if a corresponding increase can be achieved in other directions that results in the RPA remaining the same. However, such changes should be the exception rather than the rule and must be assessed on a tree-by-tree basis by BTC.
Under some circumstances, it may be acceptable to place footpaths, roads, services (including drains and soakaways) and unoccupied buildings within zone 1, but special precautions will be required and should be detailed after consultation with BTC. However, designers should always remember that the more encroachment there is into the RPA, the more likely the LPA are to object to the layout. Further consideration is required for occupied buildings; areas within the existing or future crown spread of retained trees or in areas of excessive shade should be avoided. This is the zone 2 illustrated on the plan. Exceptionally, non-inhabited buildings such as garages may be acceptable within zone 2, but this would not normally apply to residential occupied buildings. Pruning overhanging branches may also be an option, but often prompts objections from LPAs. If such pruning is proposed, BTC must advise on the implications.

Limitations and warnings

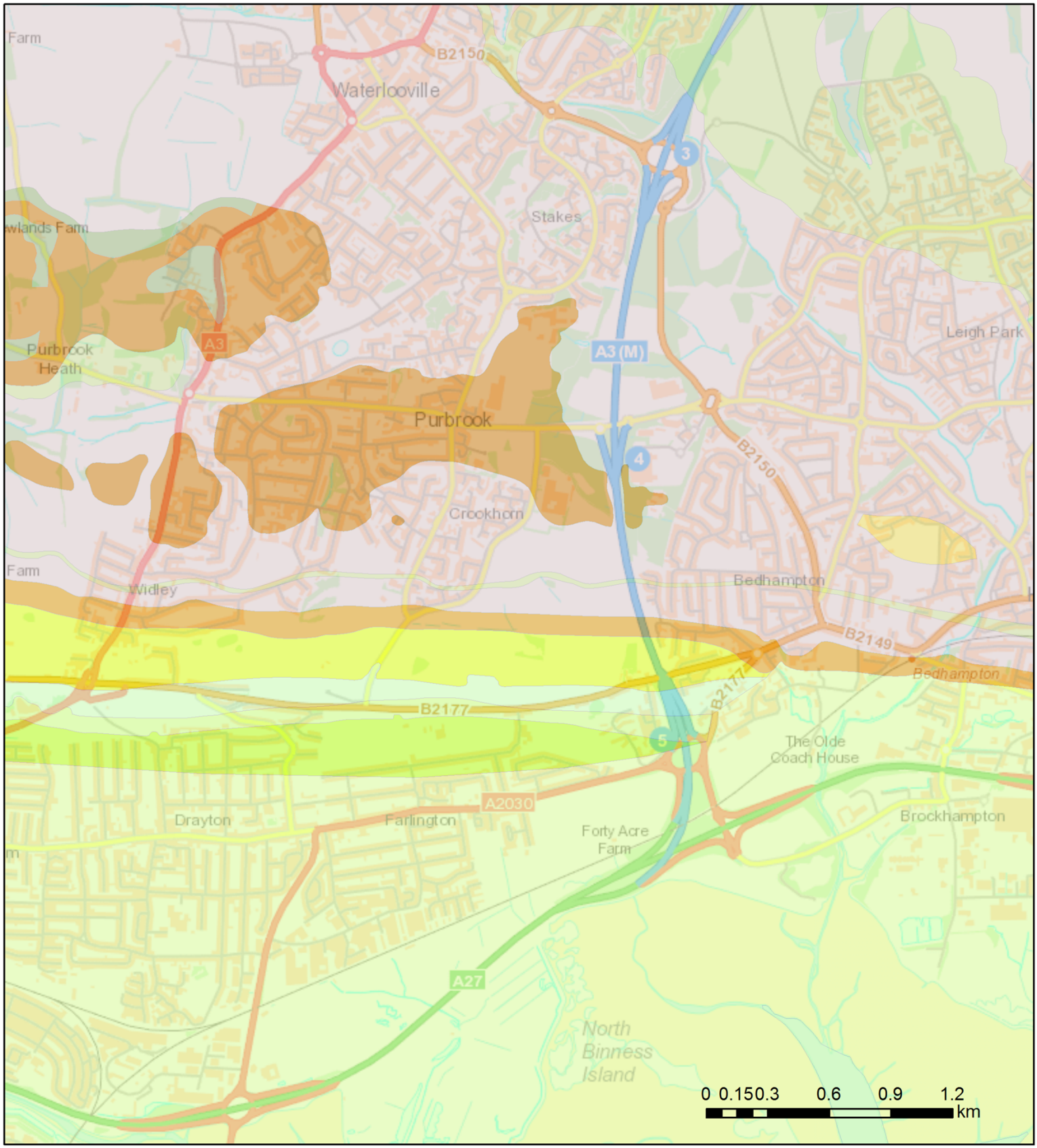
- This plan is confidential to the client and should not be released to any third parties without authorisation
- It does not consider any ecological or other constraints that may exist on the site
- Assessing constraints is subjective, especially the zone 2 advice, and the LPA may not agree with the BTC interpretation
- The plan is based on provided information and should only be used for dealing with the tree issues
- All scaled measurements must be checked against the original documents
- This constraints guidance is preliminary and only suitable for drawing up initial design proposals
- Further consultation with BTC is essential before finalising any layout

APPENDIX C

British Geological Survey (BGS) Data

Bedrock Geology

GEOINDEX ONSHORE



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GeoIndex Onshore Data Sources: NERC, Natural England, English Heritage and Ordnance Survey

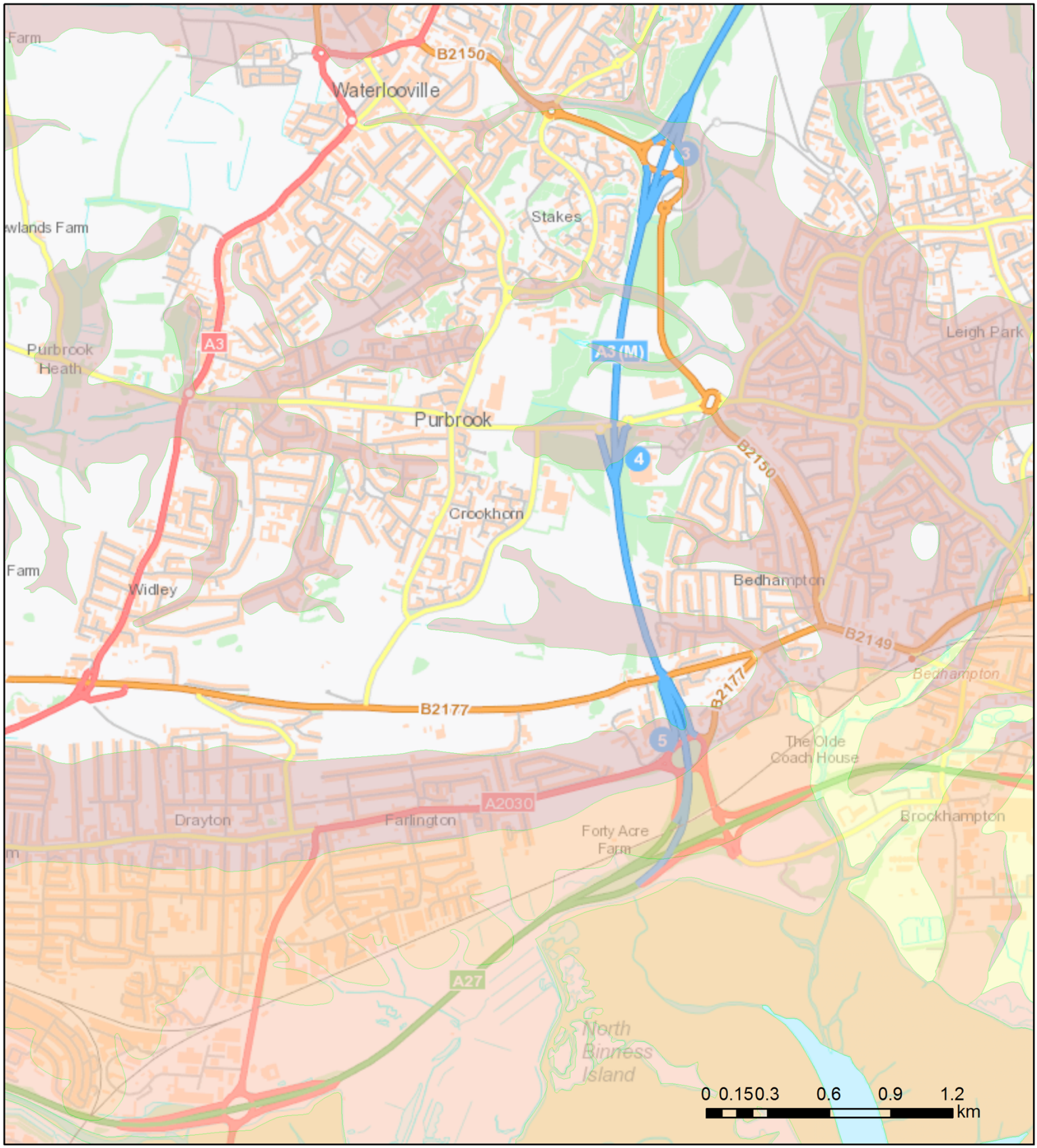
Map Key

Bedrock geology 1:50,000 scale

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

Superficial Deposits

GEOINDEX ONSHORE



Contains OS data © Crown Copyright and database right 2017

GeoIndex Onshore Data Sources: NERC, Natural England, English Heritage and Ordnance Survey

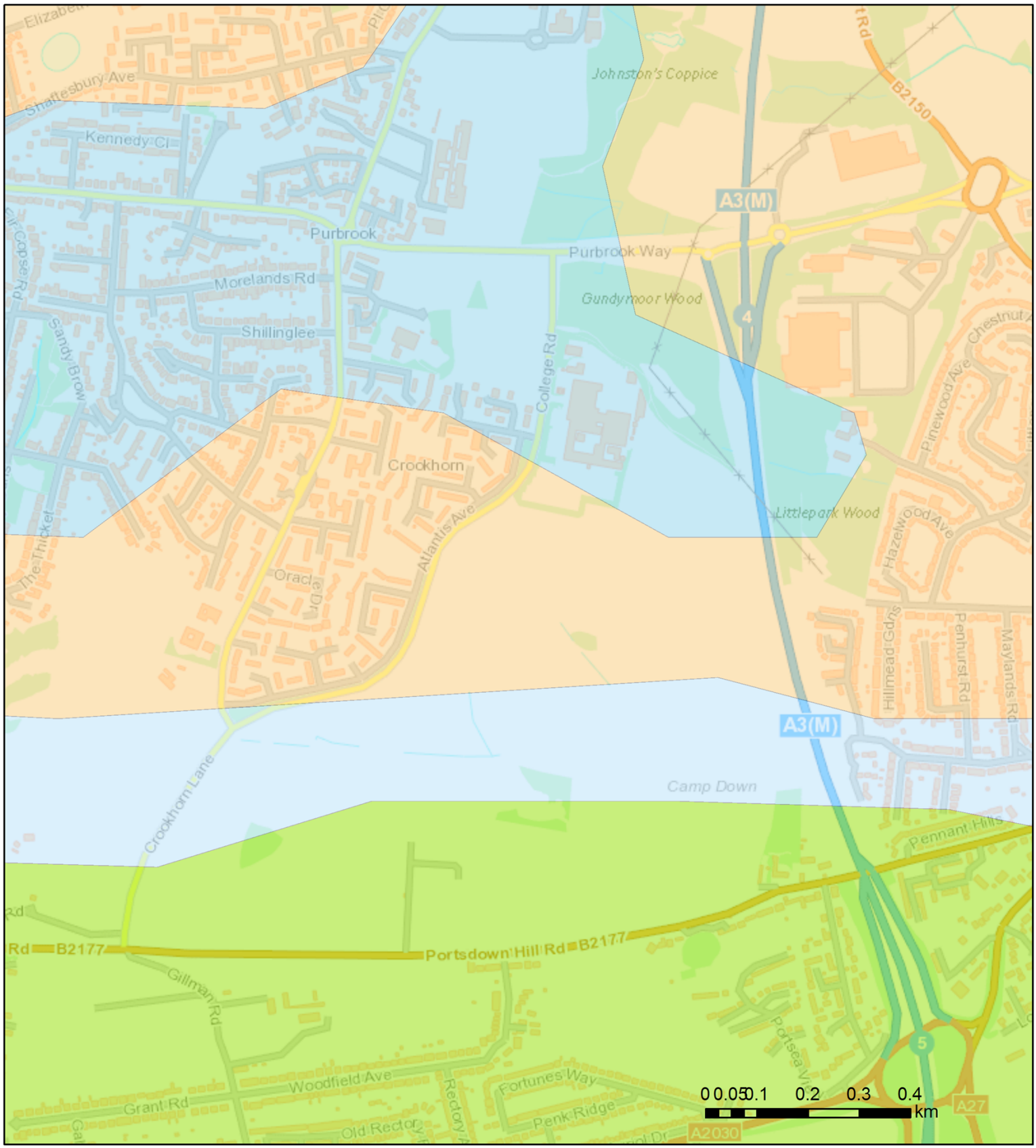
Map Key

Superficial deposits 1:50,000 scale

- ALLUVIUM - CLAY, SILT, SAND AND GRAVEL
- RAISED MARINE DEPOSITS - SAND AND GRAVEL
- HEAD - CLAY AND GRAVEL
- RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND, SILT AND CLAY
- BEACH AND TIDAL FLAT DEPOSITS (UNDIFFERENTIATED) - CLAY, SILT, SAND AND GRAVEL

Hydrogeology

GEOINDEX ONSHORE



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GeoIndex Onshore Data Sources: NERC, Natural England, English Heritage and Ordnance Survey

Map Key

Hydrogeology 1:625,000 scale

Aquifers with significant intergranular flow

Highly productive aquifer

Moderately productive aquifer

Low productivity aquifer

Aquifers in which flow is virtually all through fractures and other discontinuities

Highly productive aquifer

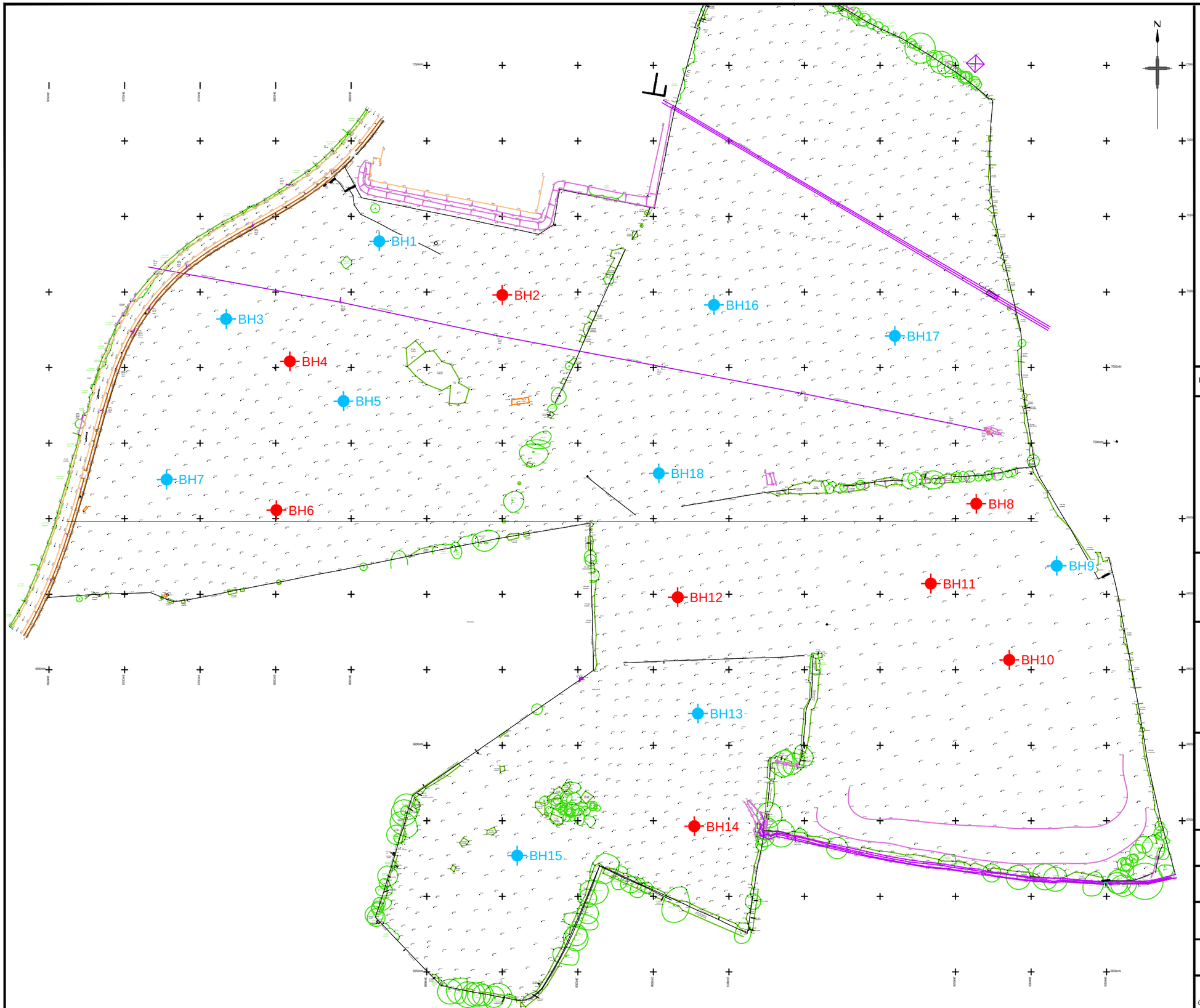
Moderately productive aquifer

Low productivity aquifer

Rocks with essentially no groundwater

APPENDIX D

Geo-Environmental Site Assessment Extracts



LEGEND

- Borehole Location
- Borehole Location with Installation

Rev.	Date	Amendment	Drawn	Chkd.	Appd.

RSK

18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT
United Kingdom

Tel: +44 (0) 1442 437500
Fax: +44 (0) 1442 437550
Email: info@rsk.co.uk
Web: www.rsk.co.uk

Client

RADIAN

Project Title

CAMPDOWN,
WATERLOOVILLE

Drawing Title

EXPLORATORY HOLE
LOCATION PLAN

Drawn	Date	Checked	Date	Approved	Date
ASC	11.08.16	ARJ	11.08.16	ARJ	11.08.16

Scale	Orig Size	Dimensions
1:2500	A3	m

Project No.	Drawing File
28720 - R01 (00)	28720 (R01-00) Fig 2.dwg

Drawing No.	Rev.
FIGURE 2	P1

Scale 1 : 2,500

0 20 40 60 80 100 120 140 160 180 200m

WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Campdown	**Radian**	**BH1**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
28720	**07.09.16** End: **02.08.16**	**---**	**---**	**1** of **1**

Progress	Samples / Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Window Run	Depth	No	Type	Results					
	0.10-0.20	1	ES				MADE GROUND: (Firm) orange brown sandy slightly gravelly CLAY. Sand is fine. Gravel is subangular to subrounded fine to medium of brick. (Topsoil)	(0.35)	
								0.35	
	0.50	2	D				Firm medium strength orange brown mottled grey slightly sandy CLAY. Sand is fine. (HEAD DEPOSITS)		
	0.50		V	c_r=66					
	1.00-1.45	1	SPT	N=10					
	1.10		V	c_r=66					
	1.50	3	D					(3.10)	
	2.00-2.45	2	SPT	N=16					
	2.50	4	D						
	3.00-3.45	3	SPT	N=23			. . . Below 3.00m bgl, high strength		
								3.45	
							Borehole terminated at 3.45m depth.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. No groundwater was encountered
2. Gas and groundwater monitoring well installed to 3.00m depth

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	**Archway Competitor+**	**ADavidson**	**RSpeight**	

GINT_LIBRARY_V8_06.GLB LibVersion: v8_06_013 PrjVersion: v8_06 - Core+Logs - 001 | Log WINDOW SAMPLE LOG - A4P | 28720 CAMPDOWN.GPJ - v8_06.
RSK Environment Ltd, 18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT. Tel: 01442 437550, Fax: 01442 437500, Web: www.rsk.co.uk. | 08/09/16 - 13:58 | EH1 |

WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Campdown	**Radian**	**BH2**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
28720	**02.08.16** End: **02.08.16**	**---**	**---**	**1** of **1**

Progress	Samples / Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Window Run	Depth	No	Type	Results					
	0.10-0.20	1	ES				MADE GROUND: (Firm) orange brown sandy slightly gravelly CLAY. Sand is fine. Gravel is subangular to subrounded fine to medium of brick. (Topsoil)	(0.35)	
								0.35	
	0.50	2	D				Firm medium strength orange brown mottled grey sandy CLAY. Sand is fine. (HEAD DEPOSITS)		
	0.50		V	c_r=57					
	1.00		V	c_r=67					
	1.50	3	D					(2.65)	
							. . . Below 2.00m bgl, orange red brown mottled grey.		
	2.30		V	c_r=80			. . . Below 2.30m bgl, high strength		
	2.50	4	D						
								3.00	
							Borehole terminated at 3.00m depth.		

Drilling Progress and Water Observations

Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. No groundwater was encountered
2. Borehole backfilled with arisings upon completion

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	**Archway Competitor**	**Michael O'Shea**	**RSpeight**	

GINT_LIBRARY_V8_06.GLB LibVersion: v8_06_013 PrjVersion: v8_06 - Core+Logs - 001 | Log WINDOW SAMPLE LOG - A4P | 28720 CAMPDOWN.GPJ - v8_06.
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WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Campdown	**Radian**	**BH3**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
28720	End: **02.08.16**	**---**	**---**	**1** of **1**

Progress	Samples / Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Window Run	Depth	No	Type	Results					
	0.10-0.20	1	ES				MADE GROUND: Grass over friable sandy gravelly CLAY. Sand is fine. Gravel is angular to subrounded fine to coarse of flint. (Topsoil)	(0.30)	
								0.30	
	0.50	2	D				Firm medium strength orange brown mottled grey slightly sandy gravelly CLAY. Sand is fine. Gravel is angular to subrounded fine to coarse of flint. (HEAD DEPOSITS)	(0.60)	
	0.60		V	c_r=45					
								0.90	
	1.00-1.45	1	SPT	N=11			Firm medium strength orange red brown mottled grey slightly sandy CLAY. Sand is fine. (HEAD DEPOSITS)	(1.10)	
	1.40		V	c_r=61					
	1.50	3	D						
								2.00	
	2.00-2.45	2	SPT	N=7			Firm medium strength orange brown mottled grey slightly sandy silty CLAY. (HEAD DEPOSITS)	(1.45)	
	2.30		V	c_r=41					
	2.50	4	D						
	3.00-3.45	3	SPT	N=7					
								3.45	
							Borehole terminated at 3.45m depth.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. No groundwater was encountered
2. Gas and groundwater monitoring well installed to 3.00m depth

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	**Archway Competitor+**	**ADavidson**	**RSpeight**	

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WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Campdown	**Radian**	**BH4**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
28720	**02.08.16** End: **02.08.16**	**---**	**---**	**1** of **1**

Progress	Samples / Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Window Run	Depth	No	Type	Results					
	0.10-0.20	1	ES				MADE GROUND: Grass over friable sandy gravelly CLAY. Sand is fine. Gravel is angular to subrounded fine to coarse of flint. (Topsoil)	(0.30) 0.30	
	0.50	2	D				Firm medium strength orange brown mottled grey sandy slightly gravelly CLAY. Sand is fine. Gravel is angular to subrounded fine to medium of flint. (HEAD DEPOSITS)	(0.70) 1.00	
	0.80		V	c_r=44	1		Firm grey brown slightly sandy CLAY with occasional flint gravel. Sand is fine. Gravel is angular to subrounded fine to medium. (HEAD DEPOSITS)		
	1.40	3	D				. . . Between 1.20 and 1.25m bgl, gravel band with water.	(1.00)	
							. . . Between 1.90 and 2.00m bgl, gravel band with water.	2.00	
	2.40	4	D				Firm orange grey brown mottled sandy silty CLAY. Sand is fine. (HEAD DEPOSITS)	(1.00) 3.00	
							Borehole terminated at 3.00m depth.		

Drilling Progress and Water Observations

Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. Groundwater was encountered between 1.20-1.25m
2. Borehole backfilled with arisings upon completion

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	**Archway Competitor**	**Michael O'Shea**	**RSpeight**	

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WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Campdown	**Radian**	**BH5**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
28720	End: **02.08.16**	**---**	**---**	**1** of **1**

Progress	Samples / Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Window Run	Depth	No	Type	Results					
	0.10-0.20	1	ES				MADE GROUND: Grass over friable sandy gravelly CLAY. Sand is fine. Gravel is angular to subrounded fine to coarse of flint. (Topsoil)	(0.30)	
								0.30	
	0.50	2	D				Firm medium strength orange brown grey mottled silty CLAY. (HEAD DEPOSITS)		
	0.50		V	c_r=67					
							. . . Below 0.80m bgl, flint gravel with red orange clay band.		
	1.00-1.45	1	SPT	N=10					
	1.50	3	D				. . . Below 1.40m bgl, grey brown with occasional decomposed plant matter and flint gravel.		
	1.60		V	c_r=60				(3.15)	
	2.00-2.45	2	SPT	N=10					
	2.70	4	D						
	3.00-3.45	3	SPT	N=8				3.45	
							Borehole terminated at 3.45m depth.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. No groundwater was encountered
2. Gas and groundwater monitoring well installed to 3.00m

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	**Archway Competitor+**	**ADavidson**	**RSpeight**	

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WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Campdown	**Radian**	**BH6**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
28720	**02.08.16** End: **02.08.16**	**---**	**---**	**1** of **1**

Progress	Samples / Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Window Run	Depth	No	Type	Results					
	0.10-0.20	1	ES				MADE GROUND: Grass over friable sandy gravelly CLAY. Sand is fine. Gravel is angular to subrounded fine to coarse of flint. (Topsoil)	(0.30)	
								0.30	
	0.50	2	D				Firm medium to high strength orange brown mottled grey slightly sandy CLAY. (HEAD DEPOSITS)		
	0.60		V	c_r=58					
	0.90		V	c_r=75					
	1.00-1.45	1	SPT	N=11					
	1.50		V	c_r=89					
	1.60	3	D				. . . At 1.60m bgl, single flint gravel, subrounded, coarse.	(3.15)	
	2.00-2.45	2	SPT	N=12			. . . Below 2.00m bgl, firm to stiff red orange brown grey mottled.		
	2.50		V	c_r=89					
	2.60	4	D						
	3.00-3.45	3	SPT	N=12					
								3.45	
							Borehole terminated at 3.45m depth.		

Drilling Progress and Water Observations

Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. No groundwater was encountered
2. Rootlets to 1.00m depth
3. Borehole backfilled with arisings upon completion

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	**Archway Competitor**	**Michael O'Shea**	**RSpeight**	

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WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Campdown	**Radian**	**BH7**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
28720	End: **02.08.16**	**---**	**---**	**1** of **1**

Progress	Samples / Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Window Run	Depth	No	Type	Results					
	0.10-0.20	1	ES				MADE GROUND: Grass over friable sandy gravelly CLAY. Sand is fine. Gravel is angular to subrounded fine to coarse of flint. (Topsoil)	(0.30) 0.30	
	0.50	2	ES				MADE GROUND: Orange brown sandy slightly gravelly CLAY with occasional pockets of grey clay. Sand is fine. Gravel is angular to subrounded fine to coarse of flint. (Reworked Natural)	(0.70) 1.00	
	1.10-1.20	3	ES				MADE GROUND: (Firm) grey brown silty slightly gravelly CLAY. Gravel is subrounded to subangular fine to coarse of brick and clinker.	(0.50) 1.50	
	1.70		V	c_r=35			Soft becoming firm low strength orange brown mottled grey silty CLAY. (HEAD DEPOSITS)	(1.50) 3.00	
	2.30	4	D						
							Borehole terminated at 3.00m depth.		

Drilling Progress and Water Observations

Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. No groundwater was encountered
2. Gas and groundwater monitoring well installed to 3.00m

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	**Archway Competitor+**	**ADavidson**	**RSpeight**	

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WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Campdown	**Radian**	**BH8**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
28720	**03.08.16** End: **03.08.16**	**---**	**---**	**1** of **1**

Progress	Samples / Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Window Run	Depth	No	Type	Results					
	0.00-0.20	1	ES				TOPSOIL: Light brown slightly clayey SAND. Sand is fine.	0.20	
	0.50	2	D				Dense orange brown very silty clayey fine SAND. (BOGNOR SAND MEMBER) . . . At 0.60m bgl, single subangular coarse flint gravel.	(3.25)	
	1.00-1.45	1	SPT	N=38					
	1.30	3	D						
	2.00-2.45	2	SPT	N=41					
	2.50	4	D						
	3.00-3.45	3	SPT	N=40					
							Borehole terminated at 3.45m depth.	3.45	

Drilling Progress and Water Observations

Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. No groundwater was encountered
2. Borehole backfilled with arisings upon completion

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	**Archway Competitor**	**Michael O'Shea**	**RSpeight**	

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WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Campdown	**Radian**	**BH9**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
28720	**07.09.16** End: **03.08.16**	**---**	**---**	**1** of **1**

Progress	Samples / Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Window Run	Depth	No	Type	Results					
	0.10-0.20	1	ES				TOPSOIL: Brown sandy gravelly CLAY. Sand is fine. Gravel is subangular to subrounded fine to coarse of flint.	(0.35)	
								0.35	
	0.50	2	D				Firm medium to high strength orange brown mottled grey silty CLAY. (HEAD DEPOSITS)		
	0.50		V	c_r=65					
	1.00-1.45	1	SPT	N=7			. . . Below 1.00m bgl, occasional orange brown silty sand parting.		
	1.15		V	c_r=66					
	1.40	3	D						
	1.80		V	c_r=76				(3.10)	
	2.00-2.45	2	SPT	N=8			. . . Below 2.00m bgl, red orange brown grey mottled.		
	2.60	4	D						
	3.00-3.45	3	SPT	N=17					
								3.45	
							Borehole terminated at 3.45m depth.		

Drilling Progress and Water Observations

Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. No groundwater was encountered
2. Gas and groundwater monitoring well installed to 3.00m

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	**Archway Competitor+**	**ADavidson**	**RSpeight**	

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WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Campdown	**Radian**	**BH10**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
28720	End: **03.08.16**	**---**	**---**	**1** of **1**

Progress	Samples / Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Window Run	Depth	No	Type	Results					
	0.10-0.20	1	ES				TOPSOIL: Brown sandy gravelly CLAY. Sand is fine. Gravel is subangular to subrounded fine to coarse of flint.	(0.30)	
								0.30	
	0.50	2	D				Firm medium strength orange brown mottled grey slightly gravelly silty CLAY. Gravel is subangular to subrounded fine to coarse of flint. (HEAD DEPOSITS)		
	0.50		V	c_r=52					
							. . . Below 1.00m bgl, red brown orange grey mottled and no gravel.		
	1.30	3	D						
	1.30		V	c_r=53				(2.70)	
	2.50	4	D						
	2.50		V	c_r=63					
								3.00	
							Borehole terminated at 3.00m depth.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. No groundwater was encountered
2. Borehole backfilled with arisings upon completion

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	**Archway Competitor+**	**ADavidson**	**RSpeight**	

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WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Campdown	**Radian**	**BH11**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
28720	**03.08.16** End: **03.08.16**	**---**	**---**	**1** of **1**

Progress	Samples / Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Window Run	Depth	No	Type	Results					
	0.10-0.20	1	ES				TOPSOIL: Brown sandy gravelly CLAY. Sand is fine. Gravel is subangular to subrounded fine to coarse of flint.	0.20	
	0.40	2	D				Firm brown sandy gravelly CLAY. Sand is fine. Gravel is subangular to subrounded fine to coarse of flint. (HEAD DEPOSITS)	(0.30) 0.50	
	0.70 0.80	3	V D	c_r=46			Firm medium strength orange grey brown mottled slightly sandy silty CLAY with occasional silty sand partings. (HEAD DEPOSITS)		
	1.00-1.45	1	SPT	N=8					
	1.50 1.60	4	V D	c_r=63				(2.95)	
	2.00-2.45	2	SPT	N=11			. . . Below 2.00m bgl, red orange grey brown mottled.		
	2.50	5	D						
	2.50		V	c_r=64					
	3.00-3.45	3	SPT	N=13					
							Borehole terminated at 3.45m depth.	3.45	

Drilling Progress and Water Observations

Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. No groundwater was encountered
2. Borehole backfilled with arisings upon completion

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	**Archway Competitor**	**Michael O'Shea**	**RSpeight**	

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WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Campdown	**Radian**	**BH12**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
28720	**03.08.16** End: **03.08.16**	**---**	**---**	**1** of **1**

Progress	Samples / Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Window Run	Depth	No	Type	Results					
	0.10-0.20	1	ES				TOPSOIL: Red brown grey mottled sandy CLAY.	(0.30) 0.30	
	0.40	2	D				Firm medium strength orange brown grey mottled sandy CLAY. (HEAD DEPOSITS)	(1.40) 1.70	
	0.50		V	c_r=72					
	1.40	3	D						
	1.50		V	c_r=65					
	1.90	4	D				Orange brown silty SAND. (BOGNOR SAND MEMBER) . . . Below 2.00m bgl, slightly damp.	(1.30) 3.00	
	2.50	5	D						
							Borehole terminated at 3.00m depth.		

Drilling Progress and Water Observations

Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. No groundwater was encountered
2. Borehole backfilled with arisings upon completion

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	**Archway Competitor**	**Michael O'Shea**	**RSpeight**	

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WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Campdown	**Radian**	**BH13**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
28720	**07.09.16** End: **03.08.16**	**---**	**---**	**1** of **1**

Progress	Samples / Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Window Run	Depth	No	Type	Results					
	0.10-0.20	1	ES				TOPSOIL: Red brown grey mottled sandy CLAY.	(0.30)	
								0.30	
	0.50	2	D				Firm medium strength orange brown mottled grey slightly sandy silty CLAY. Sand is fine. (HEAD DEPOSITS)		
	0.50		V	c_r=50				(0.70)	
								1.00	
	1.00-1.45	1	SPT	N=8			Firm medium strength red orange brown grey mottled CLAY. (LAMBETH GROUP) . . . Below 1.00m bgl, red orange brown grey mottled.		
	1.50	3	D						
	1.50		V	c_r=65					
	2.00-2.45	2	SPT	N=10				(2.45)	
	2.70	4	D				. . . Below 2.50m bgl, becoming fissured with no sand.		
	3.00-3.45	3	SPT	N=16					
								3.45	
							Borehole terminated at 3.45m depth.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. No groundwater was encountered
2. Gas and groundwater monitoring well installed to 3.00m

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	**Archway Competitor+**	**ADavidson**	**RSpeight**	

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WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Campdown	**Radian**	**BH14**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
28720	**03.08.16** End: **03.08.16**	**---**	**---**	**1** of **1**

Progress	Samples / Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Window Run	Depth	No	Type	Results					
	0.10-0.20	1	ES				TOPSOIL: Red brown grey mottled sandy CLAY.	(0.30) 0.30	
	0.60	2	D				Orange brown slightly sandy gravelly CLAY. Sand is fine. Gravel is angular to subangular medium to coarse of flint. (HEAD DEPOSITS)	(0.80) 1.10	
	1.30	3	D				Firm high strength red grey mottled slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is angular to rounded fine to coarse of flint. (LAMBETH GROUP)		
	1.60		V	c_r=>120			. . . Below 1.50m bgl, becoming stiff to very stiff with no gravel.	(1.90) 3.00	
	2.40	4	D						
							Borehole terminated at 3.00m depth.		

Drilling Progress and Water Observations

Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. No groundwater was encountered
2. Borehole backfilled with arisings upon completion

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	**Archway Competitor**	**Michael O'Shea**	**RSpeight**	

GINT_LIBRARY_V8_06.GLB LibVersion: v8_06_013 PrjVersion: v8_06 - Core+Logs - 001 | Log WINDOW SAMPLE LOG - A4P | 28720 CAMPDOWN.GPJ - v8_06.
RSK Environment Ltd, 18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT. Tel: 01442 437500, Fax: 01442 437550, Web: www.rsk.co.uk. | 08/09/16 - 13:58 | EH1 |

WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Campdown	**Radian**	**BH15**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
28720	**07.09.16** End: **03.08.16**	**---**	**---**	**1** of **1**

Progress	Samples / Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Window Run	Depth	No	Type	Results					
	0.10-0.20	1	ES				TOPSOIL: Red brown grey mottled sandy CLAY.	(0.30) 0.30	
	0.50	2	D				Soft orange grey brown mottled very sandy slightly gravelly CLAY. Sand is fine. Gravel is angular to subangular fine to medium of flint. (HEAD DEPOSITS)	(0.70) 1.00	
	1.00-1.45	1	SPT	N=24			Grey high strength orange mottled clayey SAND with rare flint gravel and occasional band of clay. Gravel is angular to subangular fine to coarse. (HEAD DEPOSITS)		
	1.40	3	D						
	2.00-2.45	2	SPT	N=16	1		. . . Below 2.00m bgl, medium strength.	(2.45)	
	2.70	4	D						
	3.00-3.45	3	SPT	N=9				3.45	
							Borehole terminated at 3.45m depth.		

Drilling Progress and Water Observations

Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. Groundwater encountered between 2.00-2.50m
2. Gas and groundwater monitoring well installed to 3.00m depth.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	**Archway Competitor+**	**ADavidson**	**RSpeight**	

GINT_LIBRARY_V8_06.GLB LibVersion: v8_06_013 PrjVersion: v8_06 - Core+Logs - 001 | Log WINDOW SAMPLE LOG - A4P | 28720 CAMPDOWN.GPJ - v8_06.
RSK Environment Ltd, 18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT. Tel: 01442 437550, Fax: 01442 437500, Web: www.rsk.co.uk. | 08/09/16 - 13:58 | EH1 |

WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Campdown	**Radian**	**BH16**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
28720	**07.09.16** End: **04.08.16**	**---**	**---**	**1** of **1**

Progress	Samples / Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Window Run	Depth	No	Type	Results					
	0.10-0.20	1	ES				Grass over firm medium strength orange brown mottled grey slightly sandy silty CLAY with occasional silty sand partings. Sand is fine. (HEAD DEPOSITS)		
	0.50	2	D						
	0.50		V	c_r=75					
	1.00-1.45	1	SPT	N=10			. . . Below 1.00m bgl, becoming sandy silty clay.		
	1.20		V	c_r=54					
	1.40	3	D					(3.45)	
	2.00-2.45	2	SPT	N=18					
	2.50	4	D						
	3.00-3.45	3	SPT	N=18					
								3.45	
							Borehole terminated at 3.45m depth.		

Drilling Progress and Water Observations

Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. No groundwater was encountered
2. Roots present to 0.80m
3. Gas and groundwater monitoring well installed to 3.00m

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	**Archway Competitor+**	**ADavidson**	**RSpeight**	

GINT_LIBRARY_V8_06.GLB LibVersion: v8_06_013 PrjVersion: v8_06 - Core+Logs - 001 | Log WINDOW SAMPLE LOG - A4P | 28720 CAMPDOWN.GPJ - v8_06.
RSK Environment Ltd, 18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT. Tel: 01442 437550, Fax: 01442 437500, Web: www.rsk.co.uk. | 08/09/16 - 13:58 | EH1 |

WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Campdown	**Radian**	**BH17**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
28720	**07.09.16** End: **04.08.16**	**---**	**---**	**1** of **1**

Progress	Samples / Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Window Run	Depth	No	Type	Results					
	0.10-0.20	1	ES				TOPSOIL: Firm brown sandy gravelly CLAY. Sand is fine. Gravel is subangular to subrounded fine to medium of chalk and rare brick.	0.25	
	0.50	2	D				Firm medium to high strength orange brown slightly sandy CLAY. Sand is fine. Occasional mottled grey. (HEAD DEPOSITS)		
	0.50		V	c_r=64					
	1.00-1.45	1	SPT	N=10					
	1.20		V	c_r=71					
	1.30	3	D						
	1.60		V	c_r=86				(3.20)	
	2.00-2.45	2	SPT	N=13			. . . Below 2.00m bgl, occasional pockets of fine to medium sand.		
	2.40	4	D						
	3.00-3.45	3	SPT	N=13					
								3.45	
							Borehole terminated at 3.45m depth.		

Drilling Progress and Water Observations

Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. No groundwater was encountered
2. Gas and groundwater monitoring well installed to 3.00m depth

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	**Archway Competitor+**	**ADavidson**	**RSpeight**	

GINT_LIBRARY_V8_06.GLB LibVersion: v8_06_013 PrjVersion: v8_06 - Core+Logs - 001 | Log WINDOW SAMPLE LOG - A4P | 28720 CAMPDOWN.GPJ - v8_06.
RSK Environment Ltd, 18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT. Tel: 01442 437500, Fax: 01442 437550, Web: www.rsk.co.uk. | 08/09/16 - 13:58 | EH1 |

WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Campdown	**Radian**	**BH18**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
28720	End: **04.08.16**	**---**	**---**	**1** of **1**

Progress	Samples / Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Window Run	Depth	No	Type	Results					
	0.10-0.20	1	ES				TOPSOIL: Brown grey mottled slightly sandy silty CLAY.	0.25	
	0.40	2	D				Firm medium strength orange brown grey mottled sandy silty CLAY. Sand is fine. (HEAD DEPOSITS)		
	0.50		V	c_r=43					
	0.80		V	c_r=48					
	1.00-1.45	1	SPT	N=9			. . . Below 1.00m bgl, red brown grey mottled, slightly sandy.		
	1.20	3	D						
	1.40		V	c_r=70				(3.20)	
	1.90		V	c_r=75					
	2.00-2.45	2	SPT	N=11					
	2.30	4	D						
	3.00-3.45	3	SPT	N=12					
							Borehole terminated at 3.45m depth.	3.45	

Drilling Progress and Water Observations

Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. No groundwater was encountered
2. Gas and groundwater monitoring well installed to 3.00m depth

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Tracked window sampling	**Archway Competitor+**	**ADavidson**	**RSpeight**	

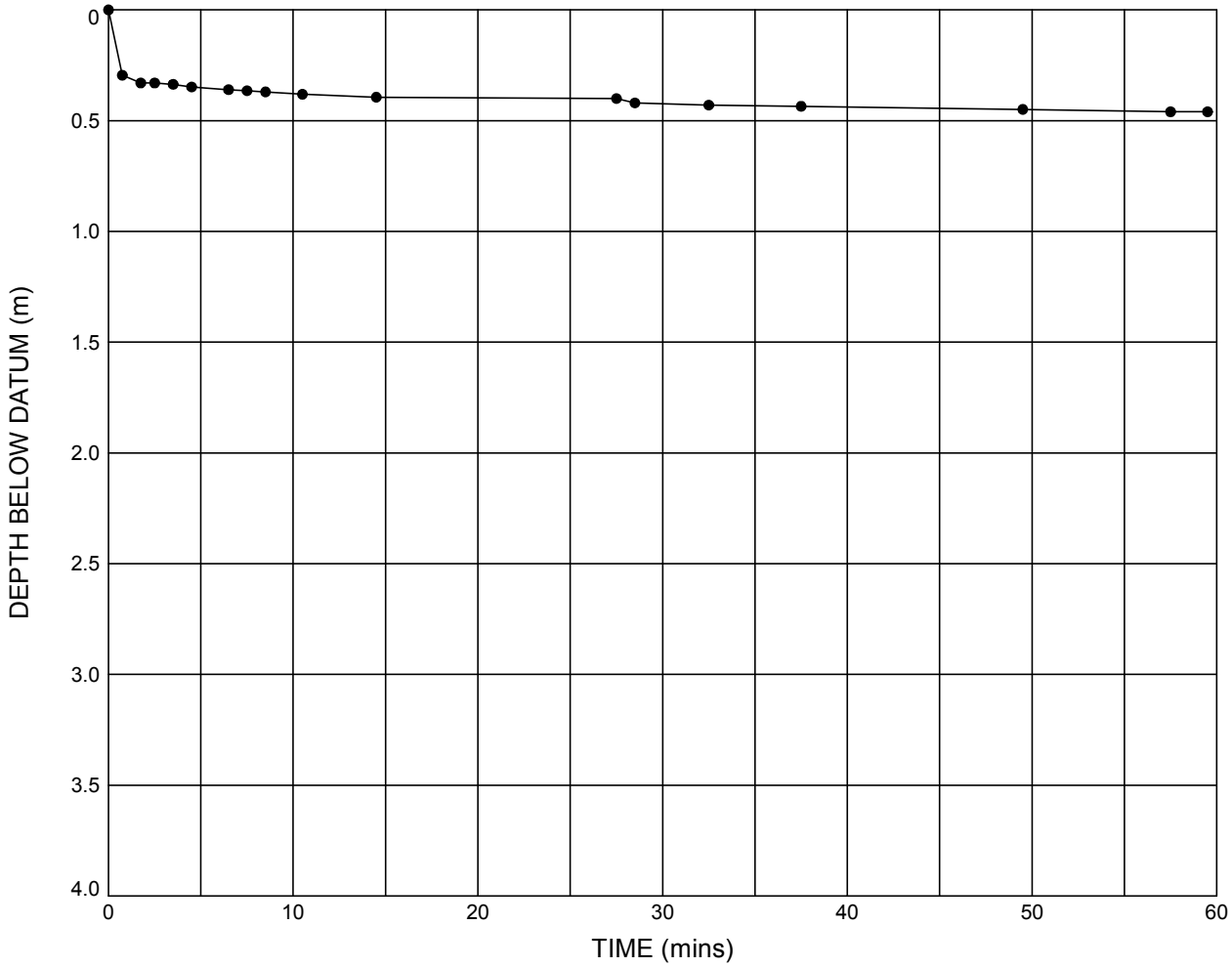
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RSK Environment Ltd, 18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT. Tel: 01442 437550, Fax: 01442 437500, Web: www.rsk.co.uk. | 08/09/16 - 13:58 | EH1 |

BOREHOLE SOAKAWAY TEST

Test position: BH1

Ground Level: **---** Co-ordinates: **---**

PLOT OF DEPTH OF WATER BELOW DATUM AGAINST TIME



Effective depth, De	=	**3.45**	m
Effective storage volume, V_{p75-25}	=	**0.003387**	m^3
Surface area, a_{p50}	=	**0.272926**	m^2
Time, t_{p75-25}	=	**75272**	secs
Infiltration coefficient, f	=	**1.65×10^{-7}**	m/s

Test hole details:

Measurement datum was **GL**
Hole depth at start of test: **3.45**mBGL
Borehole diameter: **50**mm

Legend:

● Test 1 (02/09/2016)

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18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Compiled By	Date	Checked By	Date
MDStrawson	**09/09/16**		**09/09/16**

Contract	Contract Ref:
Campdown	**28720**

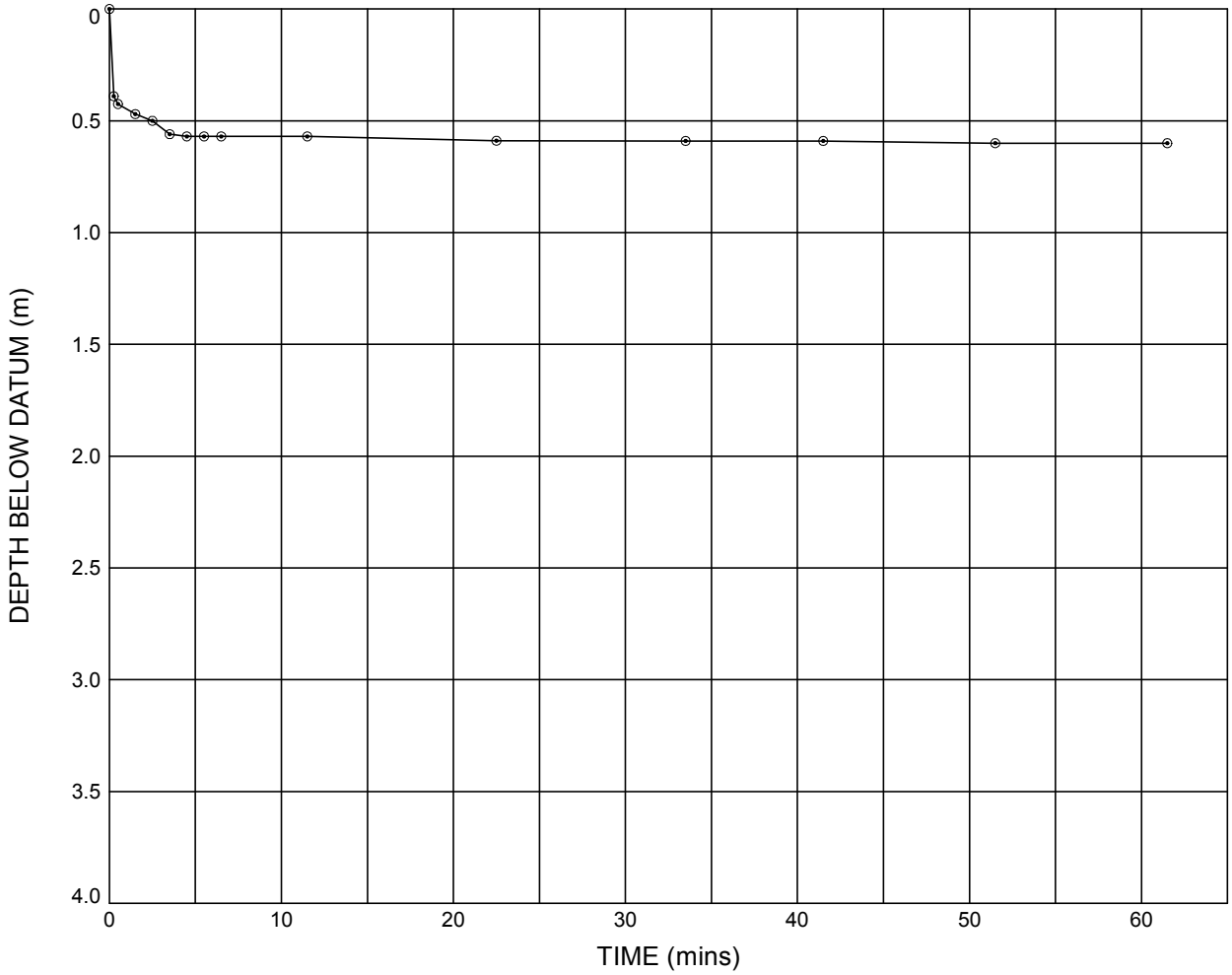
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BOREHOLE SOAKAWAY TEST

Test position: BH5

Ground Level: **---** Co-ordinates: **---**

PLOT OF DEPTH OF WATER BELOW DATUM AGAINST TIME



Effective depth, De	=	**3.45**	m
Effective storage volume, V_{p75-25}	=	**0.003387**	m^3
Surface area, a_{p50}	=	**0.272926**	m^2
Time, t_{p75-25}	=	**103500**	secs
Infiltration coefficient, f	=	**1.20×10^{-7}**	m/s

Test hole details:

Measurement datum was **GL**
Hole depth at start of test: **3.45**mBGL
Borehole diameter: **50**mm

Legend:

⊙ Test 1 (02/09/2016)

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Hertfordshire
HP3 9RT

Compiled By	Date	Checked By	Date
MDStrawson	**09/09/16**		**09/09/16**

Contract: **Campdown**

Contract Ref: **28720**

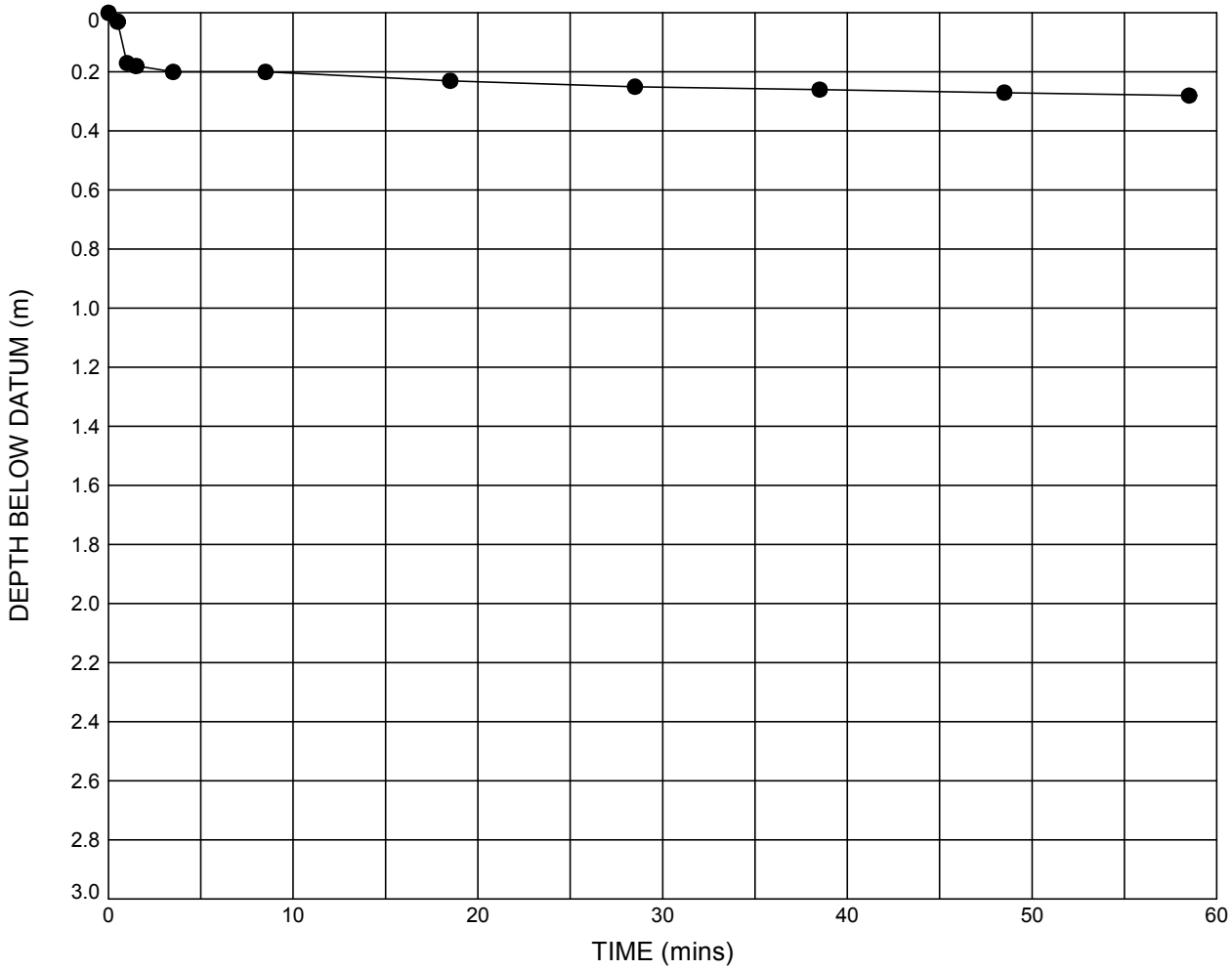
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BOREHOLE SOAKAWAY TEST

Test position: BH7

Ground Level: **---** Co-ordinates: **---**

PLOT OF DEPTH OF WATER BELOW DATUM AGAINST TIME



Effective depth, De	=	**3**	m
Effective storage volume, V_{p75-25}	=	**0.002945**	m^3
Surface area, a_{p50}	=	**0.237583**	m^2
Time, t_{p75-25}	=	**90000**	secs
Infiltration coefficient, f	=	**1.38×10^{-7}**	m/s

Test hole details:

Measurement datum was **GL**
Hole depth at start of test: **3.00**mBGL
Borehole diameter: **50**mm

Legend:

Test 1 (02/09/2016)

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18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Compiled By	Date	Checked By	Date
MDStrawson	**09/09/16**		**09/09/16**

Contract	Contract Ref:
Campdown	**28720**

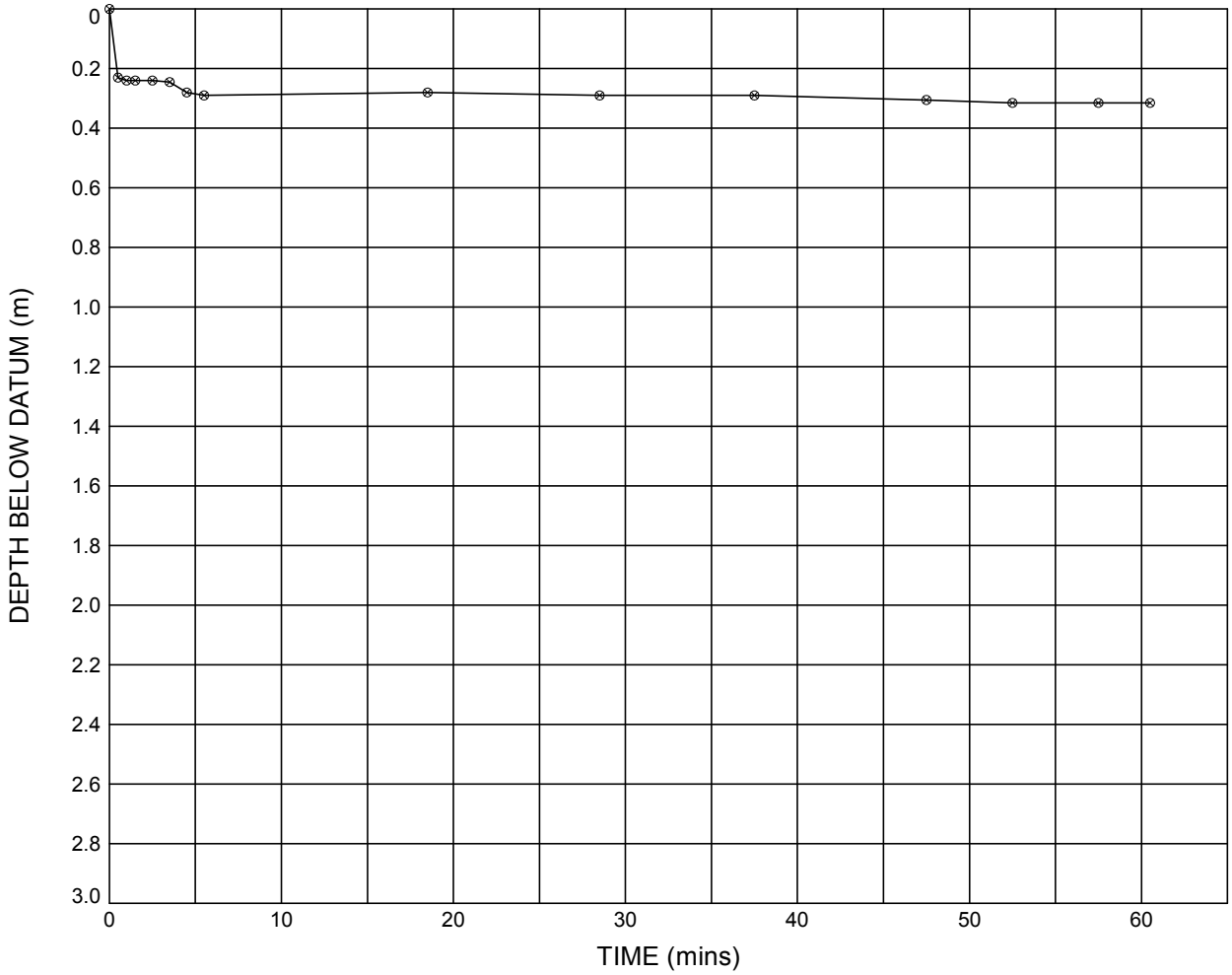
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BOREHOLE SOAKAWAY TEST

Test position: BH9

Ground Level: **---** Co-ordinates: **---**

PLOT OF DEPTH OF WATER BELOW DATUM AGAINST TIME



Effective depth, De	=	**2.93**	m
Effective storage volume, V_{p75-25}	=	**0.002872**	m^3
Surface area, a_{p50}	=	**0.231692**	m^2
Time, t_{p75-25}	=	**43875**	secs
Infiltration coefficient, f	=	**2.82×10^{-7}**	m/s

Test hole details:

Measurement datum was **GL**
Hole depth at start of test: **2.93**mBGL
Borehole diameter: **50**mm

Legend:

⊗ Test 1 (02/09/2016)

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Hemel Hempstead
Hertfordshire
HP3 9RT

Compiled By	Date	Checked By	Date
MDStrawson	**09/09/16**		**09/09/16**

Contract: **Campdown**

Contract Ref: **28720**

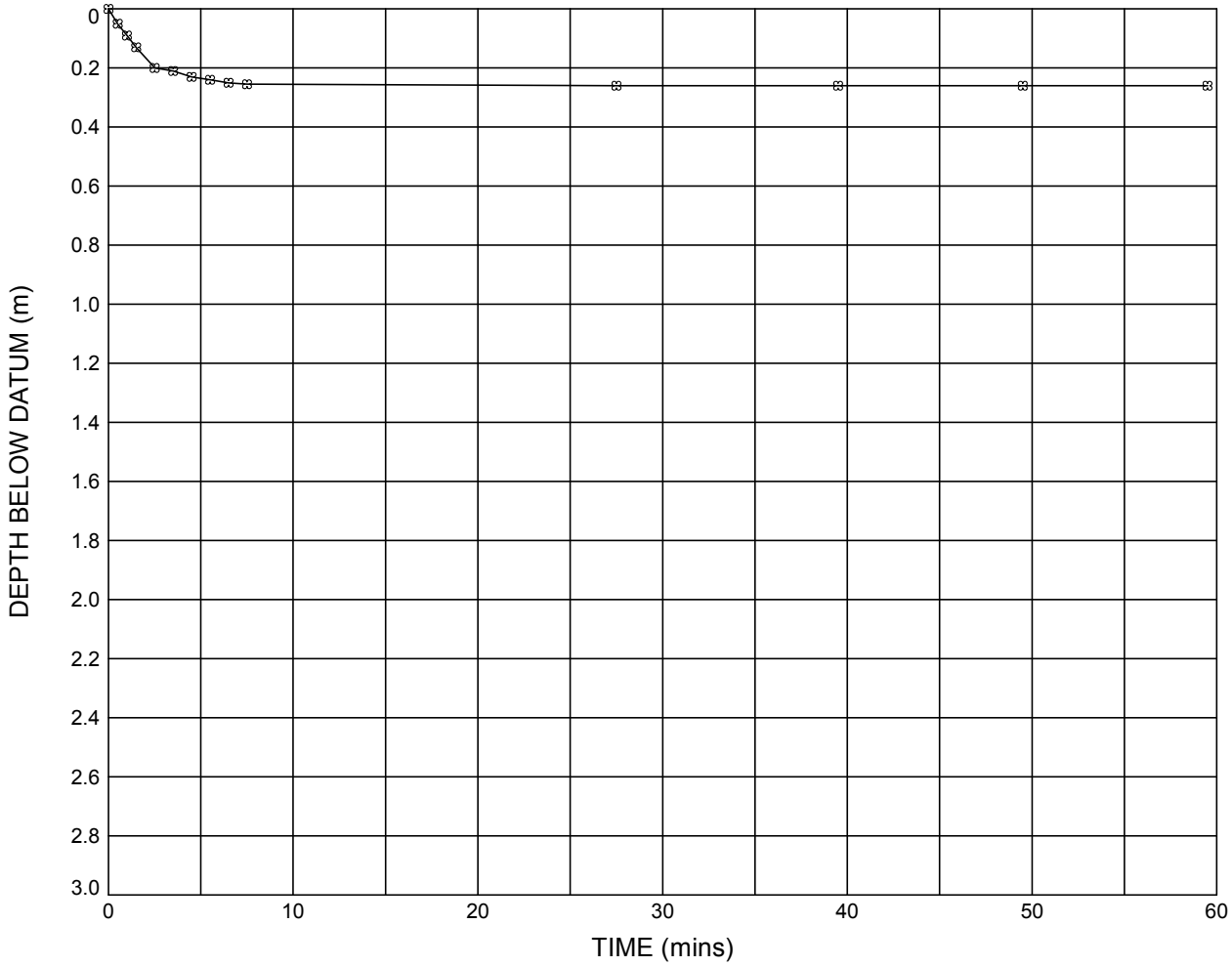
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BOREHOLE SOAKAWAY TEST

Test position: BH15

Ground Level: **---** Co-ordinates: **---**

PLOT OF DEPTH OF WATER BELOW DATUM AGAINST TIME



Effective depth, De	=	**2.55**	m
Effective storage volume, V_{p75-25}	=	**0.002503**	m^3
Surface area, a_{p50}	=	**0.202240**	m^2
Time, t_{p75-25}	=	**306000**	secs
Infiltration coefficient, f	=	**4.05×10^{-8}**	m/s

Test hole details:

Measurement datum was **GL**
Hole depth at start of test: **2.55**mBGL
Borehole diameter: **50**mm

Legend:

Test 1 (02/09/2016)

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Hertfordshire
HP3 9RT

Compiled By	Date	Checked By	Date
MDStrawson	**09/09/16**		**09/09/16**

Contract	Contract Ref:
Campdown	**28720**

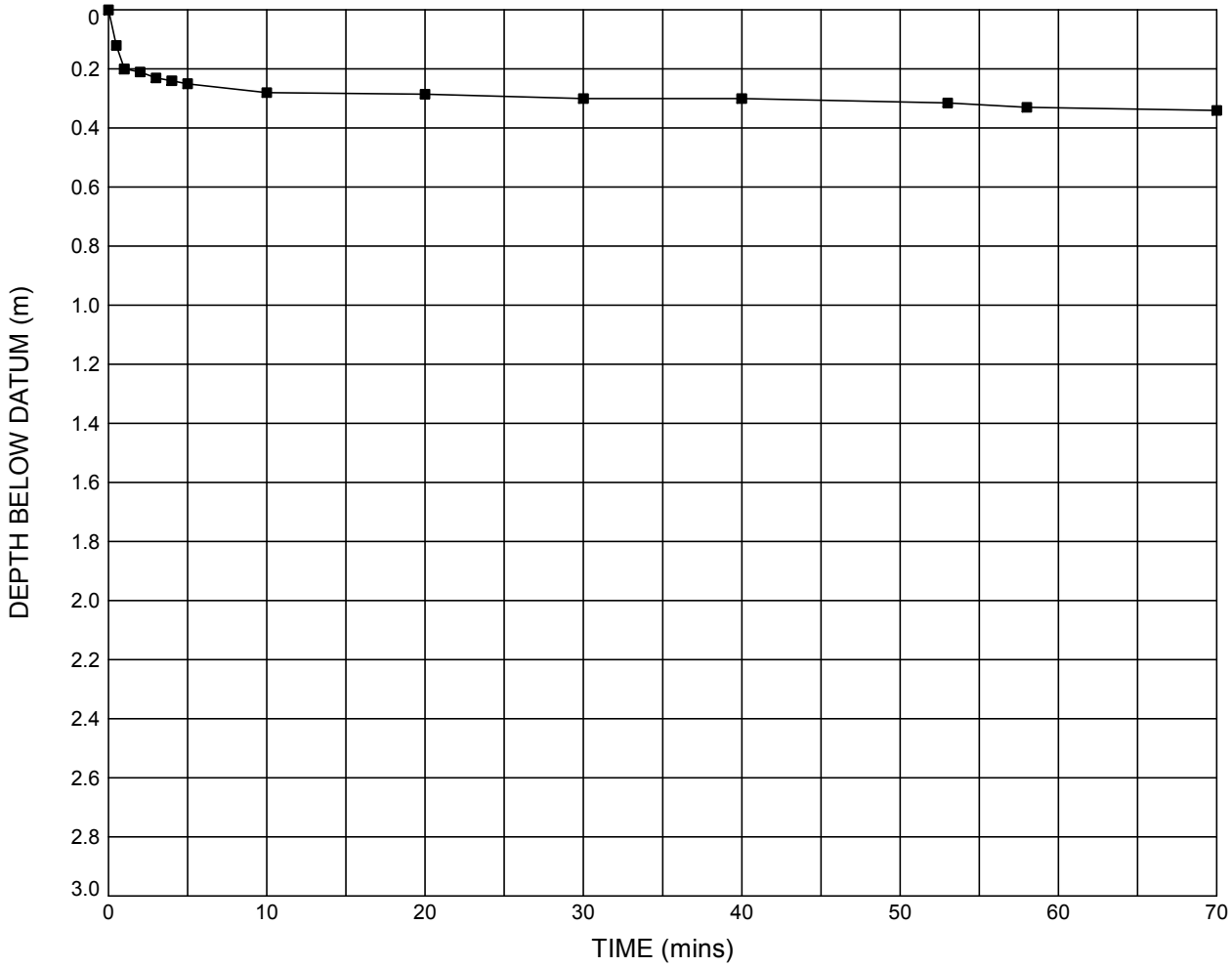
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BOREHOLE SOAKAWAY TEST

Test position: BH16

Ground Level: **---** Co-ordinates: **---**

PLOT OF DEPTH OF WATER BELOW DATUM AGAINST TIME



Effective depth, De	=	**2.78**	m
Effective storage volume, V_{p75-25}	=	**0.002729**	m^3
Surface area, a_{p50}	=	**0.220304**	m^2
Time, t_{p75-25}	=	**100080**	secs
Infiltration coefficient, f	=	**1.24×10^{-7}**	m/s

Test hole details:

Measurement datum was **GL**
Hole depth at start of test: **2.78**mBGL
Borehole diameter: **50**mm

Legend:

■ Test 1 (02/09/2016)

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Hemel Hempstead
Hertfordshire
HP3 9RT

Compiled By	Date	Checked By	Date
MDStrawson	**09/09/16**		**09/09/16**

Contract	Contract Ref:
Campdown	**28720**

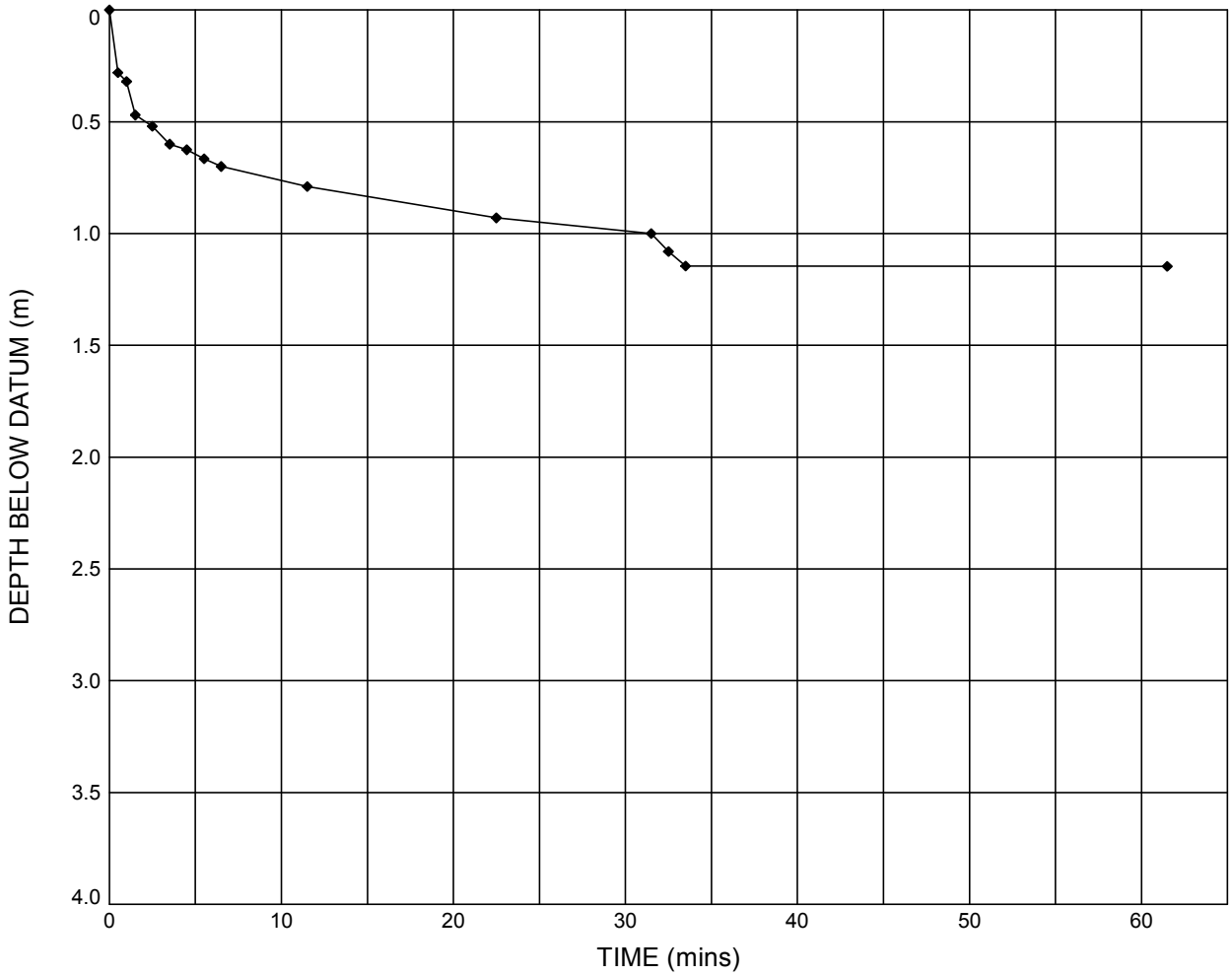
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BOREHOLE SOAKAWAY TEST

Test position: BH17a

Ground Level: **---** Co-ordinates: **---**

PLOT OF DEPTH OF WATER BELOW DATUM AGAINST TIME



Effective depth, De	=	**3.45**	m
Effective storage volume, V_{p75-25}	=	**0.003387**	m^3
Surface area, a_{p50}	=	**0.272926**	m^2
Time, t_{p75-25}	=	**2310**	secs
Infiltration coefficient, f	=	**5.37×10^{-6}**	m/s

Test hole details:

Measurement datum was **GL**
Hole depth at start of test: **3.45**mBGL
Borehole diameter: **50**mm

Legend:

◆ Test 1 (02/09/2016)

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Hemel Hempstead
Hertfordshire
HP3 9RT

Compiled By	Date	Checked By	Date
MDStrawson	**09/09/16**		**09/09/16**

Contract	Contract Ref:
Campdown	**28720**

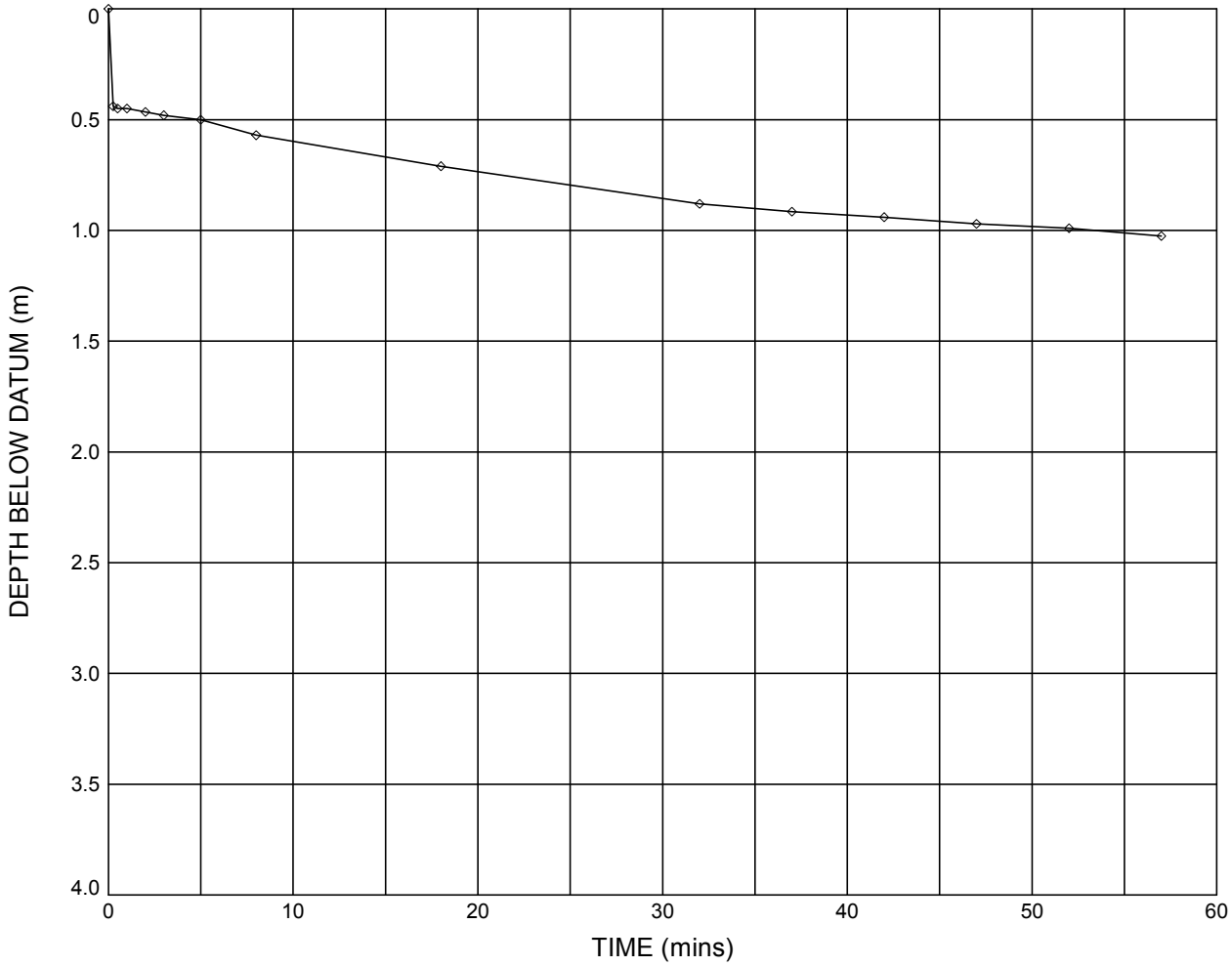
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BOREHOLE SOAKAWAY TEST

Test position: BH17b

Ground Level: **---** Co-ordinates: **---**

PLOT OF DEPTH OF WATER BELOW DATUM AGAINST TIME



Effective depth, De	=	**3.45**	m
Effective storage volume, V_{p75-25}	=	**0.003387**	m^3
Surface area, a_{p50}	=	**0.272926**	m^2
Time, t_{p75-25}	=	**14979**	secs
Infiltration coefficient, f	=	**8.28×10^{-7}**	m/s

Test hole details:

Measurement datum was **GL**
Hole depth at start of test: **3.45**mBGL
Borehole diameter: **50**mm

Legend:

◇ Test 1 (02/09/2016)

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18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Compiled By	Date	Checked By	Date
MDStrawson	**09/09/16**		**09/09/16**

Contract	Contract Ref:
Campdown	**28720**

GINT_LIBRARY_V8_06.GLB LibVersion: v8_06_013 PrjVersion: v8_06 - Core+Logs - 001 | Graph I - BH SOAKAWAY - A4P | 28720 CAMPDOWN.GPJ - v8_06. | 09/09/16 - 16:56 | MS4 |

APPENDIX E

Environment Agency (EA) Data

Environment Agency

Enter a postcode or place name:

Go

Other topics for this area...

Groundwater

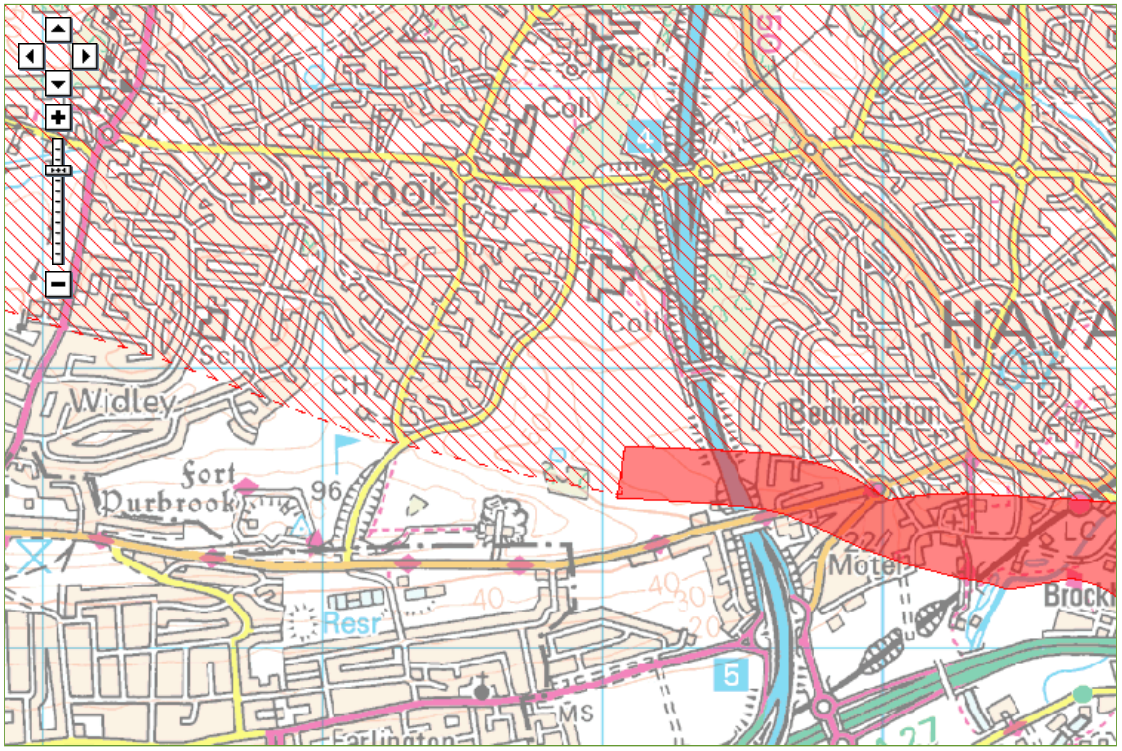
Groundwater

Map legend

- 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)
- BGS Aquifer Maps - Superficial Deposits Designation
- BGS Aquifer Maps - Bedrock Designation
- Groundwater Vulnerability Zones
- Other national environmental organisations

X: 468,856;Y: 106,969 at scale 1:20,000

Other maps | Data search | Text only version



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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's 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.

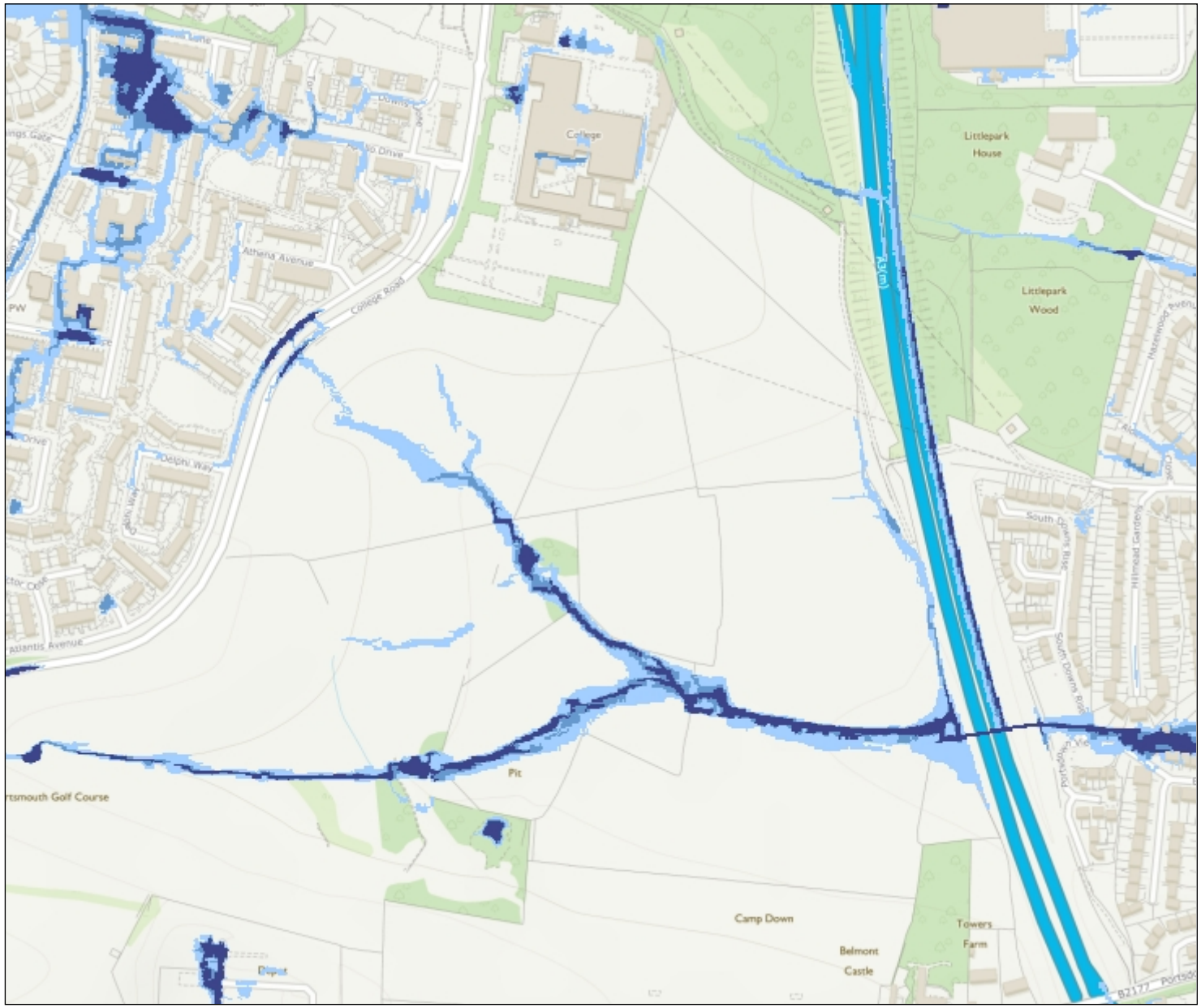
Understanding the British Geological Survey's Aquifer maps

Groundwater Vulnerability Maps:

Ww are currently updating our groundwater vulnerability maps to reflect improvements in data mapping and understanding of the factors affecting vulnerability. The new maps will be released later in 2017.

The 'New groundwater vulnerability mapping methodology' report provides technical information about how the new maps have been created.
The user guide outlines the kinds of activities the new maps can be used for.
These reports have been published on GOV.UK in advance of the release of the new maps to give users time to understand the new approach and how this differs from the previous groundwater vulnerability maps.

Risk of flooding from Surface Water centred on land at College Road, Havant - Created on 11/10/2017



Environment Agency

Scale 1:6,250

N
W E
S

Likelihood of flooding from Surface Water

- High (>= 3.3%)
- Medium (3.3% - 1%)
- Low (1% - 0.1%)
- Very Low

Likelihood of flooding from Surface Water

High:	Greater than or equal to 3.3% (1 in 30) chance in any given year
Medium:	Less than 3.3% (1 in 30) but greater than or equal to 1% (1 in 100) chance in any given year
Low:	Less than 1% (1 in 100) but greater than or equal to 0.1% (1 in 1,000) chance in any given year
Very Low:	Less than 0.1% (1 in 1,000) chance in any given year

This information is shown on the Risk of Flooding from Surface Water map on our website.

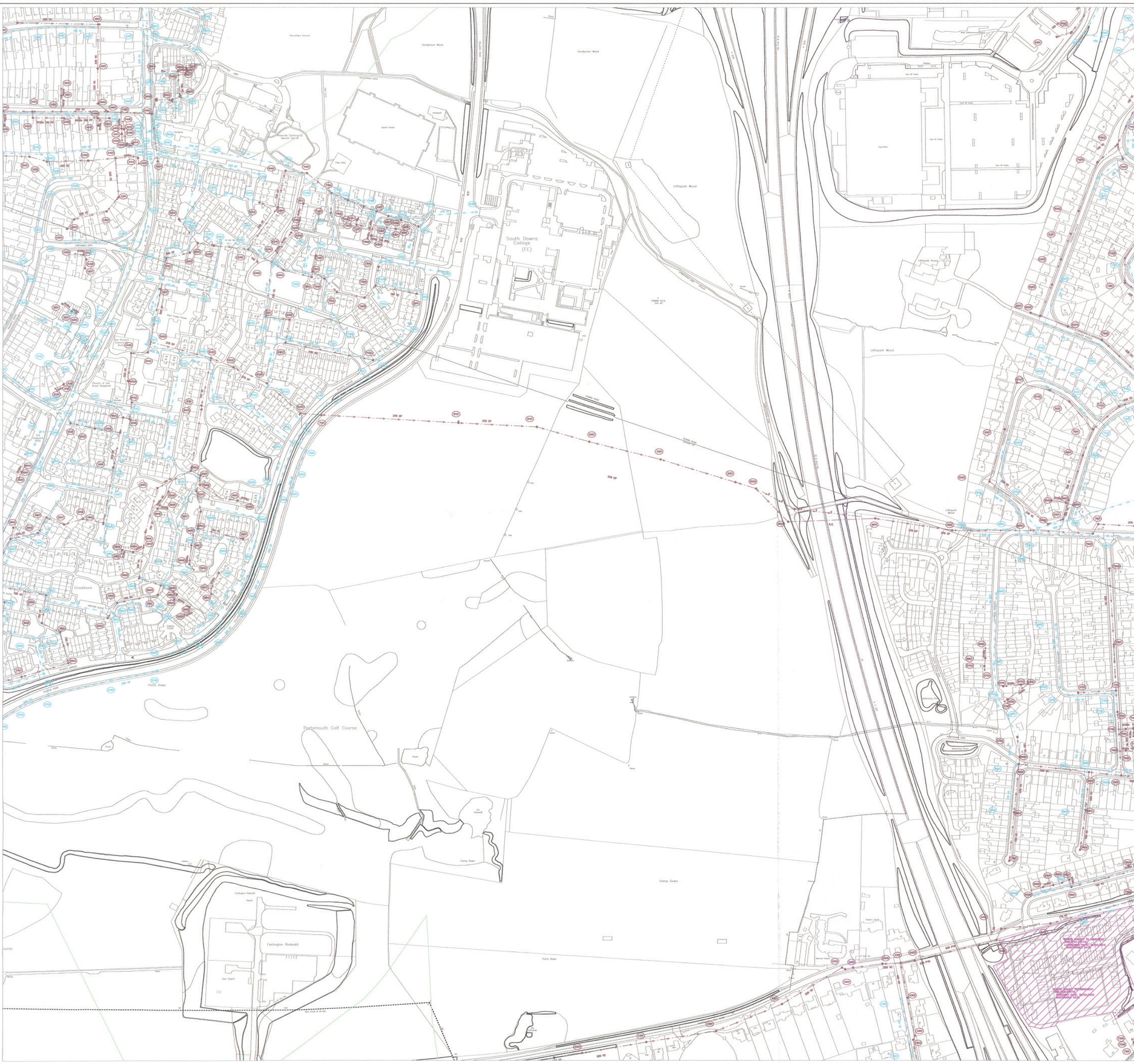
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Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). E-mail: enquires@environment-agency.gov.uk

APPENDIX F

Southern Water Services Ltd (SWSL) Records

107630



106301 468321 469757

SEWER RECORDS

Node	Cover	Invert	Size	Material	Shape	
0001X	47.93	44.5	375	CP	CIRC	
0301X	50.47	48.47	225	VC	CIRC	
1001X	44.35		375	CP	CIRC	
1301X			UNK	UNK	CIRC	
2001X	39.01	36.98	375	CP	CIRC	
2002X	37.62		375	CP	CIRC	
2301X			UNK	UNK	CIRC	
3001X			UNK	UNK	CIRC	
300DX			UNK	UNK	CIRC	
3050X	58.61	57.97	100	VC	CIRC	
3051X	58.02	56.81	375	CP	CIRC	
3052X	58.22	57.46	150	VC	CIRC	
305DX			300	CP	CIRC	
3101X			UNK	UNK	CIRC	
3102X			UNK	UNK	CIRC	
3151X	55.94	55.1	150	VC	CIRC	
3152X	55.74	54.79	150	VC	CIRC	
3154X	59.08	57.29	225	VC	CIRC	
3156X	58.39	56.47	225	VC	CIRC	
3157X	56.96	55.65	225	VC	CIRC	
3158X	56.19	54.97	375	CP	CIRC	
3201X			UNK	UNK	CIRC	
3250X	56.01	54.18	225	VC	CIRC	
3251X	56.61	54.96	225	VC	CIRC	
3252X	56.46	55.62	150	PF	CIRC	
3301X			UNK	UNK	CIRC	
3350X	54.67	53.02	225	VC	CIRC	
3352X	51.95	51.08	150	VC	CIRC	
3401X	49.02	46.99	225	VC	CIRC	*
3401X			225	VC	CIRC	*
3402X	49.19	47.18	225	VC	CIRC	*
3402X	48	46.19	225	VC	CIRC	*
3403X	48.71	46.48	225	VC	CIRC	*
3403X	48.17	45.63	225	VC	CIRC	*
3404X			150	PF	CIRC	
3405X			UNK	UNK	CIRC	
340DX			225	VC	CIRC	
341DX			225	VC	CIRC	
3450X	48.51	47.25	225	VC	CIRC	
3451X	49.03	47.96	150	VC	CIRC	
3452X	47.99	46.44	225	VC	CIRC	
3453X	47.31	45.67	600	CP	CIRC	
3454X	48.17	47.02	150	VC	CIRC	
3501X			UNK	UNK	CIRC	
351DX			UNK	UNK	CIRC	
3601X	52.69	51.33	225	VC	CIRC	
3650X	52.91	51.47	150	VC	CIRC	
3701X	65.25	64.15	150	VC	CIRC	
3751X	64.77	62.27	225	CP	CIRC	
3753X	65.26	62.43	225	CP	CIRC	
3754X	66.1	64.34	225	CP	CIRC	
3755X	67.09	65.21	225	CP	CIRC	
3801X	63.34	61.81	150	VC	CIRC	
3805X	61.66	60.24	150	VC	CIRC	
3806X	62.61	61.09	150	VC	CIRC	
3850X	61.93	60.49	225	CP	CIRC	
3851X	61.46	60.19	300	CP	CIRC	
3853X	61.3	59.36	300	CP	CIRC	
3856X	63.26	61.43	225	CP	CIRC	
3857X	63.27	62.36	150	VC	CIRC	
3858X	63.36		150	VC	CIRC	
3901X			UNK	UNK	CIRC	*
3901X	58.66	56.29	225	VC	CIRC	*
3902X	58.91	56.97	225	VC	CIRC	*
3902X	34.1	32.78	375	CP	CIRC	*
3903X	59.44	57.94	225	VC	CIRC	
3904X	59.24	58.06	150	VC	CIRC	
3907X	58.93	56.06	225	VC	CIRC	
3950X	59.44	58.21	375	CP	CIRC	
3951X	58.83	57	450	CP	CIRC	
3954X	59.55	57.86	375	CP	CIRC	
4001X	56.24	54.92	225	CP	CIRC	
4002X	54.86	53.12	225	CP	CIRC	
4003X	55.52	54.02	150	VC	CIRC	
4050X	57.65	55.76	450	CP	CIRC	
4051X	57.88	54.67	450	CP	CIRC	
4052X	56.45	54.27	450	CP	CIRC	
4053X	55.24	53.45	450	CP	CIRC	
4054X	57.45	55.24	225	CP	CIRC	
4055X	55.46	54.37	150	VC	CIRC	
4101X	54.42	52.73	225	CP	CIRC	
4102X	54.48	52.57	225	CP	CIRC	
4103X	54.37	52.25	225	CP	CIRC	
4104X	53.94	52.06	225	CP	CIRC	
4105X	53.38	51.47	225	CP	CIRC	
4106X	56.69	55.98	150	VC	CIRC	
4150X	55.49	54.36	150	VC	CIRC	
4151X	56.69	55.53	150	VC	CIRC	
4152X	55.26	53.55	225	CP	CIRC	
4153X	54.11	52.54	450	CP	CIRC	
4201X			UNK	UNK	CIRC	
4250X	54.55	53.55	225	VC	CIRC	
4251X	55.85	54.4	150	VC	CIRC	
4252X	56.05	54.97	150	PF	CIRC	
4253X	55.3	53.97	150	VC	CIRC	
4254X	54.66	53.55	150	VC	CIRC	
4255X	54.57	53.1	225	VC	CIRC	
4257X	53.17	52.4	375	CP	CIRC	
425DX			375	VC	CIRC	
426DX			375	CP	CIRC	
4301X			225	VC	CIRC	*
4301X	39.77	38.66	150	VC	CIRC	*
4302X	43.8	42.79	150	VC	CIRC	*
4302X			225	VC	CIRC	*
4303X			225	VC	CIRC	*
4303X	39.38	37.95	150	VC	CIRC	*
4304X	54.51	52	100	PF	CIRC	
4305X			UNK	UNK	CIRC	
4306X			UNK	UNK	CIRC	
4350X	55.01	53.82	150	VC	CIRC	*
4350X	43.86	43.27	150	VC	CIRC	*
4351X	53.81	52.52	150	VC	CIRC	*
4351X	37.58	37.02	225	VC	CIRC	*
4352X	51.52	50.37	150	VC	CIRC	
4353X	51.2	50.13	375	CP	CIRC	
4401X	46.45	44.8	225	VC	CIRC	*
4401Y	46.45	44.86	150	VC	CIRC	*
4401X	49.23	47.49	225	VC	CIRC	*
4402X	48.03	45.39	225	VC	CIRC	*
4402X	49.27	46.89	225	VC	CIRC	*
4403X	48.64	47.15	225	VC	CIRC	*
4403X	45.51	44.45	225	PVC	CIRC	*
4404X			150	PF	CIRC	
4405X			150	PF	CIRC	
4406X			UNK	UNK	CIRC	
4408X			150	PF	CIRC	
4410X			UNK	UNK	CIRC	
4411X			UNK	UNK	CIRC	
4412X			UNK	UNK	CIRC	
4413X			UNK	UNK	CIRC	
4414X			UNK	UNK	CIRC	
4415X			UNK	PF	CIRC	
443DX			UNK	UNK	CIRC	
444DX			UNK	UNK	CIRC	
4450X	49.51	48.31	150	VC	CIRC	
4451X	50.42	49.23	225	VC	CIRC	
4452X	50.29	48.5	600	CP	CIRC	
4453X	49.9	48.2	600	CP	CIRC	
4455X	48.55	47.58	150	VC	CIRC	
44ADX			UNK	UNK	CIRC	
44BDX			225	VC	CIRC	
4501X			225	VC	CIRC	
4502X	49.71	48.49	225	VC	CIRC	
4550X	50.98	50.17	225	VC	CIRC	
4551X	53.51	52.57	225	VC	CIRC	
4601X	52.94		225	VC	CIRC	
4650X	52.93	52.08	150	VC	CIRC	
4651X	53.09	51.86	150	VC	CIRC	
4750X	64.46	62.91	225	CP	CIRC	
4801X	63.88	62.81	150	VC	CIRC	
4802X	64.18		150	VC	CIRC	
4803X	64.77	62.87	150	VC	CIRC	
4852X	64	62.52	225	CP	CIRC	
4853X	63.91		225	CP	CIRC	
4854X	64.07	62.67	225	CP	CIRC	
4901X	59.48	55.69	225	VC	CIRC	*
4901X	30.57	27.52	375	CP	CIRC	*
4902X	58.75	55.95	225	VC	CIRC	
4903X	63.17	61.44	150	VC	CIRC	
4904X			UNK	UNK	CIRC	
4905X			UNK	UNK	CIRC	
490DX			UNK	UNK	CIRC	
491DX			150	VC	CIRC	
4950X	59.73	57.3	225	CP	CIRC	
4951X	60.43	58.93	225	CP	CIRC	
4952X	63.04	61.14	225	CP	CIRC	
5001X	58.19	56.08	150	VC	CIRC	*
5001X			UNK	UNK	CIRC	*
5002X	57.64	56.08	150	VC	CIRC	*
5002X	26.65		225	VC	CIRC	*

Node	Cover	Invert	Size	Material	Shape	
5003X	56.65	54.34	150	VC	CIRC	
5004X	57	54.37	150	VC	CIRC	
5006X			UNK	UNK	CIRC	
5050X	57.09	55.43	375	CP	CIRC	*
5050X	28.07	26.61	225	VC	CIRC	*
5051X	26.14	24.89	225	VC	CIRC	*
5051X	56.2	54.44	375	CP	CIRC	*
5052X	25.66	24.3	225	VC	CIRC	
5101X	54.15	52.54	150	VC	CIRC	
5102X	52.98	47.14	375	CP	CIRC	
5103X	54.44	52.68	150	VC	CIRC	
5104X	52.98	51.13	225	CP	CIRC	
5150X	54.78	51.48	525	CP	CIRC	
5151X	53.76	49.88	450	CP	CIRC	
5152X	52.92	49.66	450	CP	CIRC	
5153X	52.48	49.26	600	CP	CIRC	
5201X	51.09	47.78	300	CP	CIRC	
5202X	52.9	47.45	375	CP	CIRC	
5250X	50.8	48.24	675	CP	CIRC	
5251X	51.14	49.54	225	CP	CIRC	
5252X	51.44	49.95	225	CP	CIRC	
5253X	52.13	48.71	675	CP	CIRC	
5254X	53.05	48.85	675	CP	CIRC	
5301X	50.91	47.86	300	CP	CIRC	
5302X	50.4	48.14	300	CP	CIRC	
5303X	50.11	48.3	300	CP	CIRC	
5304X	49.8	48.66	150	VC	CIRC	
5305X	49.91	48.64	225	CP	CIRC	
5350X	51	48.06	675	CP	CIRC	
5351X	50.26	47.87	675	CP	CIRC	
5352X	49.99	47.39	825	CP	CIRC	
5353X	49.43	47.95	450	CP	CIRC	
5354X	49.79	48.19	450	CP	CIRC	
5355X	49.82	47.24	825	CP	CIRC	
5356X	49.94	48.57	225	CP	CIRC	
5357X	50.49	49.83	375	CP	CIRC	
5401X	50.24	48.28	225	VC	CIRC	*
5401X	40.04	37.79	175	VC	CIRC	*
5402X	50.38	48.02	225	VC	CIRC	*
5402X	40.4	39.37	175	VC	CIRC	*
5450X	49.81	47.06	825	CP	CIRC	
5451X	49.94	46.89	825	CP	CIRC	
5452X	50.02	46.45	825	CP	CIRC	
5453X	50.92	47.93	375	CP	CIRC	
5454X			900	CP	CIRC	
5455X	50.3	49.53	375	CP	CIRC	
5456X	50.24	47.29	600	CP	CIRC	
5457X	50.2	48.63	750	CP	CIRC	
5458X	50.14	49.24	375	CP	CIRC	
5459X	50.22	48	600	CP	CIRC	
5460X	50.38	49.33	300	CP	CIRC	
5461X	50.37	49.28	300	CP	CIRC	
5462X	50.35	49.13	300	CP	CIRC	
5501X	52.35	51.5	150	VC	CIRC	*
5501X	32.21	30.97	150	VC	CIRC	*
5502X	52.6	51.23	150	VC	CIRC	
5503X	52.33	49.31	150	VC	CIRC	
5504X	52.14	49.04	150	VC	CIRC	
5505X	51.34	48.54	150	VC	CIRC	
5506X			UNK	UNK	CIRC	
5507X			UNK	UNK	CIRC	
551DX			UNK	UNK	CIRC	
552DX			150	VC	CIRC	
5550X	52.33	51.41	150	VC	CIRC	
5551X	52.57	50.8	150	VC	CIRC	
5552X	52.12	50.22	225	VC	CIRC	
5553X	52.39	50.75	150	VC	CIRC	
5554X	51.77	49.93	225	VC	CIRC	
5555X	54.86	54.02	150	VC	CIRC	
5556X	53.55	52.85	150	VC	CIRC	
5650X	25.64	24.08	150	VC	CIRC	*
5650X	55.67	54.56	150	VC	CIRC	*
5651X	55.86	54.78	150	VC	CIRC	
5701X			UNK	UNK	CIRC	
5702X			UNK	UNK	CIRC	
5703X			UNK	UNK	CIRC	
5750X	22.89		225	VC	CIRC	*
5750X	65.64	64.04	225	CP	CIRC	*
5751X	22.23		225	VC	CIRC	
5801X	63.3	62.38	150	VC	CIRC	*
5801X			UNK	UNK	CIRC	*
5802X			UNK	UNK	CIRC	
5803X			UNK	UNK	CIRC	
5804X			UNK	UNK	CIRC	
5805X			UNK	UNK	CIRC	
580DX			UNK	UNK	CIRC	
581DX			UNK	UNK	CIRC	
582DX			UNK	UNK	CIRC	
5850X	65.1	63.42	225	CP	CIRC	*
5850X	27.21		225	VC	CIRC	*
5851X	24.48		225	VC	CIRC	*
5851X	65.61	63.94	225	CP	CIRC	*
5853X	66.23	65.19	150	CP	CIRC	
5854X	65.51	64.53	150	CP	CIRC	
5856X	65.32	63.58	225	CP	CIRC	
5857X	65.14	62.98	150	VC	CIRC	
5858X	63.23	61.92	225	CP	CIRC	
5901X	58.25	56.31	150	VC	CIRC	*
5901X	28.81		375	CP	CIRC	*
5902X	59.1	57.38	150	VC	CIRC	
5903X	63.19	61.7	150	VC	CIRC	
5904X	60.65	57.99	150	VC	CIRC	
5905X			UNK	VC	CIRC	
5907X			UNK	UNK	CIRC	
5908X			UNK	UNK	CIRC	
590DX			UNK	UNK	CIRC	
591DX			UNK	UNK	CIRC	
5950X	62.36	60.55	225	CP	CIRC	
5951X	60.83	59.12	225	CP	CIRC	*
5951X	28.05		300	CP	CIRC	*
5951Y	28.05		225	CP	CIRC	*
5952X	60.66	58.94	225	CP	CIRC	
5953X	59.19	57.19	225	CP	CIRC	
5954X	59.08	56.82	375	CP	CIRC	
5955X	57.77	56.26	225	CP	CIRC	
6001X			UNK	UNK	CIRC	*
6001X	23	21.4	225	VC	CIRC	*
6002X			UNK	UNK	CIRC	
6003X			UNK	UNK	CIRC	
600DX			UNK	UNK	CIRC	
6050X	55.57	53.73	300	CP	CIRC	*
6050X	22.62	21.24	300	VC	CIRC	*
6051X	55.2	53.54	300	CP	CIRC	
6052X	54.16	50.77	375	CP	CIRC	
6053X	53.56	51.98	225	CP	CIRC	
6054X	54.69	53.06	225	CP	CIRC	
6055X	55.34	53.25	225	CP	CIRC	
6101X	53.37	47.07	375	CP	CIRC	*
6101X			UNK	UNK	CIRC	*
6102X			UNK	UNK	CIRC	*
6102X	53.73	46.82	375	CP	CIRC	*
6103X	54.13	46.68	375	CP	CIRC	*
6103X			UNK	UNK	CIRC	*
6150X	27.06	25.13	150	VC	CIRC	*
6150X	53.62	50.14	450	CP	CIRC	*
6151X	23.85	22.72	225	VC	CIRC	*
6151X	54.17	52.02	225	CP	CIRC	*
6152X	53.71	52.09	225	CP	CIRC	*
6152X	27.22	25.27	375	CP	CIRC	*
6153X			UNK	UNK	CIRC	*
6153X	53.87	52.32	225	CP	CIRC	*
6201X			UNK	UNK	CIRC	*
6201X	53.86	51.94	150	VC	CIRC	*
6202X	54.11	52.41	150	VC	CIRC	*
6202X	30.88		225	VC	CIRC	*
6203X			UNK	UNK	CIRC	*
6203X	53.96	52.5	150	VC	CIRC	*
6204X			UNK	UNK	CIRC	*
6204X	31.53		225	VC	CIRC	*
6250X	33.45		225	VC	CIRC	*
6250X	54.49	52.16	300	CP	CIRC	*
6251X			225	VC	CIRC	*
6251X	53.6	51.83	300	CP	CIRC	*
6252X	53.74		300	CP	CIRC	
6253X	53.83	51.31	375	CP	CIRC	
6301X			UNK	UNK	CIRC	*
6301X	50.68	49.27	225	CP	CIRC	*
6302X			UNK	UNK	CIRC	*
6302X	51.86	49.68	150	VC	CIRC	*
6303X			UNK	UNK	CIRC	*
6303X	51.07	49.92	150	VC	CIRC	*
6304X	51.3	49.7	225	CP	CIRC	
6305X			UNK	UNK	CIRC	
630DX			UNK	UNK	CIRC	
631DX			UNK	UNK	CIRC	
634DX			UNK	UNK	CIRC	
6350X	50.66	48.57	450	CP	CIRC	
6351X	50.92	49.19	225	CP	CIRC	
6352X	51.04	48.98	225	CP	CIRC	
6353X	51.84	49.39	450	CP	CIRC	

Node	Cover	Invert	Size	Material	Shape	
63ADX			UNK	UNK	CIRC	
6401X	34.86	33.16	175	VC	CIRC	*
6401X	52.27	50.01	225	CP	CIRC	*
6450X	51.39	48.21	225	CP	CIRC	*
6450X	30.84	29.34	225	VC	CIRC	*
6451X	52.74	49.08	375	CP	CIRC	
6501X	34.26	32.79	150	VC	CIRC	*
6501X	26.8	23.47	150	VC	CIRC	*
6502X	27.08	22.82	225	VC	CIRC	*
6502X	28.61	26.58	150	VC	CIRC	*
6503X			UNK	UNK	CIRC	
6504X			150	VC	CIRC	
6505X			UNK	UNK	CIRC	
6506X			UNK	UNK	CIRC	
650DX			UNK	UNK	CIRC	
6550X	37.11	35.74	225	VC	CIRC	*
6550X	27.15	22.96	675	CP	CIRC	*
6551X	34.33	33.15	225	VC	CIRC	
6601X	23.55	21.66	225	VC	CIRC	
6602X	22.25	19.84	225	VC	CIRC	
6603X	20.19	18.48	225	VC	CIRC	
6604X	25.95	24.04	225	VC	CIRC	
6605X	21.72	19.98	150	VC	CIRC	
6651X	20.4	18.24	750	CP	CIRC	
6652X	22.36		225	VC	CIRC	
6653X	23.33	21.89	150	VC	CIRC	
665DX			750	CP	CIRC	
6701X	21.43	20.45	150	VC	CIRC	
6702X			150	VC	CIRC	
6703X			UNK	UNK	CIRC	
670DX			UNK	UNK	CIRC	
6751X	21.57	20.11	225	VC	CIRC	
6752X	22.06	20.58	225	VC	CIRC	
6850X	63.25	61.47	225	CP	CIRC	*
6850X	24.83	23.8	225	VC	CIRC	*
6851X	61.87	60.78	150	CO	CIRC	
6852X	63.67	62.61	150	CP	CIRC	
6901X	59.47	58	150	VC	CIRC	*
6901X	25.5	22.11	225	VC	CIRC	*
6902X	25.63	23.68	225	VC	CIRC	
690DX			375	CP	CIRC	
6950X	56.89	55.3	300	CP	CIRC	*
6950X	26.73		300	CP	CIRC	*
6951X	26.48	23.57	225	VC	CIRC	*
6951X	60.75	58.87	225	CP	CIRC	*
6952X	59.77	57.97	225	CP	CIRC	*
6952X	25.32	21.97	300	VC	CIRC	*
6952Y	25.32		UNK	UNK	CIRC	*
6953X	59.68	58.53	150	VC	CIRC	
6954X	59.57	58.06	225	CP	CIRC	
7001X	22.51	20.83	225	VC	CIRC	
7051X	52.86	51.08	300	CP	CIRC	
7101X	53.17	46.43	375	CP	CIRC	
7102X	55.51	53.21	150	VC	CIRC	
7103X	22.22	20.37	225	VC	CIRC	
7150X	53.61	51.65	225	CP	CIRC	
7151X	53.72	51.98	225	CP	CIRC	*
7151X	23.75	22.48	225	VC	CIRC	*
7152X	22.1	20.65	450	CP	CIRC	*
7152X	55.67	53.21	225	CP	CIRC	*
7153X	22.22	21.02	300	VC	CIRC	*
7153X	55.29	53.33	225	CP	CIRC	*
7154X	55.12	52.85	225	CP	CIRC	*
7154X	22.53	21.47	375	CP	CIRC	*
7155X	23.19	21.81	375	CP	CIRC	
7201X	29.16	26.12	225	VC	CIRC	*
7201X	52.08	50.49	150	VC	CIRC	*
7202X			150	VC	CIRC	*
7202X			225	VC	CIRC	*
7203X	52.56	50.62	150	VC	CIRC	
7204X	53.48	51.21	150	VC	CIRC	
7205X	53.75	51.57	150	VC	CIRC	
7206X	53.65	51.73	150	VC	CIRC	
7250X	28.85	26.76	225	VC	CIRC	*
7250X	52.07	49.8	375	CP	CIRC	*
7251X	26.29	24.93	225	VC	CIRC	*
7251X	52.55	51.57	225	CP	CIRC	*
7252X	54.18	52.23	225	CP	CIRC	
7253X	54.9	52.7	225	CP	CIRC	
7254X	53.89	52.4	225	CP	CIRC	
7255X	53.94	52.16	225	CP	CIRC	
7301X	22.4	21.21	175	VC	CIRC	*
7301X	51.91	50.64	150	VC	CIRC	*
7302X	53.68	51.89	150	VC	CIRC	*
7302X	30.18	29.26	150	VC	CIRC	*
7303X	52.25	50.68	150	VC	CIRC	
7304X	52.58	50.47	225	VC	CIRC	
7305X			UNK	UNK	CIRC	*
7305X	53.37	50.67	225	VC	CIRC	*
7306X			UNK	UNK	CIRC	*
7306X	53.07	50.87	150	VC	CIRC	*
7307X	53.37	51.02	150	VC	CIRC	
7309X			150	RPM	CIRC	
7311X			UNK	UNK	CIRC	
7312X			UNK	UNK	CIRC	
731DX			UNK	UNK	CIRC	
7350X	51.6	49.99	300	CP	CIRC	
7351X	30.04	27.95	225	VC	CIRC	*
7351X	53.36	50.45	375	CP	CIRC	*
7352X	53.34	50.11	375	CP	CIRC	
7353X	52.6	49.81	375	CP	CIRC	
7354X	52.17	50.2	225	VC	CIRC	
7355X	51.87	50.81	150	VC	CIRC	
7356X	53.16	50.91	150	VC	CIRC	
7401X	52.7	50.27	225	VC	CIRC	
7402X	31.87	29.66	150	VC	CIRC	
7403X	32.53	30.64	150	VC	CIRC	
7404X	34.51	31.81	150	VC	CIRC	
741DX			UNK	UNK	CIRC	
7450X	52.41	49.55	375	CP	CIRC	*
7450X			UNK	UNK	CIRC	*
7451X	32.08	29.37	225	VC	CIRC	
7452X	35.26	32.46	225	VC	CIRC	
7453X	29.58	26.98	225	VC	CIRC	
7503X	26	23.25	175	VC	CIRC	
7504X			100	PF	CIRC	
7551X	22.96		450	CP	CIRC	
7552X	25.87	24.04	225	VC	CIRC	*
7552X	23.01		450	CP	CIRC	*
7602X	19.26	17.24	225	VC	CIRC	
7605X			100	VC	CIRC	
760DX			225	VC	CIRC	
7650X	19.67	17.69	825	CP	CIRC	
7651Y	22.9		450	CP	CIRC	*
7651X	22.9	20.41	450	CP	CIRC	*
7701X	21.14	19.24	225	VC	CIRC	
7702X	20.24	18.21	225	VC	CIRC	
7704X			UNK	UNK	CIRC	
7705X			UNK	UNK	CIRC	
770DX			UNK	UNK	CIRC	
7710X			UNK	UNK	CIRC	
772DX			225	VC	CIRC	
7750X	21.03	19.76	225	CP	CIRC	
7751X	20.6	19.19	225	CP	CIRC	
7801X	23.03	21.23	225	VC	CIRC	
7901X	24.07	22.8	375	CP	CIRC	
7902X	27.19	25.64	225	VC	CIRC	
7903X	25.48	23	375	CP	CIRC	
7950X	25.17	23.48	300	CP	CIRC	
8101X	49.85	45.87	375	CP	CIRC	
8201X	56.06	54.16	150	VC	CIRC	
8250X	56.41	54.37	225	CP	CIRC	
8251X	56.35	53.72	225	CP	CIRC	
8252X	56.11	54.03	225	CP	CIRC	
8301X	54.05	51.42	150	VC	CIRC	
8302X	53.67	51.25	150	VC	CIRC	
8303X	53.43	51.13	150	VC	CIRC	
8304X			UNK	UNK	CIRC	
830DX			UNK	UNK	CIRC	
832DX			150	RPM	CIRC	
8350X	53.65	51.8	300	CP	CIRC	
8351X			375	UNK	CIRC	
8352X	53.65	50.82	375	CP	CIRC	
8353X	54.63	52.58	225	VC	CIRC	
8354X	54.03	51.13	225	VC	CIRC	
8355X	54.26	52.67	150	VC	CIRC	
8356X	53.59	50.76	375	CP	CIRC	
9101X	50.35		UNK	UNK	CIRC	
9350X	55.37	51.85	375	CP	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

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; Dambords; 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: sewer type identifier 0-4 = Foul/Combined 5-9 = Surface Water
4th digit: next sequential node

O.S. Ref.	SU6906NW	Drawn by:	yadavsa
Scale:	1:2500	Date:	23/09/2016

Title: 224750_Site between College Ro

N

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.

WARNING: BAC pipes are constructed of Bonded Asbestos Cement

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

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Southern Water

APPENDIX G

Pluvial Flood Study

PROPOSED RESIDENTIAL DEVELOPMENT
LAND AT COLLEGE ROAD, HAVANT

PLUVIAL FLOOD STUDY REPORT

Prepared by

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Basingstoke
RG21 4AF

Tel: 01256 331144

April 2018

DOCUMENT CONTROL SHEET

Project Name Land at College Road, Havant

Project No. 17-239

Rev	Issue Purpose	Author	Checked	Reviewed	Approved	Date
-	For Issue to the Environment Agency and Hampshire County Council	ES	GG	JH	RS	APR 2018
A	Updated to latest site layout	ES	GG	JH	RS	AUG 019

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3.0	Modelling Methodology	6
4.0	Model Proving	11
5.0	Model Results	13
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APPENDICES

Appendix A Link to Hydraulic Model Files

1.0 INTRODUCTION

Appointment and Brief

1.1 Odyssey was commissioned by Persimmon Homes to carry out Hydraulic Modelling of all the overland flows draining to the proposed residential development on land at College Road Havant. Refer to **Figure 1.1** below for the site location plan.

1.2 According to the Environment Agency Flood Map for Planning, the entire site is situated within Flood Zone 1 (area out of a 1 in 1000 year fluvial flood plain) however parts of the site are subject to a 'high' (3.33% Annual Exceedance Probability) risk of pluvial flooding according to current Environment Agency's Risk of Flooding from Surface Water (RoFSW) mapping.

1.3 Hampshire County Council have recommended that additional hydraulic modelling be undertaken to confirm the building of new homes in the high risk surface water flooding areas. It was therefore necessary to complete a hydraulic rainfall model of the catchments draining to the site to quantify the risk from overland flows and test any proposed mitigation measures to ensure that flood risk is not exacerbated offsite. Please see **Table 1.1** below for the project summary.

Table 1.1: Project Summary

Project name:	Land at College Road, Havant
Project type:	Hydraulic assessment of the overland flow paths at the site and its immediate surroundings.
What is being modelled?	Overland flow analysis encompassing all areas draining to the site.
What existing modelling exists?	No hydraulic modelling currently exists.
What modelling has been undertaken and why was that approach chosen?	TUFLOW as detailed 2D (2-dimensional) modelling package.
What hydrological analysis exists?	No hydrological analysis is available for the watercourses at the site.
What hydrological analysis has been undertaken?	Direct rainfall application on all modelled areas draining to the site.
What outputs have been produced?	Flood maps and levels for the 3.3%, 1%, 1% plus climate change Annual Exceedance Probability (AEP) scenarios.

Scope of Works

1.4 The primary aim of the modelling study is to identify and quantify the pluvial flood risk associated with the overland flows generated by the local catchment.

1.5 The flood levels and floodplain extents were therefore established for the following scenarios:

- 3.3% AEP (1 in 30 year);
- 1% AEP (1 in 100 year);
- 1% AEP plus 20% climate change allowance (1 in 100 year + 20%CC);
- 1% AEP plus 40% climate change allowance (1 in 100 year + 40%CC);

1.6 The scope of works for the surface water hydraulic modelling includes the following tasks:

- Download available LiDAR data;
- Construct computational grid with sufficient detail and prepare bathymetric map based on the LiDAR data (bare-earth) to form the basis of the 2D TUFLOW model;
- Construct a direct rainfall 2D TUFLOW hydraulic model using ground model, and hydraulic structure data;
- Process the existing on-site topographical survey data to incorporate into the hydraulic model;
- Run base model for the 3.3%,1%, 1% plus climate change and Annual Exceedance Probability (AEP) scenarios to assess flood depth, velocity and flow routes associated with the watercourses in the vicinity of the site;
- Assess the model performance against historical flooding if available.
- Carry out sensitivity testing of the model (for parameters such as Mannings roughness and blockage scenarios);
- Map the baseline 3.3%,1%, 1% plus climate change Annual Exceedance Probability (AEP) flood plain extents within the vicinity of the site;
- Prepare modelling report. Submit model and modelling report to the Environment Agency.

Project Limitations

1.7 Odyssey's hydraulic modelling is based on best practice and guidance current at the time of undertaking the project.

1.8 The baseline modelling undertaken assesses flood risk for an existing site/area in its current state.

1.9 The modelling undertaken is based on the interpretation and assessment of data provided by third parties. Odyssey cannot be held responsible for the accuracy of the third-party data and the conclusions and findings of this report may change if the data is amended or updated after the date of consultation.

1.10 The conclusions of the modelling report are based on the data gathered for the purpose of the project and therefore are limited in their accuracy in proportion to the validity of the dataset. The data gathered in turn has been based on an agreed scope of works. Odyssey cannot guarantee that the data used is the best available at the time of the modelling, but it is the best available data that could be gathered within the scope of the agreed instruction.

Site Description

1.11 The site is located in Waterlooville Havant, to the west of Havant in Hampshire. Refer to **Figure 1.1** below for the site location map and **Table 1.2** below for a summary.

Table 1.2: Site Description Summary

Site National Grid Reference:	The Ordnance Survey (OS) grid reference at the centre of the site is (469150, 106986).
Site area:	The total site area is approximately 26.2 hectares and has potential for 700 new homes with associated landscaping and infrastructure.
Current use:	The site is a greenfield site.
Wider setting:	The site is bounded by Havant and South Downs College to the north, the A3(M) motorway to the east, Portsmouth Golf Course to the south, and College Road to the west.
Existing water bodies:	The surface water flow route across the north west and south west of the site shed water into a unnamed ditch adjacent to the southern site boundary which then joins the Hermitage Stream east of the site just beyond the A3(M) motorway.

Existing flood defences:	There are no known formal flood defences currently protecting the site.
Any other important comments:	No.

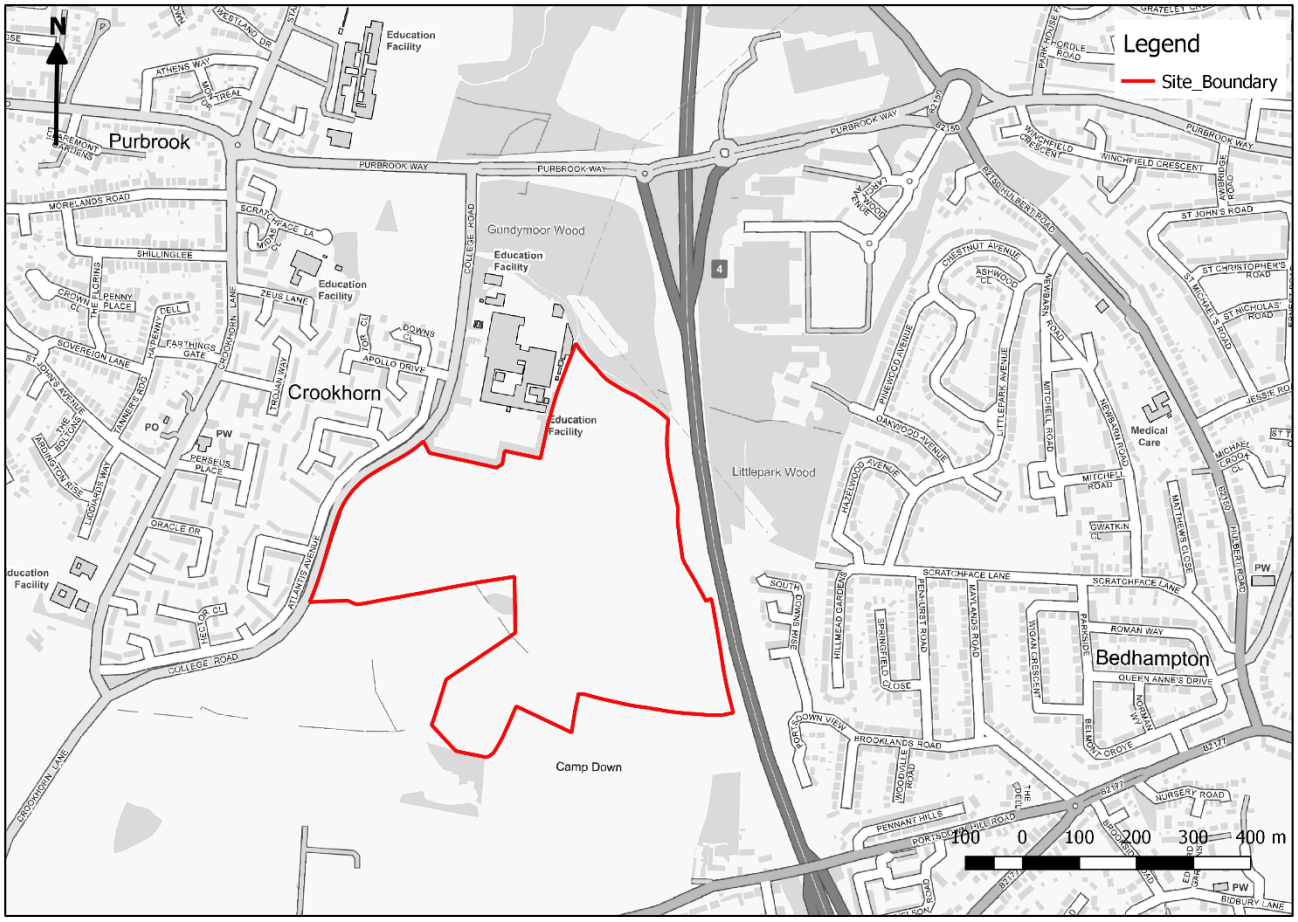


Figure 1.1 Site location

2.0 INPUT DATA

Key Input Data

2.1 Various sources of information have been utilised for this project with some of the relevant data sets listed in **Table 2.1** below.

Table 2.1: Dataset Utilised

Dataset	Source	Date	Use	Quality[1]
LiDAR (Light Detection And Ranging)	Environment Agency LiDAR	2014	Forms basis of ground level data for the 2D component of the hydraulic model.	1-2
Topographical Survey	Siteline	2016	Provides ground level data within the site	1
Existing flood defences:	None			
Hydrometric data	None			
Any other important comments:	None			

[1] Data quality scoring taken from Multi-Coloured Manual (Flood Hazard Research Centre, 2005) – 1 = best possible, 2 = data with known deficiencies, 3 = gross assumptions, 4 = heroic assumptions

3.0 MODELLING METHODOLOGY

Hydrological Analysis

3.1 A hydrological analysis was undertaken to derive the rainfall hyetographs for the hydraulic model as described in **Table 3.1** below.

Table 3.1: Hydrological Analysis

Summary of hydrological analysis required:	Design and net rainfall hyetographs from the Revitalised Flood Hydrograph methodology.
Number and location of flood estimation points:	Design rainfall hyetographs for urban areas and net rainfall hyetographs for rural areas. Revitalised Flood Hydrographs (ReFH) rainfall hyetographs calculated using FEH Catchment Descriptor based on nearby catchment (NGR 469450,106750).
Peak flows, hydrographs or hyetographs?	Hyetographs
Return periods:	1 in 30,100 year (3.3%,1%, AEP respectively).
Climate change estimation?	1% AEP (1 in 100 year) increased by 20%, 40% as per the recommendations for the peak rainfall intensity allowance.
Choice of approach?	Rural Net rainfall hyetographs for rural areas using the losses model from the Revitalised Flood Hydrograph (ReFH) rainfall-runoff method. Losses are controlled by a single parameter, the maximum soil moisture storage capacity (Cmax), this was estimated from the BFIHOST and PROPWET, two of the FEH catchment descriptors. The initial starting value of the soil moisture, Cini, was also estimated from catchment descriptors. Urban A runoff coefficient of 75% was selected for the urban areas.
Reason for approach:	Due to the small catchment area and the overland flood flow in the area is not originated from a specific single point of discharge, it was decided that a direct rainfall based on ReFH rainfall hyetograph be adopted. The ReFH method for estimating rainfall is favoured as it has been more directly calibrated to reproduce flood frequency on UK catchments giving it a greater confidence in deriving the rainfall hyetograph.

3.2 The key catchment descriptors for the catchment assessed in the hydrological analysis are in **Table 3.2** below.

Table 3.2: Key Catchment Characteristics

Catchment:	Characteristics
EASTING (m)	468893
NORTHING (m)	106784
AREA (ha)	0.68
FARL:	1
PROPWET:	0.34
BFIHOST:	0.489
LDP (km):	1.39
DPLBAR (km):	0.67
DPSBAR (m/km):	72.8
SAAR (mm):	755
SPRHOST:	35.19
URBEXT1990	0.0055
URBEXT2000	0.0929
FPEXT:	0.0276
Pumped watercourse?	No
Any unusual catchment features? In particular is BFIHOST>0.65, SPRHOST<0.20, URBEXT>0.125, FARL<0.90 or high FPEXT?	No

3.3 The FEH catchment area can be seen in **Figure 3.1** below:

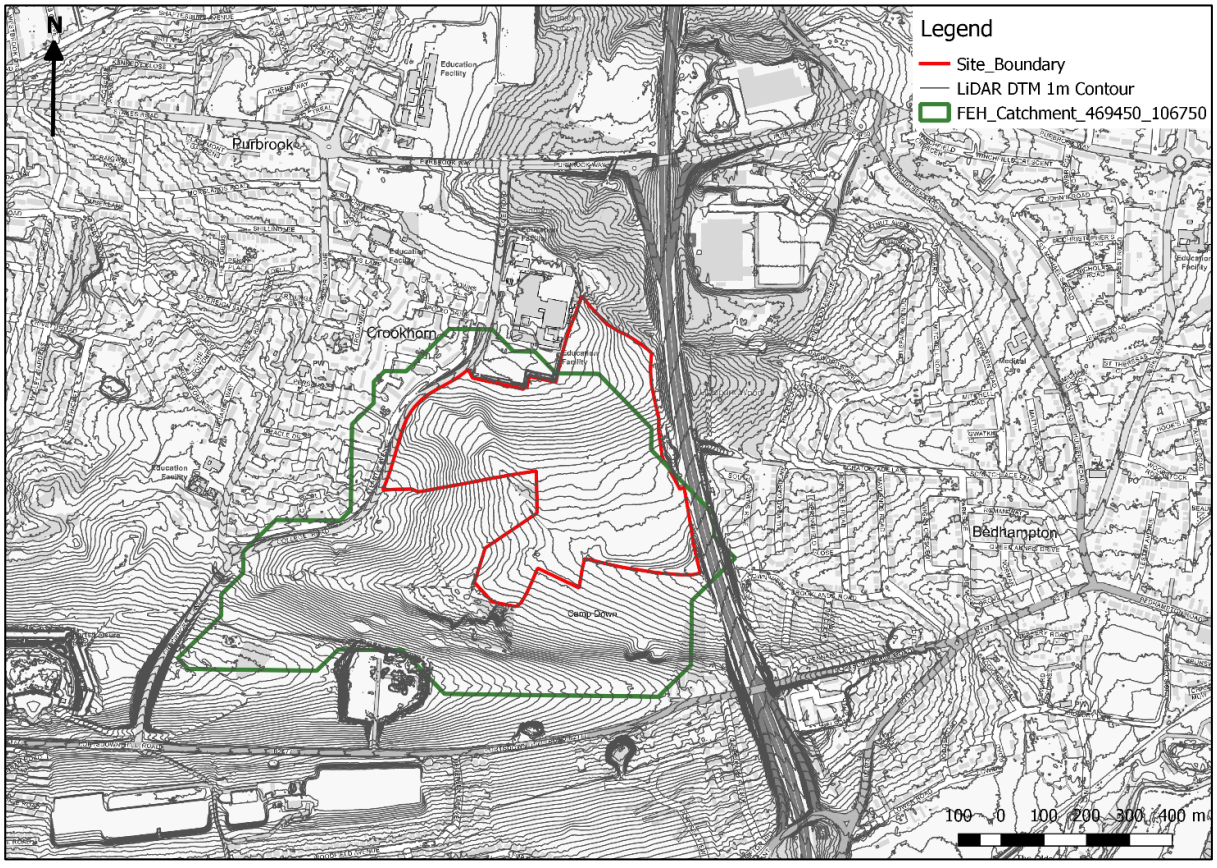


Figure 3.1 Catchment Area

3.4 The final peak flow estimates for the above catchment were calculated using the REFH boundary unit in Flood Modeller and summarised in **Table 3.2** below.

Table 3.3: Summary of Peak Flows

Return Period	Flows (m^3/s)
3.3% AEP (1 in 20 year)	0.63
1% AEP (1 in 100 year)	0.84
1% AEP + 20% (1 in 100 year + 20% CC)	1.01
1% AEP + 40% (1 in 100 year + 40% CC)	1.18

Baseline Hydraulic Modelling

3.5 The process undertaken in the baseline hydraulic modelling is detailed in **Table 3.4** below.

Table 3.4: Hydrological Analysis

Summary of hydrological analysis required:	Design and net rainfall hyetographs
What modelling exists?	There are no existing hydraulic models for the area.
What modelling has been undertaken and why was that approach chosen?	**TUFLOW** 2D floodplain model based on a finite grid approach has been undertaken.
What software version(s) have been used?	TUFLOW – 2017-09-AC-iDP-w64 Double Precision modelling is necessary as the model is direct rainfall and is modelled on a relatively small 2d grid/time step combination.
How have watercourse channels been represented?	The unnamed ditch and overland flow routes have been picked up by the LiDAR data in the 2D model domain. The unnamed ditch has also been represented with a 2d-z line which represents levels from the topographical survey. Refer to Figure **3.1** below for the hydraulic model schematic.
How have watercourse channel structures been represented?	In ESTRY, the relevant key structure types were selected depending on the structure being modelled. They were parameterised in line with the ESTRY manual recommendations.
How have sewer networks been represented?	No sewer networks were modelled as part of the above proposals.

<table>
<tr><td>How has the floodplain/ground surface been represented?</td><td>The 2D domain was constructed using TUFLOW and based upon filtered LiDAR data. A grid size of 4m was chosen to allow for detailed modelling of the overland flow paths. Refer to Figure 3.1 below for the hydraulic model schematic.</td></tr>
<tr><td>How have different models been linked?</td><td>The model was represented mostly in the 2D domain. The boundary between the 1D and 2D models was chosen, as appropriate, for the hydraulic structure. An SX boundary (Flow-eXchange or Flow from eXternal source) was used for the link in TUFLOW, which takes the water level from ESTRY and applies it along the boundary to allow flow into the 2D domain.</td></tr>
<tr><td>Have any adjustments to the raw DTM been made?</td><td>The site topographical survey was incorporated into the hydraulic model.</td></tr>
<tr><td>How have flood defences been represented?</td><td>There are no known formal flood defences along the modelled watercourses.</td></tr>
<tr><td>What boundary conditions have been used?</td><td>A RF (Rainfall verses Time) boundary based on current land use was created to apply rainfall hyetograph into the model.

A HQ (head verses flow) boundary based on floodplain slope in TUFLOW was created to allow flow to exit the model at the downstream end of the 2D domain.</td></tr>
<tr><td>What roughness values have been used?</td><td>Channel and floodplain roughness were represented within the model by using Manning’s n values for roughness. Parameters were chosen with reference to standard values, using site visit photographs and engineering judgement.

<table>
<tr><th>ESTRY</th><th>Manning’s n</th></tr>
<tr><td>In-channel – normal bed</td><td>n = 0.04</td></tr>
<tr><th>TUFLOW</th><th>Manning’s n</th></tr>
<tr><td>Grass</td><td>0.04</td></tr>
<tr><td>Woodland</td><td>0.06</td></tr>
<tr><td>Roads</td><td>0.02</td></tr>
<tr><td>Buildings</td><td>1.0</td></tr>
<tr><td>Inland Water</td><td>0.03</td></tr>
<tr><td>Roadside</td><td>0.02</td></tr>
<tr><td>Paths</td><td>0.03</td></tr>
</table></td></tr>
<tr><td>What structure coefficients have been used?</td><td>Culverts properties were chosen with reference to standard values recommended by TUFLOW.

<table>
<tr><th>Properties</th><th>Coefficient</th></tr>
<tr><td>Manning’s n</td><td>0.02</td></tr>
<tr><td>Height contraction coefficient at inlet</td><td>0.60</td></tr>
<tr><td>Width contraction coefficient at inlet</td><td>0.90</td></tr>
<tr><td>Entry loss coefficient for outlet</td><td>0.50</td></tr>
<tr><td>Exit loss coefficient for outlet</td><td>1.00</td></tr>
</table></td></tr>
</table>

Are there any changes to default model or run parameters? Why?	No changes to default parameters.
What timestep has been used?	A 1.0 second 2D TUFLOW time step was used for different model runs. This is in accordance with the recommendations that the 2D time step should be no smaller than a quarter of the 2D grid size.

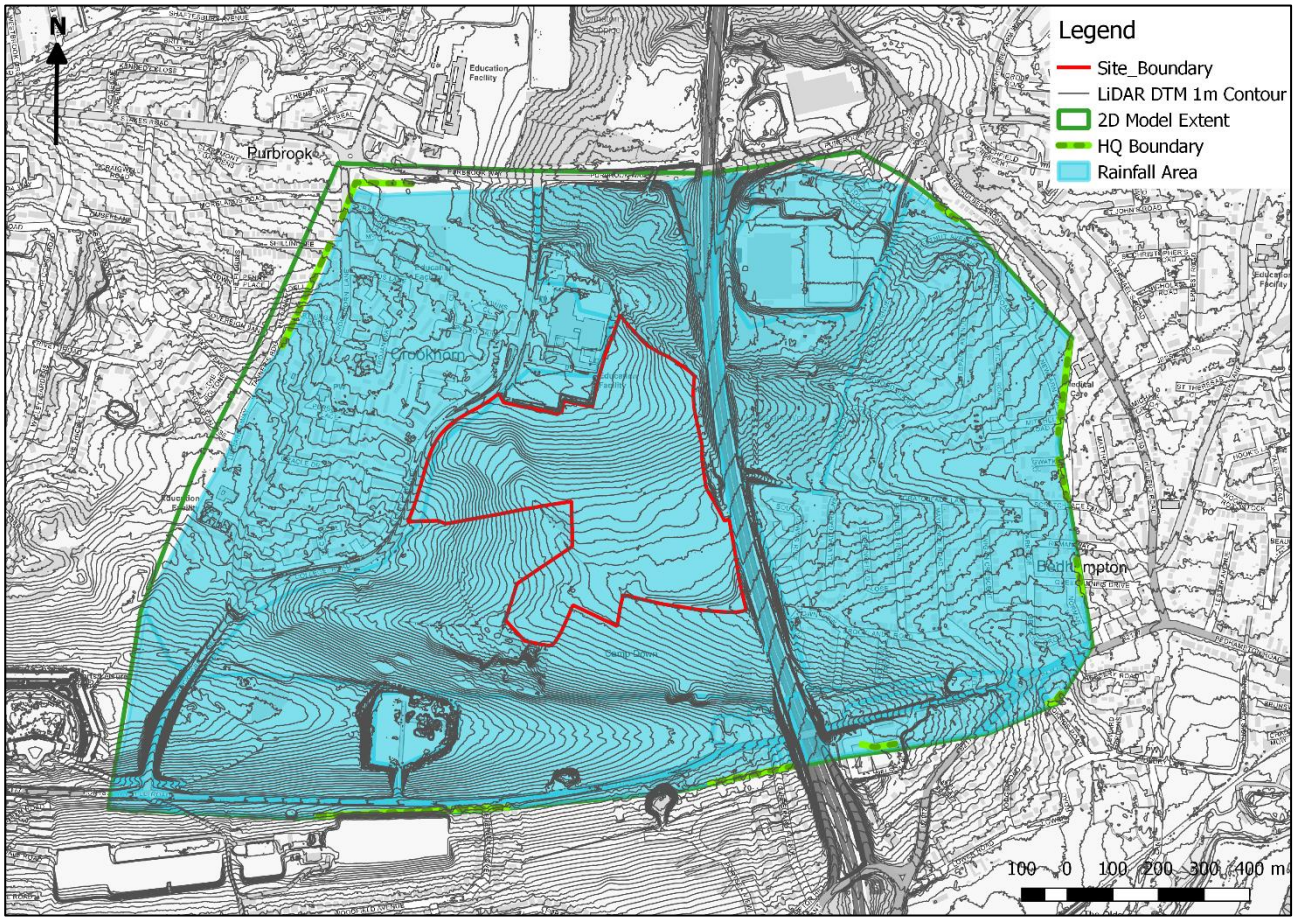


Figure 3.3 Hydraulic model schematic

4.0 MODEL PROVING

Calibration and Other Models

4.1 **Table 4.1** below summarises the calibration and verification of the hydraulic models.

Table 4.1: Calibration and Sensitivity

Was data available for calibration and verification?	No.
Is there an existing model that can be compared against?	There is currently no existing model for the area.
Has sensitivity testing been undertaken in lieu of calibration?	Yes.
Has sensitivity testing been undertaken to support the calibration?	Not applicable.

Sensitivity Analysis

Table 4.2: Calibration and Sensitivity

What sensitivity tests have been undertaken?	+/-20% roughness and 50% blockage at the culvert downstream of the proposed development site.
Are there any significant differences between the baseline and sensitivity tests?	Roughness – fairly minor differences. Approximately 0.088m maximum decrease in peak water level at the site for +20% roughness for a localised area but generally less than 0.035m. Roughness - fairly minor differences. Approximately 0.065m maximum increase in peak water level at the site for -20% roughness for a localised area but generally less than 0.022m.
Is the model sensitive to key parameters tested?	Roughness – On average generally not sensitive to changes in roughness.

Blockage Analysis

Table 4.2: Calibration and Sensitivity

Was blockage analysis undertaken?	Yes

What scenarios were tested?	A 50% blockage of the culvert downstream of the site which crosses the A3 Motorway was carried out.
What were the key outcomes?	The results of the blockage analysis show that surface water flood risk will not be increased during the 1 in 100 year event. Care will still have to be taken to ensure that the culvert is kept clear of debris.

Run Performance

4.2 A summary of the run performance is summarised in **Table 4.2** below.

Table 4.2: Run Performance

Is the model stable?	Yes, very little fluctuation in model results.
Is the mass balance error sensible?	Yes, the final cumulative mass balance for the 1 in 100 year event is less than 3% in accordance with the recommended value as stated in the TUFLOW manual.
Are there any negative water depths?	No
What warnings and checks does the model give? Are any systematic of problems?	All warnings and checks associated with non-critical checks by TUFLOW.
Any other comments?	No
Is the model 'healthy'?	Yes

5.0 MODEL RESULTS

Baseline Design Runs

5.1 The primary aim of the hydraulic modelling study is to identify the pre-development overland flood flow routes in order to determine the land available for development purposes. The model was used to predict pluvial flood levels for the following events.

- 3.3% AEP (1 in 30 year);
- 1% AEP (1 in 100 year);
- 1% AEP plus 20% climate change (1 in 100 year plus 20% climate change);
- 1% AEP plus 40% climate change (1 in 100 year plus 40% climate change);

5.2 The baseline model results show that the overland flood routes will flow through the north west and south west of the site developments then shed into the unnamed drainage ditch adjacent to the south of the site. Refer to **Figures 5.1** to **5.4** below for the baseline results.

5.3 A mitigation model which includes diverting the overland flood routes through the site by raising areas situated along the overland flood routes by 0.8m to see the impact of the development. A diversion channel is proposed to the south west of the site to pick up the overland flows from the catchments upstream. The hydraulic model shows that the proposed mitigation measures will not impede the overland flood routes upstream and downstream of the site and the site will be protected from the overland flood routes without increasing the risk offsite. Refer to **Figures 5.5** to **5.9**, below for the post development flood mitigation proposals.

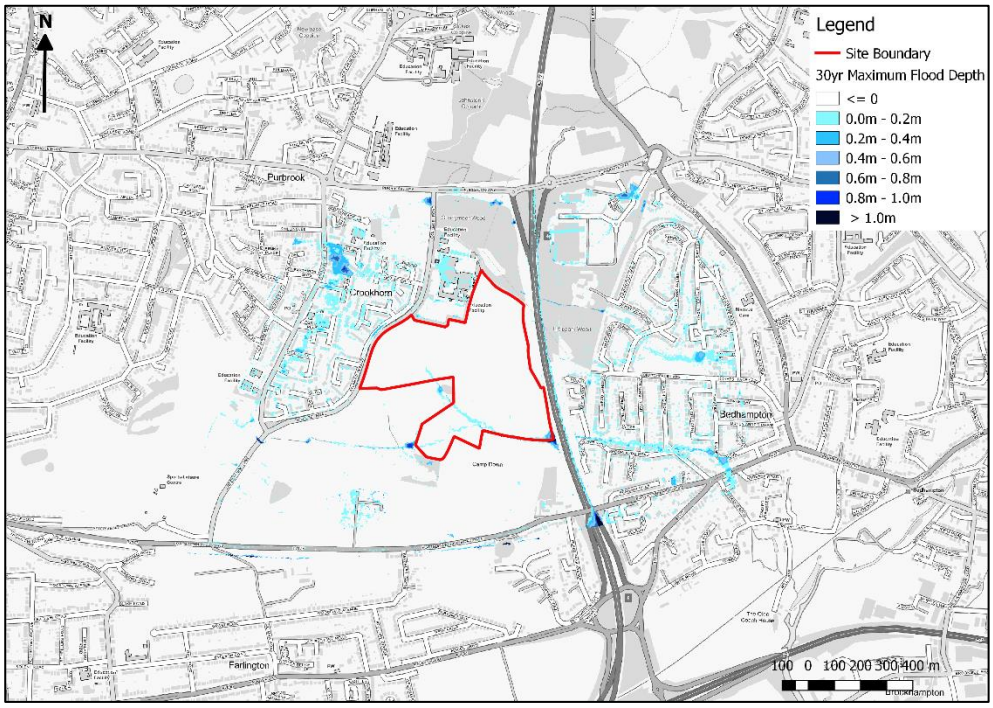


Figure 5.1 Baseline 1 in 30 year peak flood depths

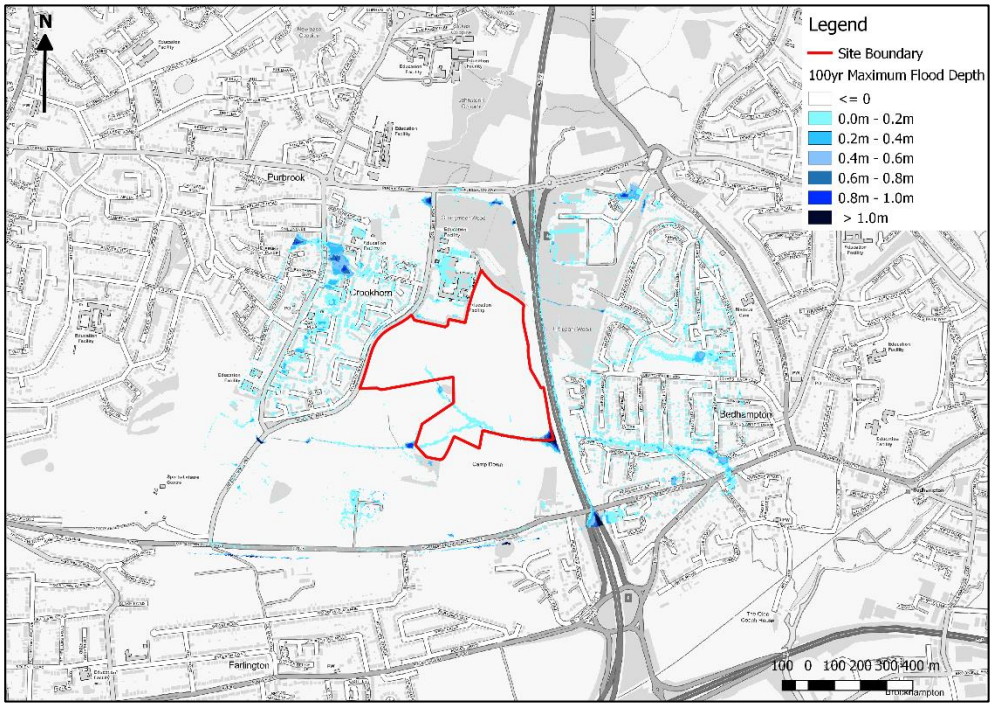


Figure 5.2 Baseline 1 in 100 year peak flood depths

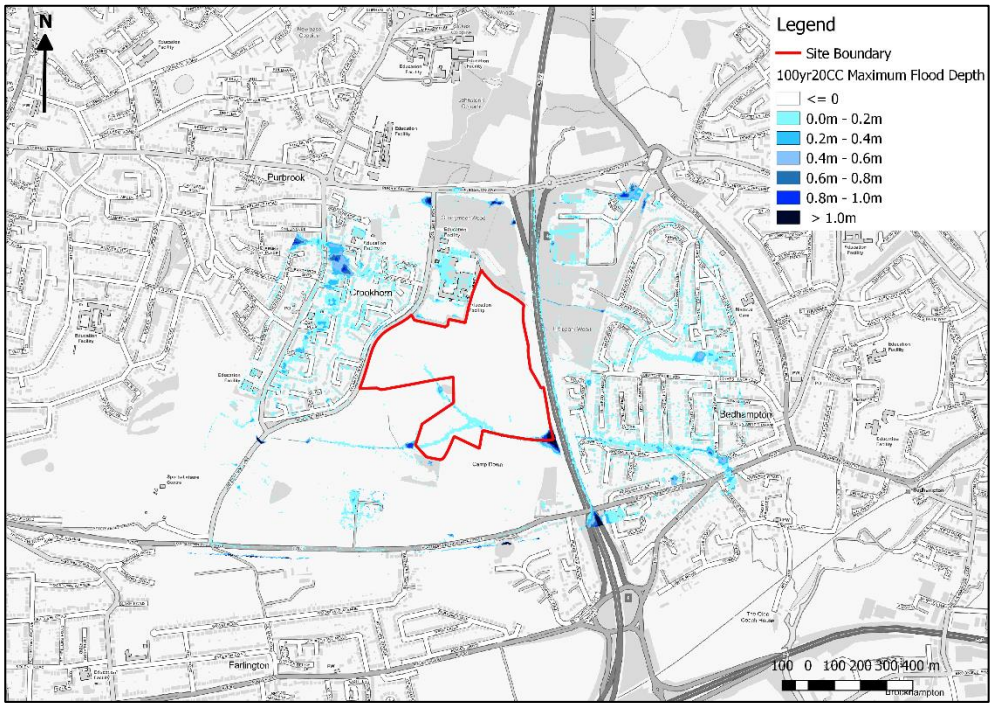


Figure 5.3 Baseline 1 in 100 year plus climate change (20%) peak flood depths

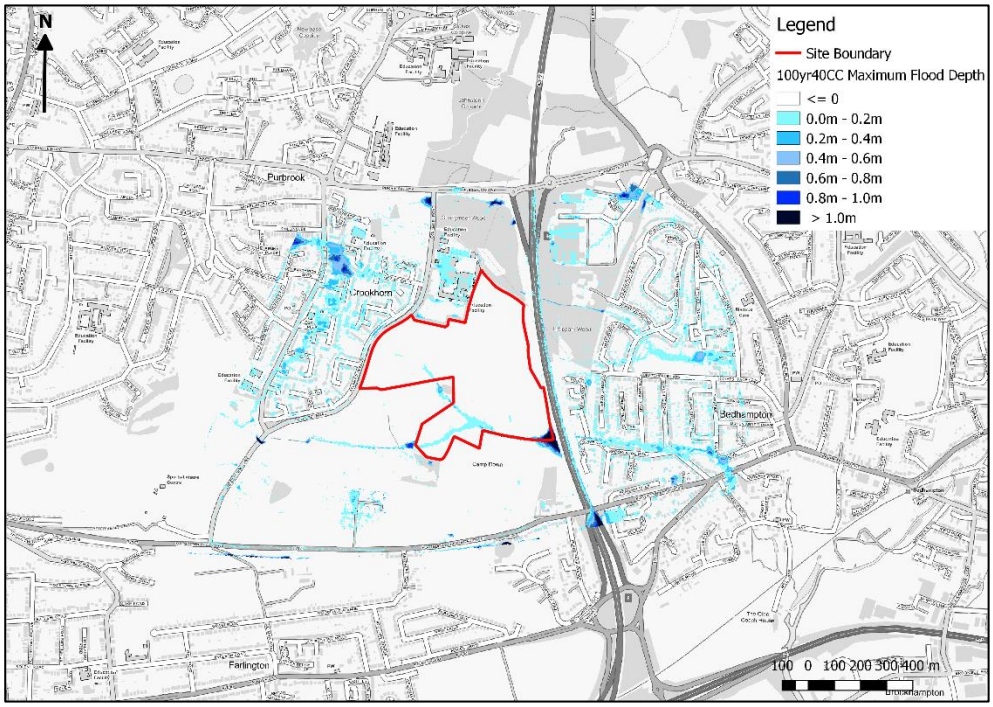


Figure 5.4 Baseline 1 in 100 year plus climate change (40%) peak flood depths

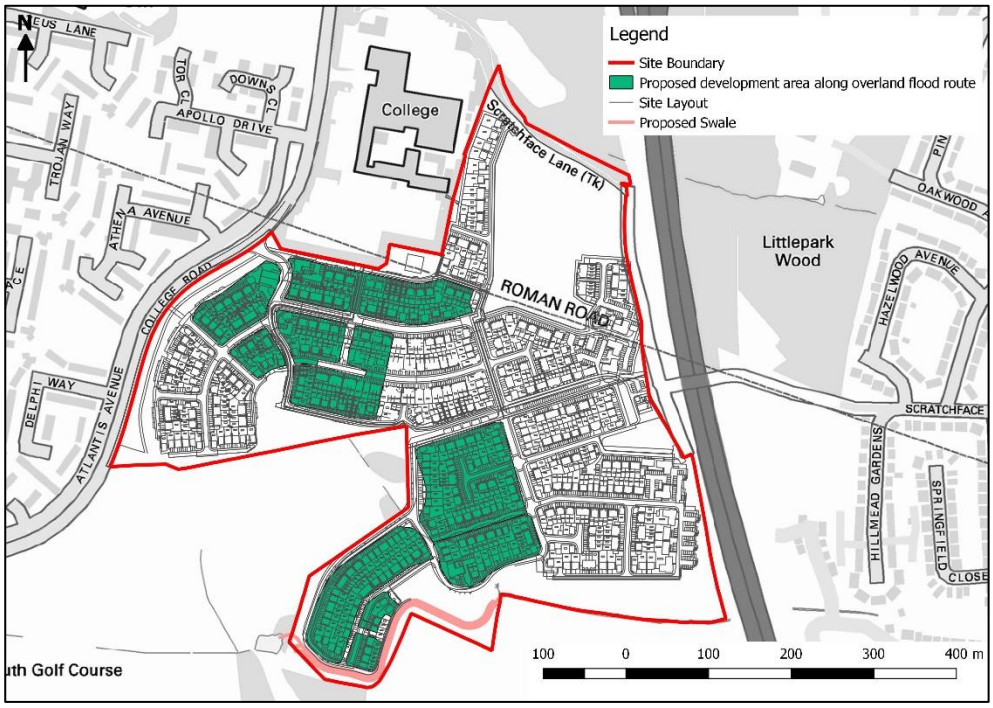


Figure 5.5 Post development flood mitigation proposals

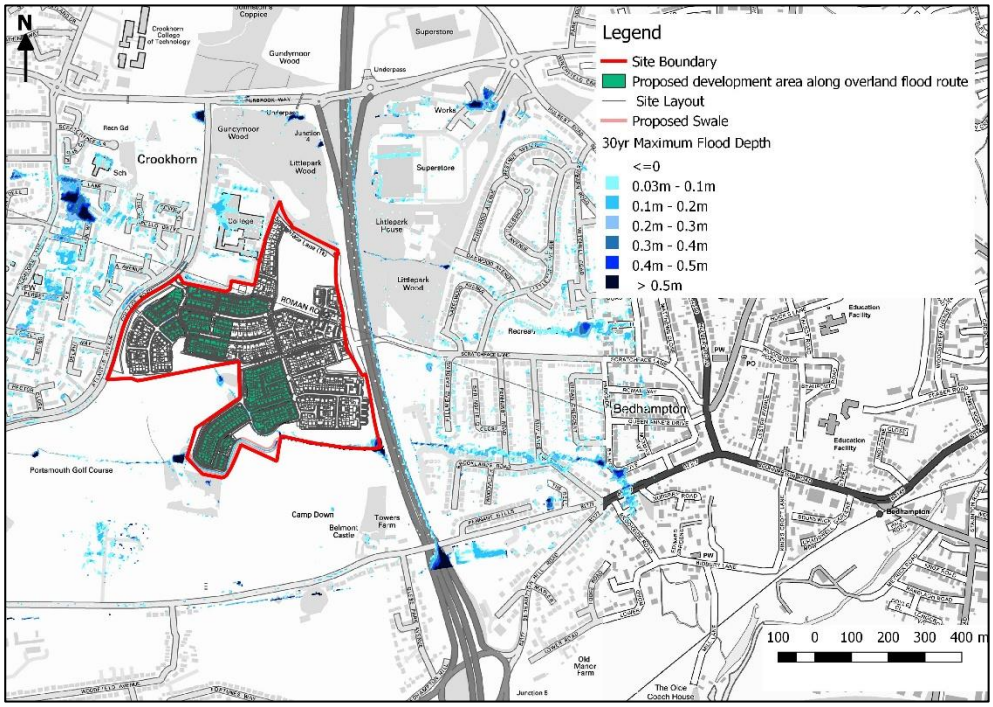


Figure 5.6 Post Development 1 in 30 year peak flood depths

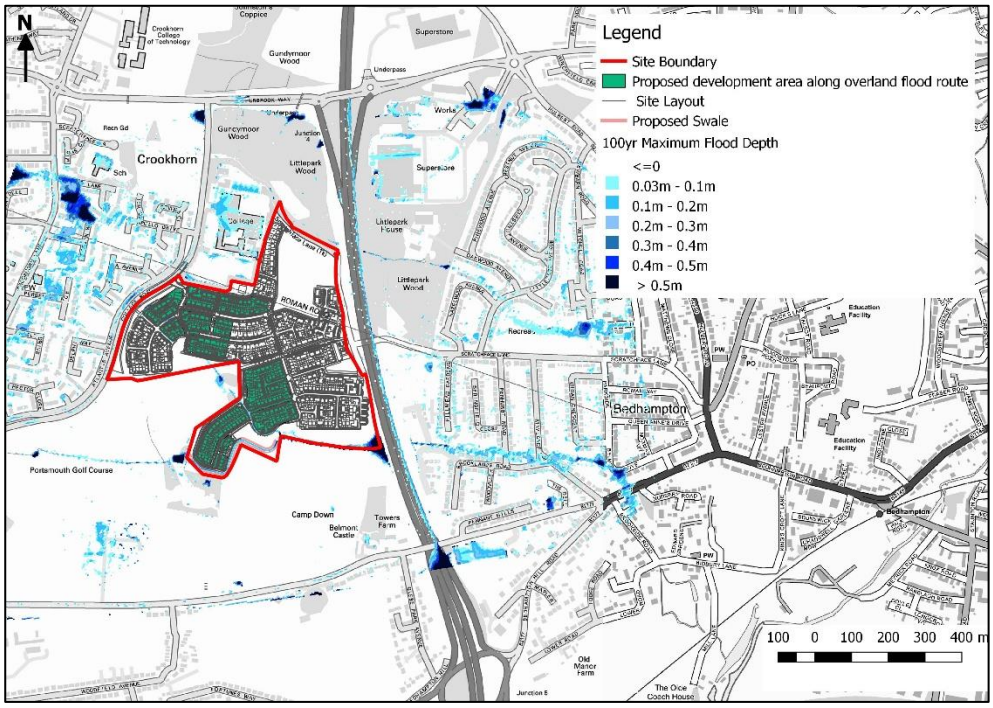


Figure 5.7 Post Development 1 in 100 year peak flood depths

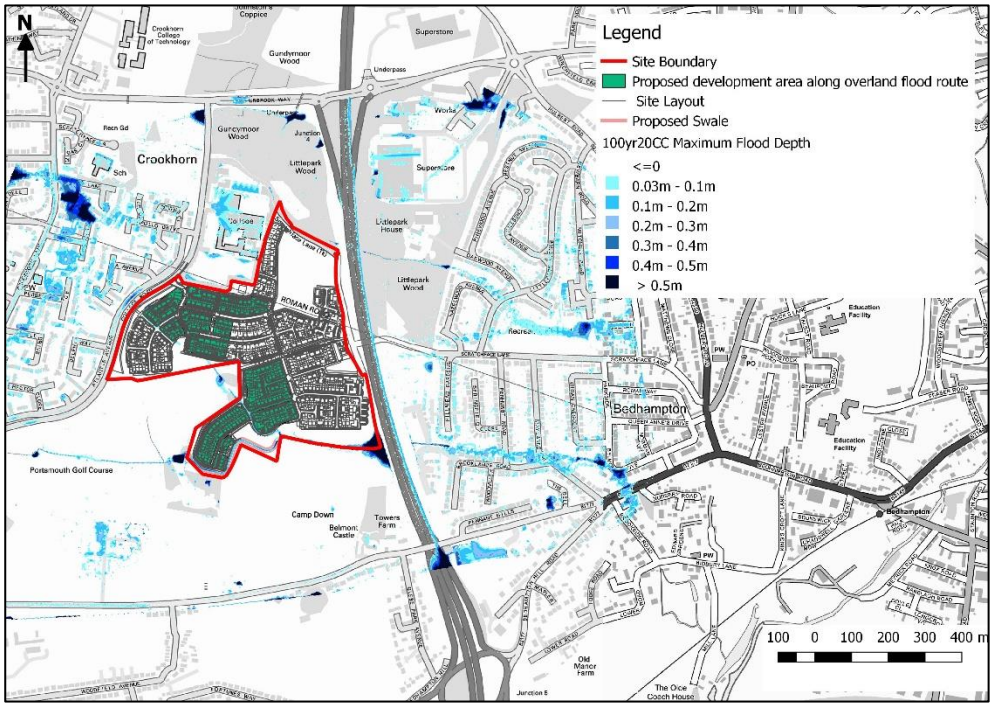


Figure 5.8 Post Development 1 in 100 year plus climate change (20%) peak flood depths

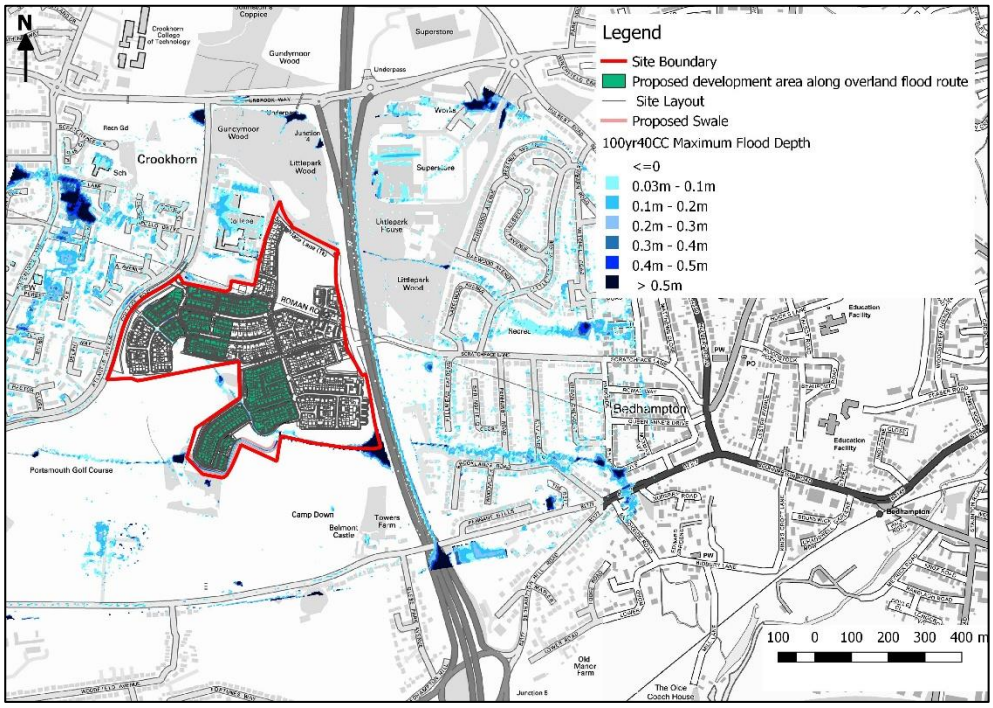


Figure 5.9 Post Development 1 in 100 year plus climate change (40%) peak flood depths

6.0 CONCLUSIONS & RECOMMENDATIONS

Conclusions

6.1 Odyssey has been commissioned by Persimmon Homes to assess flood risk associated with overland flows for a proposed development on land at College Road, Havant.

6.2 According to the Environment Agency's RoFSW mapping, part of the site may be subject to a 'high' (3.33% Annual Exceedance Probability) risk of pluvial flooding. However, there are no records of historic flooding within the site boundaries.

6.3 The surface water mapping shows that there is a surface flood route across the north west and south west of the site, originating offsite. However, the masterplan has been laid out such that the flood route is not impeded by development, and the proposed diversion channel redirects surface water to the watercourse without impacting the development and will not increase flood risk offsite.

6.4 The overland flow assessment was undertaken using TUFLOW hydraulic modelling package and the model extent was set to cover the area at risk of flooding with a 4m grid.

6.5 The sensitivity analysis has shown that the flood levels are not sensitive to any variation in roughness and the existing culvert underneath the A3 Motorway.

6.6 It is recommended that the hydraulic assessment is accepted as best available source of information and the results will inform the following for the Flood Risk Assessment:

- Confirmation of the above flood mitigation option to ensure that the proposals do not exacerbate flooding in all areas upstream and downstream of the site;

- Finished floor levels for the proposed development parcels.

APPENDIX A

LINK TO HYDRAULIC MODEL FILES

https://www.dropbox.com/sh/0uk614h4r1m1hct/AAAnRYCqN1IbAiNUA8SoJFwOa?dl=0

APPENDIX H

SuDS Catchment Plan (Drawing 17-239/005)
Preliminary Surface Water and Foul Drainage Strategy (Drawings 17-239/002-004)
& Micro Drainage Calculations

NOTES

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LEGEND

- SITE BOUNDARY
- NON-INFILTRATING CELLULAR STORAGE (95% VOID)
- PROPOSED SURFACE WATER SEWER & MANHOLE.
- HYDROBRAKE FLOW CONTROL CHAMBER
- PROPOSED POND / WETLAND
- PROPOSED FOUL SEWER & MANHOLE
- PROPOSED FOUL RISING MAIN
- TREE ROOT PROTECTION ZONE

DRAFT

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PRELIMINARY DRAINAGE STRATEGY
SHEET 1 OF 3

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FOR CONTINUATION SEE DRAWING 17-239/003

FOR CONTINUATION SEE DRAWING 17-239/004

P:\17-239 - College Road, Havant\Tech\Acad\Drawings\17-239-002 Preliminary Drainage Strategy - Sheet 1 of 3.dwg

College
(FE)

Shelter

Gas
Gov

COLLEGE ROAD

Line Of Posts

Path

ROMAN VILLA (site of)

SCRATCHFACE LANE

(Track)

ETL

Issues

A 3(M)

CR

ESS

G3

T10

T11

T13

T15

HYDRO-BRAKE FLOW CONTROL
DISCHARGE LIMITED TO 3.6ls
DESIGN HEAD: 1.5m
IL: 52.80m

CELLULAR STORAGE TANK
Length = 57.0m x 12.0m

FOR CONTINUATION SEE DRAWING 17-239/002

1.2m Road

POND/WETLAND 1
1.5m TOTAL DEPTH

HYDRO-BRAKE FLOW CONTROL
DISCHARGE LIMITED TO 11.5ls
DESIGN HEAD: 1.5m
IL: 41.80m

CELLULAR STORAGE TANK
Length = 57.0m x 12.0m

HYDRO-BRAKE FLOW CONTROL
DISCHARGE LIMITED TO 14.0ls
DESIGN HEAD: 1.5m
IL: 36.30m

FOR CONTINUATION SEE DRAWING 17-239/004

CONNECT INTO EXISTING
FOUL MANHOLE

POND/WETLAND 2

ED & Ward Bay

P:\17-239 - College Road, Havant\Tech\Acad\Drawings\17-239-003 Preliminary Drainage Strategy - Sheet 2 of 3.dwg

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- PROPOSED FOUL RISING MAIN
- TREE ROOT PROTECTION ZONE
- EXISTING SOUTHERN WATER FOUL SEWER

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FOR CONTINUATION SEE DRAWING 17-239/002

HYDRO-BRAKE FLOW CONTROL DISCHARGE LIMITED TO 11.5l/s DESIGN HEAD: 1.5m IL: 41.80m

CELLULAR STORAGE TANK 5 27m x 5m x 1.2m

HYDRO-BRAKE FLOW CONTROL DISCHARGE LIMITED TO: 14.0l/s DESIGN HEAD: 1.5m IL: 39.30m

HYDRO-BRAKE FLOW CONTROL DISCHARGE LIMITED TO 1.5l/s DESIGN HEAD: 1.5m IL: 33.60m

CELLULAR STORAGE TANK 4 45m x 5.5m x 1.2m

CONNECT INTO EXISTING FOUL MANHOLE

POND/WETLAND 2
1.5m TOTAL DEPTH

HYDRO-BRAKE FLOW CONTROL DISCHARGE LIMITED TO 5.8l/s DESIGN HEAD: 1.5m IL: 32.30m

HYDRO-BRAKE FLOW CONTROL DISCHARGE LIMITED TO 0.9l/s DESIGN HEAD: 1.2m IL: 30.10m

CELLULAR STORAGE TANK 10 27m x 5.5m x 1.2m

PUMPING STATION

CELLULAR STORAGE TANK 7 50m x 5m x 1.2m

CELLULAR STORAGE TANK 6 15.5m x 12m x 1.2m

CELLULAR STORAGE TANK 8 15.5m x 12m x 1.2m

HYDRO-BRAKE FLOW CONTROL DISCHARGE LIMITED TO 13.0l/s DESIGN HEAD: 1.2m IL: 26.10m

HYDRO-BRAKE FLOW CONTROL DISCHARGE LIMITED TO 2.2l/s DESIGN HEAD: 1.2m IL: 29.60m

CELLULAR STORAGE TANK 8 110m x 18m x 1.6m

HYDRO-BRAKE FLOW CONTROL DISCHARGE LIMITED TO 68.1l/s DESIGN HEAD: 1.6m IL: 27.30m

HYDRO-BIOCELL OR SIMILAR

OUTFALL 6 - 675mm Ø DRAINAGE

HYDRO-BRAKE FLOW CONTROL DISCHARGE LIMITED TO: 0.9l/s DESIGN HEAD: 1.2m IL: 30.10m

HYDRO-BRAKE FLOW CONTROL DISCHARGE LIMITED TO: 7.8l/s DESIGN HEAD: 1.2m IL: 35.70m

POND/WETLAND 3
1.5m TOTAL DEPTH

Issues

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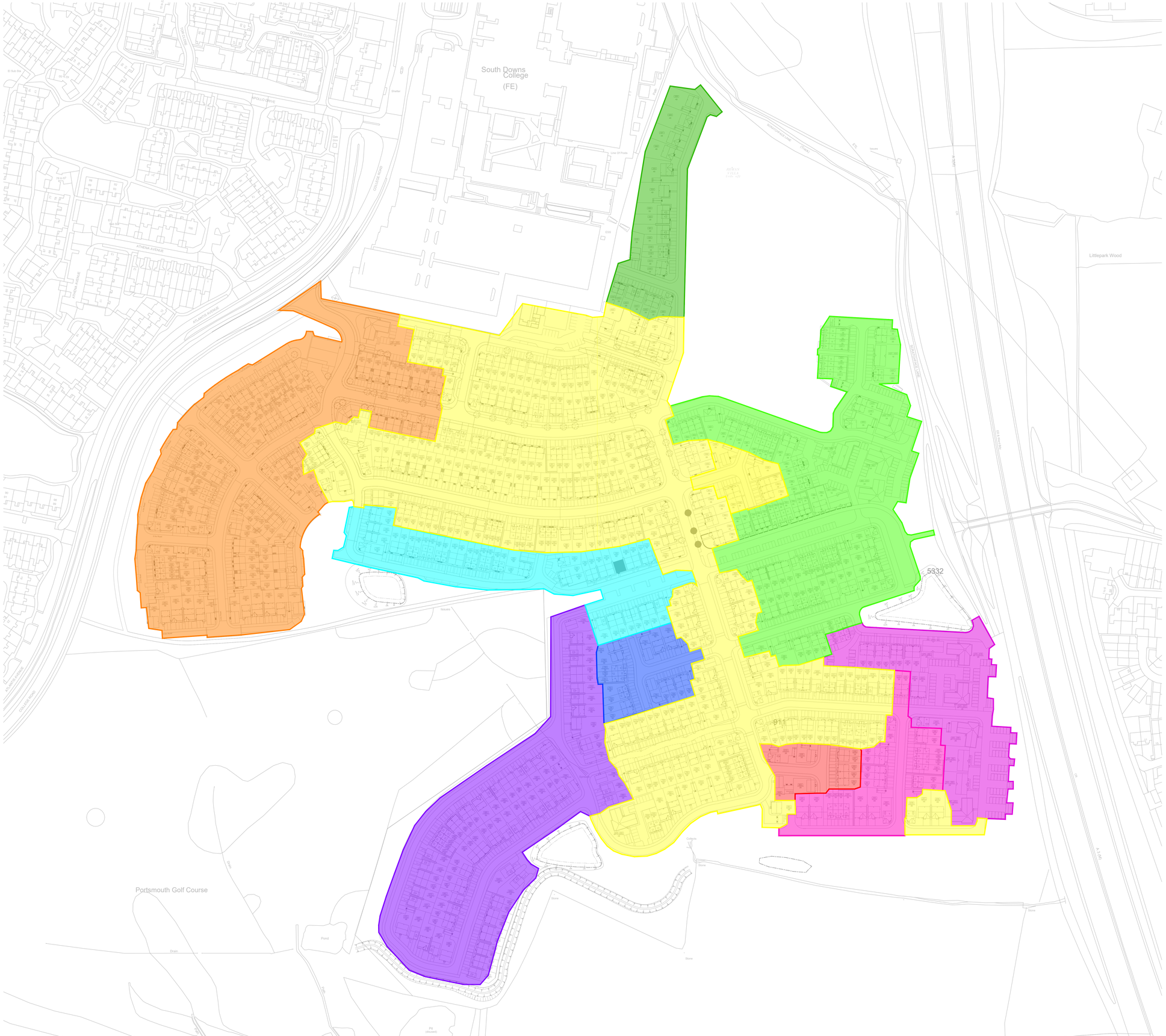
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LEGEND

- POND / WETLAND 1
- POND / WETLAND 2
- POND / WETLAND 3
- CELLULAR STORAGE TANK 2
- CELLULAR STORAGE TANK 3
- CELLULAR STORAGE TANK 4
- CELLULAR STORAGE TANK 5
- CELLULAR STORAGE TANK 6
- CELLULAR STORAGE TANK 7
- CELLULAR STORAGE TANK 8

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Job No	Drawing No	Rev.
17-239	17-239/005	A

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ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.400
Area (ha)	26.240	Urban	0.000
SAAR (mm)	746	Region Number	Region 7

Results l/s

QBAR Rural	96.2
QBAR Urban	96.2
Q100 years	306.8
Q1 year	81.8
Q30 years	218.0
Q100 years	306.8

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Cascade Summary of Results for Basin 1.SRCX

Upstream Structures	Outflow To	Overflow To
CS1a.SRCX CS1b.SRCX	CS3.SRCX	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	42.045	0.545	11.5	385.1	O K
30 min Summer	42.159	0.659	11.5	477.7	O K
60 min Summer	42.291	0.791	11.5	589.2	O K
120 min Summer	42.439	0.939	11.5	722.2	O K
180 min Summer	42.532	1.032	11.5	808.6	O K
240 min Summer	42.597	1.097	11.5	871.3	O K
360 min Summer	42.685	1.185	11.5	958.7	O K
480 min Summer	42.742	1.242	11.5	1017.2	Flood Risk
600 min Summer	42.782	1.282	11.5	1058.2	Flood Risk
720 min Summer	42.810	1.310	11.5	1087.5	Flood Risk
960 min Summer	42.786	1.286	11.5	1062.3	Flood Risk
1440 min Summer	42.724	1.224	11.5	998.1	Flood Risk
2160 min Summer	42.642	1.142	11.5	916.3	O K
2880 min Summer	42.569	1.069	11.5	844.8	O K
4320 min Summer	42.472	0.972	11.5	752.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.274	0.0	505.2	19
30 min Summer	87.712	0.0	628.6	34
60 min Summer	54.845	0.0	809.0	64
120 min Summer	34.294	0.0	1011.3	124
180 min Summer	26.058	0.0	1151.4	182
240 min Summer	21.444	0.0	1261.6	242
360 min Summer	16.294	0.0	1431.4	362
480 min Summer	13.409	0.0	1558.2	482
600 min Summer	11.528	0.0	1655.5	602
720 min Summer	10.188	0.0	1723.9	722
960 min Summer	8.012	0.0	1724.5	960
1440 min Summer	5.710	0.0	1651.2	1212
2160 min Summer	4.069	0.0	2175.0	1580
2880 min Summer	3.200	0.0	2278.8	1988
4320 min Summer	2.357	0.0	2503.3	2848

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Cascade Summary of Results for Basin 1.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
5760 min Summer	42.351	0.851	11.5	642.5	O K
7200 min Summer	42.240	0.740	11.5	545.7	O K
8640 min Summer	42.139	0.639	11.5	460.7	O K
10080 min Summer	42.048	0.548	11.5	387.9	O K
15 min Winter	42.103	0.603	11.5	431.9	O K
30 min Winter	42.229	0.729	11.5	536.3	O K
60 min Winter	42.374	0.874	11.5	662.7	O K
120 min Winter	42.538	1.038	11.5	814.4	O K
180 min Winter	42.638	1.138	11.5	912.0	O K
240 min Winter	42.710	1.210	11.5	983.9	Flood Risk
360 min Winter	42.809	1.309	11.5	1086.4	Flood Risk
480 min Winter	42.875	1.375	11.5	1157.0	Flood Risk
600 min Winter	42.923	1.423	11.5	1208.3	Flood Risk
720 min Winter	42.958	1.458	11.5	1246.7	Flood Risk
960 min Winter	42.941	1.441	11.5	1228.3	Flood Risk
1440 min Winter	42.880	1.380	11.5	1161.6	Flood Risk
2160 min Winter	42.780	1.280	11.5	1056.5	Flood Risk
2880 min Winter	42.687	1.187	11.5	961.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Summer	1.897	0.0	2710.0	3584
7200 min Summer	1.603	0.0	2862.3	4320
8640 min Summer	1.397	0.0	2992.3	5016
10080 min Summer	1.244	0.0	3104.4	5744
15 min Winter	140.274	0.0	565.1	19
30 min Winter	87.712	0.0	699.1	33
60 min Winter	54.845	0.0	906.0	62
120 min Winter	34.294	0.0	1131.8	122
180 min Winter	26.058	0.0	1287.5	180
240 min Winter	21.444	0.0	1408.6	240
360 min Winter	16.294	0.0	1589.4	356
480 min Winter	13.409	0.0	1715.2	472
600 min Winter	11.528	0.0	1773.7	588
720 min Winter	10.188	0.0	1769.8	702
960 min Winter	8.012	0.0	1739.4	926
1440 min Winter	5.710	0.0	1674.4	1354
2160 min Winter	4.069	0.0	2435.4	1684
2880 min Winter	3.200	0.0	2550.7	2136

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Cascade Summary of Results for Basin 1.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
4320 min Winter	42.547	1.047	11.5	823.2	O K
5760 min Winter	42.364	0.864	11.5	653.5	O K
7200 min Winter	42.177	0.677	11.5	492.7	O K
8640 min Winter	42.021	0.521	11.5	366.6	O K
10080 min Winter	41.900	0.400	11.5	274.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
4320 min Winter	2.357	0.0	2787.4	3068
5760 min Winter	1.897	0.0	3035.4	3920
7200 min Winter	1.603	0.0	3206.0	4608
8640 min Winter	1.397	0.0	3352.0	5192
10080 min Winter	1.244	0.0	3478.4	5840

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Cascade Rainfall Details for Basin 1.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 469450 106750 SU 69450 06750
C (1km)	-0.029
D1 (1km)	0.456
D2 (1km)	0.298
D3 (1km)	0.379
E (1km)	0.310
F (1km)	2.242
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) 1.488

Time (mins) From:	To:	Area (ha)
0	4	1.488

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Cascade Model Details for Basin 1.SRCX

Storage is Online Cover Level (m) 43.000

Tank or Pond Structure

Invert Level (m) 41.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	627.0	1.500	1122.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0148-1150-1500-1150
Design Head (m)	1.500
Design Flow (l/s)	11.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	148
Invert Level (m)	41.500
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	11.5	Kick-Flo®	0.939	9.2
Flush-Flo™	0.439	11.5	Mean Flow over Head Range	-	10.0

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	5.3	1.200	10.3	3.000	16.0	7.000	24.0
0.200	10.4	1.400	11.1	3.500	17.2	7.500	24.8
0.300	11.2	1.600	11.9	4.000	18.3	8.000	25.6
0.400	11.5	1.800	12.5	4.500	19.4	8.500	26.3
0.500	11.5	2.000	13.2	5.000	20.4	9.000	27.0
0.600	11.3	2.200	13.8	5.500	21.3	9.500	27.8
0.800	10.6	2.400	14.4	6.000	22.2		
1.000	9.5	2.600	14.9	6.500	23.1		

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Cascade Summary of Results for Basin 2.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	CS6.SRCX	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	32.827	0.527	5.8	388.5	O K
30 min Summer	32.936	0.636	5.8	483.1	O K
60 min Summer	33.062	0.762	5.8	598.4	O K
120 min Summer	33.204	0.904	5.8	737.0	O K
180 min Summer	33.293	0.993	5.8	829.4	O K
240 min Summer	33.358	1.058	5.8	898.4	O K
360 min Summer	33.449	1.149	5.8	999.2	O K
480 min Summer	33.513	1.213	5.8	1071.3	Flood Risk
600 min Summer	33.559	1.259	5.8	1126.0	Flood Risk
720 min Summer	33.595	1.295	5.8	1169.0	Flood Risk
960 min Summer	33.595	1.295	5.8	1168.3	Flood Risk
1440 min Summer	33.568	1.268	5.8	1136.5	Flood Risk
2160 min Summer	33.511	1.211	5.8	1069.3	Flood Risk
2880 min Summer	33.460	1.160	5.8	1011.0	O K
4320 min Summer	33.410	1.110	5.8	955.5	O K
5760 min Summer	33.358	1.058	5.8	898.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.274	0.0	370.6	19
30 min Summer	87.712	0.0	448.6	34
60 min Summer	54.845	0.0	605.3	64
120 min Summer	34.294	0.0	753.3	124
180 min Summer	26.058	0.0	847.6	184
240 min Summer	21.444	0.0	897.2	244
360 min Summer	16.294	0.0	896.0	362
480 min Summer	13.409	0.0	881.5	482
600 min Summer	11.528	0.0	869.8	602
720 min Summer	10.188	0.0	861.6	722
960 min Summer	8.012	0.0	848.9	962
1440 min Summer	5.710	0.0	828.7	1440
2160 min Summer	4.069	0.0	1620.0	1816
2880 min Summer	3.200	0.0	1663.0	2192
4320 min Summer	2.357	0.0	1541.0	2984
5760 min Summer	1.897	0.0	2037.6	3856

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Cascade Summary of Results for Basin 2.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Summer	33.303	1.003	5.8	839.8	O K
8640 min Summer	33.243	0.943	5.8	777.5	O K
10080 min Summer	33.171	0.871	5.8	704.5	O K
15 min Winter	32.882	0.582	5.8	435.6	O K
30 min Winter	33.001	0.701	5.8	541.9	O K
60 min Winter	33.138	0.838	5.8	672.0	O K
120 min Winter	33.294	0.994	5.8	829.7	O K
180 min Winter	33.391	1.091	5.8	933.8	O K
240 min Winter	33.461	1.161	5.8	1012.6	O K
360 min Winter	33.562	1.262	5.8	1128.9	Flood Risk
480 min Winter	33.632	1.332	5.8	1213.3	Flood Risk
600 min Winter	33.685	1.385	5.8	1278.6	Flood Risk
720 min Winter	33.727	1.427	5.8	1330.7	Flood Risk
960 min Winter	33.732	1.432	5.8	1337.3	Flood Risk
1440 min Winter	33.715	1.415	5.8	1316.0	Flood Risk
2160 min Winter	33.659	1.359	5.8	1246.6	Flood Risk
2880 min Winter	33.598	1.298	5.8	1171.4	Flood Risk
4320 min Winter	33.532	1.232	5.8	1094.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Summer	1.603	0.0	2151.8	4680
8640 min Summer	1.397	0.0	2249.5	5528
10080 min Summer	1.244	0.0	2334.2	6256
15 min Winter	140.274	0.0	410.9	19
30 min Winter	87.712	0.0	476.3	33
60 min Winter	54.845	0.0	677.0	64
120 min Winter	34.294	0.0	835.6	122
180 min Winter	26.058	0.0	903.8	182
240 min Winter	21.444	0.0	903.1	240
360 min Winter	16.294	0.0	886.1	358
480 min Winter	13.409	0.0	874.7	476
600 min Winter	11.528	0.0	869.5	592
720 min Winter	10.188	0.0	869.9	708
960 min Winter	8.012	0.0	868.2	940
1440 min Winter	5.710	0.0	864.7	1386
2160 min Winter	4.069	0.0	1752.7	2028
2880 min Winter	3.200	0.0	1710.4	2304
4320 min Winter	2.357	0.0	1588.1	3240

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Cascade Summary of Results for Basin 2.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
5760 min Winter	33.457	1.157	5.8	1007.9	O K
7200 min Winter	33.376	1.076	5.8	917.4	O K
8640 min Winter	33.286	0.986	5.8	821.9	O K
10080 min Winter	33.171	0.871	5.8	704.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Winter	1.897	0.0	2282.0	4152
7200 min Winter	1.603	0.0	2409.7	5048
8640 min Winter	1.397	0.0	2518.7	5968
10080 min Winter	1.244	0.0	2614.1	6760

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Cascade Rainfall Details for Basin 2.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 469450 106750 SU 69450 06750
C (1km)	-0.029
D1 (1km)	0.456
D2 (1km)	0.298
D3 (1km)	0.379
E (1km)	0.310
F (1km)	2.242
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) 1.494

Time (mins) From:	To:	Area (ha)
0	4	1.494

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Cascade Model Details for Basin 2.SRCX

Storage is Online Cover Level (m) 33.800

Tank or Pond Structure

Invert Level (m) 32.300

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	636.0	1.500	1303.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0106-5800-1500-5800
Design Head (m)	1.500
Design Flow (l/s)	5.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	106
Invert Level (m)	32.300
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	5.8	Kick-Flo®	0.926	4.6
Flush-Flo™	0.453	5.8	Mean Flow over Head Range	-	5.1

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	3.6	1.200	5.2	3.000	8.0	7.000	12.0
0.200	5.2	1.400	5.6	3.500	8.6	7.500	12.4
0.300	5.6	1.600	6.0	4.000	9.2	8.000	12.8
0.400	5.8	1.800	6.3	4.500	9.7	8.500	13.1
0.500	5.8	2.000	6.6	5.000	10.2	9.000	13.5
0.600	5.7	2.200	6.9	5.500	10.7	9.500	13.9
0.800	5.3	2.400	7.2	6.000	11.1		
1.000	4.8	2.600	7.5	6.500	11.6		

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Cascade Summary of Results for Basin 3.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	CS8.SRCX	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	30.849	0.649	7.8	311.1	O K
30 min Summer	30.969	0.769	7.8	385.4	O K
60 min Summer	31.102	0.902	7.8	474.5	O K
120 min Summer	31.243	1.043	7.8	577.9	O K
180 min Summer	31.326	1.126	7.8	642.2	O K
240 min Summer	31.383	1.183	7.8	688.0	O K
360 min Summer	31.456	1.256	7.8	749.7	Flood Risk
480 min Summer	31.501	1.301	7.8	788.3	Flood Risk
600 min Summer	31.529	1.329	7.8	813.3	Flood Risk
720 min Summer	31.547	1.347	7.8	829.2	Flood Risk
960 min Summer	31.511	1.311	7.8	797.1	Flood Risk
1440 min Summer	31.446	1.246	7.8	741.1	Flood Risk
2160 min Summer	31.364	1.164	7.8	672.7	O K
2880 min Summer	31.289	1.089	7.8	613.2	O K
4320 min Summer	31.186	0.986	7.8	535.0	O K
5760 min Summer	31.056	0.856	7.8	443.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.274	0.0	312.8	19
30 min Summer	87.712	0.0	391.1	34
60 min Summer	54.845	0.0	494.1	64
120 min Summer	34.294	0.0	618.0	124
180 min Summer	26.058	0.0	704.3	182
240 min Summer	21.444	0.0	772.6	242
360 min Summer	16.294	0.0	880.0	362
480 min Summer	13.409	0.0	964.7	482
600 min Summer	11.528	0.0	1035.1	600
720 min Summer	10.188	0.0	1095.0	720
960 min Summer	8.012	0.0	1140.3	876
1440 min Summer	5.710	0.0	1139.5	1112
2160 min Summer	4.069	0.0	1323.5	1512
2880 min Summer	3.200	0.0	1387.4	1928
4320 min Summer	2.357	0.0	1531.7	2764
5760 min Summer	1.897	0.0	1646.5	3520

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Cascade Summary of Results for Basin 3.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Summer	30.929	0.729	7.8	360.0	O K
8640 min Summer	30.817	0.617	7.8	291.9	O K
10080 min Summer	30.718	0.518	7.8	236.0	O K
15 min Winter	30.911	0.711	7.8	349.1	O K
30 min Winter	31.041	0.841	7.8	433.1	O K
60 min Winter	31.185	0.985	7.8	534.2	O K
120 min Winter	31.338	1.138	7.8	651.7	O K
180 min Winter	31.429	1.229	7.8	726.2	Flood Risk
240 min Winter	31.491	1.291	7.8	780.0	Flood Risk
360 min Winter	31.575	1.375	7.8	854.3	Flood Risk
480 min Winter	31.628	1.428	7.8	903.2	Flood Risk
600 min Winter	31.663	1.463	7.8	936.8	Flood Risk
720 min Winter	31.687	1.487	7.8	960.2	Flood Risk
960 min Winter	31.658	1.458	7.8	932.0	Flood Risk
1440 min Winter	31.582	1.382	7.8	861.3	Flood Risk
2160 min Winter	31.483	1.283	7.8	773.0	Flood Risk
2880 min Winter	31.384	1.184	7.8	689.4	O K
4320 min Winter	31.229	1.029	7.8	567.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Summer	1.603	0.0	1739.1	4248
8640 min Summer	1.397	0.0	1818.4	4928
10080 min Summer	1.244	0.0	1887.6	5640
15 min Winter	140.274	0.0	350.4	19
30 min Winter	87.712	0.0	437.6	33
60 min Winter	54.845	0.0	553.5	62
120 min Winter	34.294	0.0	692.1	122
180 min Winter	26.058	0.0	788.6	180
240 min Winter	21.444	0.0	865.0	238
360 min Winter	16.294	0.0	984.6	356
480 min Winter	13.409	0.0	1077.8	470
600 min Winter	11.528	0.0	1152.4	584
720 min Winter	10.188	0.0	1202.6	698
960 min Winter	8.012	0.0	1199.0	914
1440 min Winter	5.710	0.0	1155.6	1168
2160 min Winter	4.069	0.0	1482.3	1620
2880 min Winter	3.200	0.0	1553.8	2076
4320 min Winter	2.357	0.0	1714.9	2984

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Cascade Summary of Results for Basin 3.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
5760 min Winter	31.019	0.819	7.8	418.0	O K
7200 min Winter	30.821	0.621	7.8	294.6	O K
8640 min Winter	30.659	0.459	7.8	204.6	O K
10080 min Winter	30.538	0.338	7.7	143.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Winter	1.897	0.0	1844.2	3752
7200 min Winter	1.603	0.0	1947.9	4400
8640 min Winter	1.397	0.0	2036.8	5096
10080 min Winter	1.244	0.0	2114.5	5648

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Cascade Rainfall Details for Basin 3.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 469450 106750 SU 69450 06750
C (1km)	-0.029
D1 (1km)	0.456
D2 (1km)	0.298
D3 (1km)	0.379
E (1km)	0.310
F (1km)	2.242
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) 1.206

Time (mins) From:	To:	Area (ha)
0	4	1.206

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Cascade Model Details for Basin 3.SRCX

Storage is Online Cover Level (m) 31.700

Tank or Pond Structure

Invert Level (m) 30.200

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	371.0	1.500	973.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0122-7800-1500-7800
Design Head (m)	1.500
Design Flow (l/s)	7.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	122
Invert Level (m)	30.200
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	7.8	Kick-Flo®	0.924	6.2
Flush-Flo™	0.444	7.8	Mean Flow over Head Range	-	6.8

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	4.4	1.200	7.0	3.000	10.8	7.000	16.2
0.200	7.0	1.400	7.5	3.500	11.6	7.500	16.7
0.300	7.6	1.600	8.0	4.000	12.4	8.000	17.2
0.400	7.7	1.800	8.5	4.500	13.1	8.500	17.7
0.500	7.7	2.000	8.9	5.000	13.8	9.000	18.2
0.600	7.6	2.200	9.3	5.500	14.4	9.500	18.7
0.800	7.1	2.400	9.7	6.000	15.0		
1.000	6.4	2.600	10.1	6.500	15.6		

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Cascade Summary of Results for CS1a.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	Basin 1.SRCX	(None)

Half Drain Time : 880 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	49.008	0.408	0.0	1.7	1.7	58.2	O K
30 min Summer	49.105	0.505	0.0	1.7	1.7	72.0	O K
60 min Summer	49.221	0.621	0.0	1.7	1.7	88.6	O K
120 min Summer	49.352	0.752	0.0	1.7	1.7	107.1	O K
180 min Summer	49.431	0.831	0.0	1.7	1.7	118.4	O K
240 min Summer	49.485	0.885	0.0	1.7	1.7	126.2	O K
360 min Summer	49.554	0.954	0.0	1.7	1.7	136.0	O K
480 min Summer	49.593	0.993	0.0	1.7	1.7	141.5	O K
600 min Summer	49.614	1.014	0.0	1.8	1.8	144.5	O K
720 min Summer	49.626	1.026	0.0	1.8	1.8	146.3	O K
960 min Summer	49.585	0.985	0.0	1.7	1.7	140.4	O K
1440 min Summer	49.513	0.913	0.0	1.7	1.7	130.1	O K
2160 min Summer	49.420	0.820	0.0	1.7	1.7	116.9	O K
2880 min Summer	49.340	0.740	0.0	1.7	1.7	105.4	O K
4320 min Summer	49.229	0.629	0.0	1.7	1.7	89.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.274	0.0	58.6	19
30 min Summer	87.712	0.0	73.3	34
60 min Summer	54.845	0.0	92.6	64
120 min Summer	34.294	0.0	115.8	122
180 min Summer	26.058	0.0	132.0	182
240 min Summer	21.444	0.0	144.8	242
360 min Summer	16.294	0.0	165.1	362
480 min Summer	13.409	0.0	181.1	480
600 min Summer	11.528	0.0	194.5	596
720 min Summer	10.188	0.0	206.2	656
960 min Summer	8.012	0.0	215.9	764
1440 min Summer	5.710	0.0	229.7	1024
2160 min Summer	4.069	0.0	248.0	1444
2880 min Summer	3.200	0.0	260.0	1848
4320 min Summer	2.357	0.0	287.1	2680

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Cascade Summary of Results for CS1a.SRCX

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
5760 min Summer	49.098	0.498	0.0	1.7	1.7	70.9	O K
7200 min Summer	48.989	0.389	0.0	1.7	1.7	55.5	O K
8640 min Summer	48.907	0.307	0.0	1.7	1.7	43.7	O K
10080 min Summer	48.845	0.245	0.0	1.7	1.7	34.9	O K
15 min Winter	49.058	0.458	0.0	1.7	1.7	65.3	O K
30 min Winter	49.168	0.568	0.0	1.7	1.7	81.0	O K
60 min Winter	49.299	0.699	0.0	1.7	1.7	99.6	O K
120 min Winter	49.448	0.848	0.0	1.7	1.7	120.8	O K
180 min Winter	49.540	0.940	0.0	1.7	1.7	134.0	O K
240 min Winter	49.605	1.005	0.0	1.8	1.8	143.2	O K
360 min Winter	49.690	1.090	0.0	1.8	1.8	155.3	O K
480 min Winter	49.741	1.141	0.0	1.9	1.9	162.6	O K
600 min Winter	49.773	1.173	0.0	1.9	1.9	167.2	O K
720 min Winter	49.792	1.192	0.0	1.9	1.9	169.9	O K
960 min Winter	49.739	1.139	0.0	1.9	1.9	162.3	O K
1440 min Winter	49.651	1.051	0.0	1.8	1.8	149.7	O K
2160 min Winter	49.525	0.925	0.0	1.7	1.7	131.8	O K
2880 min Winter	49.408	0.808	0.0	1.7	1.7	115.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Summer	1.897	0.0	308.5	3456
7200 min Summer	1.603	0.0	325.9	4112
8640 min Summer	1.397	0.0	340.7	4760
10080 min Summer	1.244	0.0	353.7	5448
15 min Winter	140.274	0.0	65.7	19
30 min Winter	87.712	0.0	82.1	33
60 min Winter	54.845	0.0	103.7	62
120 min Winter	34.294	0.0	129.7	120
180 min Winter	26.058	0.0	147.9	180
240 min Winter	21.444	0.0	162.2	238
360 min Winter	16.294	0.0	184.8	352
480 min Winter	13.409	0.0	202.7	466
600 min Winter	11.528	0.0	217.7	578
720 min Winter	10.188	0.0	230.6	686
960 min Winter	8.012	0.0	241.3	868
1440 min Winter	5.710	0.0	253.3	1096
2160 min Winter	4.069	0.0	277.8	1556
2880 min Winter	3.200	0.0	291.2	2016

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Cascade Summary of Results for CS1a.SRCX

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
4320 min Winter	49.235	0.635	0.0	1.7	1.7	90.5	O K
5760 min Winter	49.024	0.424	0.0	1.7	1.7	60.4	O K
7200 min Winter	48.883	0.283	0.0	1.7	1.7	40.3	O K
8640 min Winter	48.793	0.193	0.0	1.6	1.6	27.6	O K
10080 min Winter	48.740	0.140	0.0	1.5	1.5	19.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
4320 min Winter	2.357	0.0	321.6	2896
5760 min Winter	1.897	0.0	345.6	3584
7200 min Winter	1.603	0.0	365.0	4248
8640 min Winter	1.397	0.0	381.7	4840
10080 min Winter	1.244	0.0	396.2	5448

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Cascade Rainfall Details for CS1a.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 469450 106750 SU 69450 06750
C (1km)	-0.029
D1 (1km)	0.456
D2 (1km)	0.298
D3 (1km)	0.379
E (1km)	0.310
F (1km)	2.242
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) 0.226

Time (mins) From:	To:	Area (ha)
0	4	0.226

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Cascade Model Details for CS1a.SRCX

Storage is Online Cover Level (m) 51.000

Cellular Storage Structure

Invert Level (m) 48.600 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	150.0	150.0	1.201	0.0	208.8
1.200	150.0	208.8			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0063-1900-1200-1900
Design Head (m)	1.200
Design Flow (l/s)	1.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	63
Invert Level (m)	48.600
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	1.9	Kick-Flo®	0.558	1.3
Flush-Flo™	0.274	1.7	Mean Flow over Head Range	-	1.5

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	1.4	1.200	1.9	3.000	2.9	7.000	4.3
0.200	1.6	1.400	2.0	3.500	3.1	7.500	4.4
0.300	1.7	1.600	2.2	4.000	3.3	8.000	4.6
0.400	1.6	1.800	2.3	4.500	3.5	8.500	4.7
0.500	1.5	2.000	2.4	5.000	3.7	9.000	4.8
0.600	1.4	2.200	2.5	5.500	3.8	9.500	5.0
0.800	1.6	2.400	2.6	6.000	4.0		
1.000	1.7	2.600	2.7	6.500	4.1		

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Cascade Summary of Results for CS1b.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	Basin 1.SRCX	(None)

Half Drain Time : 1361 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	43.724	0.424	0.0	1.3	1.3	70.6	O K
30 min Summer	43.828	0.528	0.0	1.3	1.3	87.7	O K
60 min Summer	43.952	0.652	0.0	1.3	1.3	108.4	O K
120 min Summer	44.097	0.797	0.0	1.3	1.3	132.5	O K
180 min Summer	44.190	0.890	0.0	1.3	1.3	147.9	O K
240 min Summer	44.257	0.957	0.0	1.4	1.4	159.2	O K
360 min Summer	44.352	1.052	0.0	1.4	1.4	174.9	O K
480 min Summer	44.415	1.115	0.0	1.5	1.5	185.3	O K
600 min Summer	44.458	1.158	0.0	1.5	1.5	192.6	O K
720 min Summer	44.489	1.189	0.0	1.5	1.5	197.7	O K
960 min Summer	44.461	1.161	0.0	1.5	1.5	193.0	O K
1440 min Summer	44.401	1.101	0.0	1.5	1.5	183.1	O K
2160 min Summer	44.324	1.024	0.0	1.4	1.4	170.3	O K
2880 min Summer	44.258	0.958	0.0	1.4	1.4	159.2	O K
4320 min Summer	44.185	0.885	0.0	1.3	1.3	147.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.274	0.0	69.8	19
30 min Summer	87.712	0.0	86.4	34
60 min Summer	54.845	0.0	111.1	64
120 min Summer	34.294	0.0	138.9	124
180 min Summer	26.058	0.0	158.1	182
240 min Summer	21.444	0.0	173.2	242
360 min Summer	16.294	0.0	195.9	362
480 min Summer	13.409	0.0	209.9	482
600 min Summer	11.528	0.0	213.8	602
720 min Summer	10.188	0.0	215.1	720
960 min Summer	8.012	0.0	213.0	934
1440 min Summer	5.710	0.0	207.5	1154
2160 min Summer	4.069	0.0	298.2	1536
2880 min Summer	3.200	0.0	312.4	1960
4320 min Summer	2.357	0.0	342.5	2768

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Cascade Summary of Results for CS1b.SRCX

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
5760 min Summer	44.114	0.814	0.0	1.3	1.3	135.3	O K
7200 min Summer	44.045	0.745	0.0	1.3	1.3	123.9	O K
8640 min Summer	43.980	0.680	0.0	1.3	1.3	113.0	O K
10080 min Summer	43.916	0.616	0.0	1.3	1.3	102.4	O K
15 min Winter	43.776	0.476	0.0	1.3	1.3	79.1	O K
30 min Winter	43.892	0.592	0.0	1.3	1.3	98.4	O K
60 min Winter	44.032	0.732	0.0	1.3	1.3	121.6	O K
120 min Winter	44.197	0.897	0.0	1.3	1.3	149.1	O K
180 min Winter	44.303	1.003	0.0	1.4	1.4	166.8	O K
240 min Winter	44.382	1.082	0.0	1.5	1.5	179.8	O K
360 min Winter	44.493	1.193	0.0	1.5	1.5	198.4	O K
480 min Winter	44.569	1.269	0.0	1.6	1.6	211.0	O K
600 min Winter	44.624	1.324	0.0	1.6	1.6	220.2	O K
720 min Winter	44.665	1.365	0.0	1.6	1.6	227.0	O K
960 min Winter	44.645	1.345	0.0	1.6	1.6	223.6	O K
1440 min Winter	44.575	1.275	0.0	1.6	1.6	212.0	O K
2160 min Winter	44.483	1.183	0.0	1.5	1.5	196.6	O K
2880 min Winter	44.394	1.094	0.0	1.5	1.5	181.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Summer	1.897	0.0	371.3	3632
7200 min Summer	1.603	0.0	392.2	4400
8640 min Summer	1.397	0.0	410.0	5272
10080 min Summer	1.244	0.0	425.6	6048
15 min Winter	140.274	0.0	77.9	19
30 min Winter	87.712	0.0	95.0	33
60 min Winter	54.845	0.0	124.4	62
120 min Winter	34.294	0.0	155.4	122
180 min Winter	26.058	0.0	176.7	180
240 min Winter	21.444	0.0	193.0	238
360 min Winter	16.294	0.0	213.4	356
480 min Winter	13.409	0.0	218.4	472
600 min Winter	11.528	0.0	220.6	586
720 min Winter	10.188	0.0	222.5	700
960 min Winter	8.012	0.0	221.7	922
1440 min Winter	5.710	0.0	220.1	1312
2160 min Winter	4.069	0.0	333.9	1644
2880 min Winter	3.200	0.0	349.7	2104

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Cascade Summary of Results for CS1b.SRCX

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
4320 min Winter	44.281	0.981	0.0	1.4	1.4	163.1	O K
5760 min Winter	44.171	0.871	0.0	1.3	1.3	144.7	O K
7200 min Winter	44.066	0.766	0.0	1.3	1.3	127.3	O K
8640 min Winter	43.965	0.665	0.0	1.3	1.3	110.5	O K
10080 min Winter	43.860	0.560	0.0	1.3	1.3	93.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
4320 min Winter	2.357	0.0	374.3	3024
5760 min Winter	1.897	0.0	415.8	3912
7200 min Winter	1.603	0.0	439.2	4760
8640 min Winter	1.397	0.0	459.3	5624
10080 min Winter	1.244	0.0	476.8	6552

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Cascade Rainfall Details for CS1b.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 469450 106750 SU 69450 06750
C (1km)	-0.029
D1 (1km)	0.456
D2 (1km)	0.298
D3 (1km)	0.379
E (1km)	0.310
F (1km)	2.242
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) 0.272

Time (mins) From:	To:	Area (ha)
0	4	0.272

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Cascade Model Details for CS1b.SRCX

Storage is Online Cover Level (m) 46.000

Cellular Storage Structure

Invert Level (m) 43.300 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	175.0	180.0	1.501	0.0	260.5
1.500	175.0	260.5			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0056-1700-1500-1700
Design Head (m)	1.500
Design Flow (l/s)	1.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	56
Invert Level (m)	43.300
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	1.7	Kick-Flo®	0.499	1.0
Flush-Flo™	0.247	1.3	Mean Flow over Head Range	-	1.3

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	1.1	1.200	1.5	3.000	2.3	7.000	3.5
0.200	1.3	1.400	1.6	3.500	2.5	7.500	3.6
0.300	1.3	1.600	1.7	4.000	2.7	8.000	3.7
0.400	1.2	1.800	1.8	4.500	2.8	8.500	3.8
0.500	1.0	2.000	1.9	5.000	3.0	9.000	3.9
0.600	1.1	2.200	2.0	5.500	3.1	9.500	4.0
0.800	1.3	2.400	2.1	6.000	3.2		
1.000	1.4	2.600	2.2	6.500	3.3		

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Cascade Summary of Results for CS2.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	CS8.SRCX	(None)

Half Drain Time : 719 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	53.338	0.538	0.0	3.2	3.2	95.6	O K
30 min Summer	53.465	0.665	0.0	3.2	3.2	118.1	O K
60 min Summer	53.615	0.815	0.0	3.2	3.2	144.8	O K
120 min Summer	53.780	0.980	0.0	3.2	3.2	174.2	O K
180 min Summer	53.877	1.077	0.0	3.2	3.2	191.4	O K
240 min Summer	53.941	1.141	0.0	3.2	3.2	202.8	O K
360 min Summer	54.017	1.217	0.0	3.3	3.3	216.3	O K
480 min Summer	54.054	1.254	0.0	3.3	3.3	222.7	O K
600 min Summer	54.072	1.272	0.0	3.3	3.3	226.0	O K
720 min Summer	54.084	1.284	0.0	3.3	3.3	228.1	O K
960 min Summer	54.024	1.224	0.0	3.3	3.3	217.4	O K
1440 min Summer	53.919	1.119	0.0	3.2	3.2	198.8	O K
2160 min Summer	53.785	0.985	0.0	3.2	3.2	175.0	O K
2880 min Summer	53.665	0.865	0.0	3.2	3.2	153.7	O K
4320 min Summer	53.461	0.661	0.0	3.2	3.2	117.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.274	0.0	97.1	19
30 min Summer	87.712	0.0	121.5	33
60 min Summer	54.845	0.0	153.0	64
120 min Summer	34.294	0.0	191.3	122
180 min Summer	26.058	0.0	218.1	182
240 min Summer	21.444	0.0	239.3	242
360 min Summer	16.294	0.0	272.8	360
480 min Summer	13.409	0.0	299.3	480
600 min Summer	11.528	0.0	321.6	538
720 min Summer	10.188	0.0	341.0	600
960 min Summer	8.012	0.0	357.4	722
1440 min Summer	5.710	0.0	381.6	994
2160 min Summer	4.069	0.0	409.5	1408
2880 min Summer	3.200	0.0	429.3	1820
4320 min Summer	2.357	0.0	474.0	2596

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Cascade Summary of Results for CS2.SRCX

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
5760 min Summer	53.290	0.490	0.0	3.2	3.2	87.0	O K
7200 min Summer	53.167	0.367	0.0	3.2	3.2	65.3	O K
8640 min Summer	53.081	0.281	0.0	3.2	3.2	49.8	O K
10080 min Summer	53.021	0.221	0.0	3.1	3.1	39.2	O K
15 min Winter	53.404	0.604	0.0	3.2	3.2	107.3	O K
30 min Winter	53.549	0.749	0.0	3.2	3.2	133.0	O K
60 min Winter	53.718	0.918	0.0	3.2	3.2	163.1	O K
120 min Winter	53.907	1.107	0.0	3.2	3.2	196.7	O K
180 min Winter	54.021	1.221	0.0	3.3	3.3	216.9	O K
240 min Winter	54.099	1.299	0.0	3.4	3.4	230.7	O K
360 min Winter	54.196	1.396	0.0	3.5	3.5	247.9	O K
480 min Winter	54.249	1.449	0.0	3.5	3.5	257.4	O K
600 min Winter	54.277	1.477	0.0	3.6	3.6	262.4	O K
720 min Winter	54.289	1.489	0.0	3.6	3.6	264.6	O K
960 min Winter	54.214	1.414	0.0	3.5	3.5	251.1	O K
1440 min Winter	54.079	1.279	0.0	3.3	3.3	227.2	O K
2160 min Winter	53.890	1.090	0.0	3.2	3.2	193.7	O K
2880 min Winter	53.715	0.915	0.0	3.2	3.2	162.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Summer	1.897	0.0	509.3	3288
7200 min Summer	1.603	0.0	537.9	3968
8640 min Summer	1.397	0.0	562.4	4664
10080 min Summer	1.244	0.0	583.9	5344
15 min Winter	140.274	0.0	108.8	19
30 min Winter	87.712	0.0	136.1	33
60 min Winter	54.845	0.0	171.3	62
120 min Winter	34.294	0.0	214.3	120
180 min Winter	26.058	0.0	244.3	178
240 min Winter	21.444	0.0	268.1	236
360 min Winter	16.294	0.0	305.5	350
480 min Winter	13.409	0.0	335.2	462
600 min Winter	11.528	0.0	360.1	570
720 min Winter	10.188	0.0	381.8	672
960 min Winter	8.012	0.0	400.2	760
1440 min Winter	5.710	0.0	426.9	1068
2160 min Winter	4.069	0.0	458.6	1532
2880 min Winter	3.200	0.0	480.9	1984

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Cascade Summary of Results for CS2.SRCX

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
4320 min Winter	53.388	0.588	0.0	3.2	3.2	104.4	O K
5760 min Winter	53.159	0.359	0.0	3.2	3.2	63.8	O K
7200 min Winter	53.029	0.229	0.0	3.1	3.1	40.6	O K
8640 min Winter	52.958	0.158	0.0	2.9	2.9	28.0	O K
10080 min Winter	52.918	0.118	0.0	2.7	2.7	20.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
4320 min Winter	2.357	0.0	531.0	2728
5760 min Winter	1.897	0.0	570.4	3400
7200 min Winter	1.603	0.0	602.5	4032
8640 min Winter	1.397	0.0	630.0	4664
10080 min Winter	1.244	0.0	654.1	5248

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Cascade Rainfall Details for CS2.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 469450 106750 SU 69450 06750
C (1km)	-0.029
D1 (1km)	0.456
D2 (1km)	0.298
D3 (1km)	0.379
E (1km)	0.310
F (1km)	2.242
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) 0.373

Time (mins) From:	To:	Area (ha)
0	4	0.373

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Cascade Model Details for CS2.SRCX

Storage is Online Cover Level (m) 55.500

Cellular Storage Structure

Invert Level (m) 52.800 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	187.0	187.0	1.501	0.0	269.1
1.500	187.0	269.0			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0083-3600-1500-3600
Design Head (m)	1.500
Design Flow (l/s)	3.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	83
Invert Level (m)	52.800
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	3.6	Kick-Flo®	0.739	2.6
Flush-Flo™	0.362	3.2	Mean Flow over Head Range	-	3.0

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	2.4	1.200	3.2	3.000	5.0	7.000	7.4
0.200	3.1	1.400	3.5	3.500	5.3	7.500	7.6
0.300	3.2	1.600	3.7	4.000	5.7	8.000	7.9
0.400	3.2	1.800	3.9	4.500	6.0	8.500	8.1
0.500	3.2	2.000	4.1	5.000	6.3	9.000	8.3
0.600	3.0	2.200	4.3	5.500	6.6	9.500	8.5
0.800	2.7	2.400	4.5	6.000	6.9		
1.000	3.0	2.600	4.6	6.500	7.1		

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Cascade Summary of Results for CS3.SRCX

Upstream Structures	Outflow To	Overflow To
Basin 1.SRCX CS1a.SRCX CS1b.SRCX	CS8.SRCX	(None)

Half Drain Time : 318 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	35.719	0.419	0.0	14.0	14.0	149.4	O K
30 min Summer	35.822	0.522	0.0	14.0	14.0	186.1	O K
60 min Summer	35.948	0.648	0.0	14.0	14.0	230.8	O K
120 min Summer	36.094	0.794	0.0	14.0	14.0	282.9	O K
180 min Summer	36.194	0.894	0.0	14.0	14.0	318.3	O K
240 min Summer	36.279	0.979	0.0	14.0	14.0	348.9	O K
360 min Summer	36.400	1.100	0.0	14.0	14.0	391.9	O K
480 min Summer	36.481	1.181	0.0	14.0	14.0	420.7	O K
600 min Summer	36.540	1.240	0.0	14.0	14.0	441.7	O K
720 min Summer	36.584	1.284	0.0	14.0	14.0	457.3	O K
960 min Summer	36.577	1.277	0.0	14.0	14.0	454.9	O K
1440 min Summer	36.525	1.225	0.0	14.0	14.0	436.4	O K
2160 min Summer	36.441	1.141	0.0	14.0	14.0	406.4	O K
2880 min Summer	36.367	1.067	0.0	14.0	14.0	380.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.274	0.0	645.6	19
30 min Summer	87.712	0.0	803.0	34
60 min Summer	54.845	0.0	1039.5	64
120 min Summer	34.294	0.0	1299.3	122
180 min Summer	26.058	0.0	1479.1	184
240 min Summer	21.444	0.0	1620.2	244
360 min Summer	16.294	0.0	1837.1	362
480 min Summer	13.409	0.0	1999.0	482
600 min Summer	11.528	0.0	2105.7	602
720 min Summer	10.188	0.0	2091.4	722
960 min Summer	8.012	0.0	2045.9	962
1440 min Summer	5.710	0.0	1961.3	1396
2160 min Summer	4.069	0.0	2799.3	1728
2880 min Summer	3.200	0.0	2932.3	2108

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Cascade Summary of Results for CS3.SRCX

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
4320 min Summer	36.315	1.015	0.0	14.0	14.0	361.6	O K
5760 min Summer	36.383	1.083	0.0	14.0	14.0	385.7	O K
7200 min Summer	36.324	1.024	0.0	14.0	14.0	365.0	O K
8640 min Summer	36.089	0.789	0.0	14.0	14.0	281.0	O K
10080 min Summer	35.996	0.696	0.0	14.0	14.0	248.1	O K
15 min Winter	35.770	0.470	0.0	14.0	14.0	167.4	O K
30 min Winter	35.885	0.585	0.0	14.0	14.0	208.4	O K
60 min Winter	36.025	0.725	0.0	14.0	14.0	258.2	O K
120 min Winter	36.193	0.893	0.0	14.0	14.0	318.3	O K
180 min Winter	36.316	1.016	0.0	14.0	14.0	361.9	O K
240 min Winter	36.406	1.106	0.0	14.0	14.0	394.0	O K
360 min Winter	36.536	1.236	0.0	14.0	14.0	440.2	O K
480 min Winter	36.627	1.327	0.0	14.0	14.0	472.9	O K
600 min Winter	36.696	1.396	0.0	14.0	14.0	497.3	O K
720 min Winter	36.749	1.449	0.0	14.0	14.0	516.1	O K
960 min Winter	36.749	1.449	0.0	14.0	14.0	516.3	O K
1440 min Winter	36.707	1.407	0.0	14.0	14.0	501.4	O K
2160 min Winter	36.607	1.307	0.0	14.0	14.0	465.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
4320 min Summer	2.357	0.0	3218.0	4324
5760 min Summer	1.897	0.0	3489.8	5096
7200 min Summer	1.603	0.0	3685.8	5664
8640 min Summer	1.397	0.0	3852.8	5616
10080 min Summer	1.244	0.0	3996.2	6248
15 min Winter	140.274	0.0	722.1	19
30 min Winter	87.712	0.0	893.0	33
60 min Winter	54.845	0.0	1164.2	62
120 min Winter	34.294	0.0	1454.0	122
180 min Winter	26.058	0.0	1653.4	182
240 min Winter	21.444	0.0	1808.3	240
360 min Winter	16.294	0.0	2038.7	358
480 min Winter	13.409	0.0	2135.7	476
600 min Winter	11.528	0.0	2112.0	590
720 min Winter	10.188	0.0	2097.7	708
960 min Winter	8.012	0.0	2068.3	934
1440 min Winter	5.710	0.0	2015.5	1372
2160 min Winter	4.069	0.0	3134.1	1776

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Cascade Summary of Results for CS3.SRCX

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
2880 min Winter	36.521	1.221	0.0	14.0	14.0	435.1	O K
4320 min Winter	36.414	1.114	0.0	14.0	14.0	396.8	O K
5760 min Winter	36.431	1.131	0.0	14.0	14.0	403.0	O K
7200 min Winter	36.434	1.134	0.0	14.0	14.0	404.0	O K
8640 min Winter	36.124	0.824	0.0	14.0	14.0	293.6	O K
10080 min Winter	35.895	0.595	0.0	14.0	14.0	211.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
2880 min Winter	3.200	0.0	3281.7	2216
4320 min Winter	2.357	0.0	3577.5	3112
5760 min Winter	1.897	0.0	3908.9	5424
7200 min Winter	1.603	0.0	4128.4	5752
8640 min Winter	1.397	0.0	4316.1	6160
10080 min Winter	1.244	0.0	4478.1	6448

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Cascade Rainfall Details for CS3.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 469450 106750 SU 69450 06750
C (1km)	-0.029
D1 (1km)	0.456
D2 (1km)	0.298
D3 (1km)	0.379
E (1km)	0.310
F (1km)	2.242
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) 0.572

Time (mins) From:	To:	Area (ha)
0	4	0.572

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Cascade Model Details for CS3.SRCX

Storage is Online Cover Level (m) 38.000

Cellular Storage Structure

Invert Level (m) 35.300 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	375.0	375.0	1.501	0.0	491.2
1.500	375.0	491.2			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0162-1400-1500-1400
Design Head (m)	1.500
Design Flow (l/s)	14.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	162
Invert Level (m)	35.300
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	14.0	Kick-Flo®	0.950	11.3
Flush-Flo™	0.441	14.0	Mean Flow over Head Range	-	12.1

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	5.8	1.200	12.6	3.000	19.5	7.000	29.2
0.200	12.6	1.400	13.5	3.500	21.0	7.500	30.2
0.300	13.6	1.600	14.4	4.000	22.3	8.000	31.2
0.400	14.0	1.800	15.3	4.500	23.6	8.500	32.1
0.500	13.9	2.000	16.0	5.000	24.9	9.000	33.0
0.600	13.8	2.200	16.8	5.500	26.0	9.500	33.9
0.800	12.9	2.400	17.5	6.000	27.1		
1.000	11.6	2.600	18.2	6.500	28.2		

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Cascade Summary of Results for CS4.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	CS8.SRCX	(None)

Half Drain Time : 1235 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	33.975	0.375	0.0	1.2	1.2	59.8	O K
30 min Summer	34.065	0.465	0.0	1.2	1.2	74.3	O K
60 min Summer	34.175	0.575	0.0	1.2	1.2	91.7	O K
120 min Summer	34.301	0.701	0.0	1.2	1.2	111.9	O K
180 min Summer	34.381	0.781	0.0	1.2	1.2	124.7	O K
240 min Summer	34.439	0.839	0.0	1.3	1.3	133.9	O K
360 min Summer	34.518	0.918	0.0	1.3	1.3	146.6	O K
480 min Summer	34.570	0.970	0.0	1.4	1.4	154.8	O K
600 min Summer	34.604	1.004	0.0	1.4	1.4	160.3	O K
720 min Summer	34.627	1.027	0.0	1.4	1.4	164.0	O K
960 min Summer	34.597	0.997	0.0	1.4	1.4	159.1	O K
1440 min Summer	34.541	0.941	0.0	1.3	1.3	150.2	O K
2160 min Summer	34.469	0.869	0.0	1.3	1.3	138.7	O K
2880 min Summer	34.407	0.807	0.0	1.3	1.3	128.8	O K
4320 min Summer	34.334	0.734	0.0	1.2	1.2	117.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.274	0.0	59.4	19
30 min Summer	87.712	0.0	74.0	34
60 min Summer	54.845	0.0	94.4	64
120 min Summer	34.294	0.0	118.0	124
180 min Summer	26.058	0.0	134.5	182
240 min Summer	21.444	0.0	147.4	242
360 min Summer	16.294	0.0	167.6	362
480 min Summer	13.409	0.0	183.1	482
600 min Summer	11.528	0.0	194.8	600
720 min Summer	10.188	0.0	201.3	720
960 min Summer	8.012	0.0	200.1	894
1440 min Summer	5.710	0.0	192.9	1124
2160 min Summer	4.069	0.0	253.3	1512
2880 min Summer	3.200	0.0	265.5	1932
4320 min Summer	2.357	0.0	292.5	2764

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Cascade Summary of Results for CS4.SRCX

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
5760 min Summer	34.263	0.663	0.0	1.2	1.2	105.8	O K
7200 min Summer	34.193	0.593	0.0	1.2	1.2	94.7	O K
8640 min Summer	34.121	0.521	0.0	1.2	1.2	83.1	O K
10080 min Summer	34.031	0.431	0.0	1.2	1.2	68.8	O K
15 min Winter	34.020	0.420	0.0	1.2	1.2	67.1	O K
30 min Winter	34.123	0.523	0.0	1.2	1.2	83.4	O K
60 min Winter	34.245	0.645	0.0	1.2	1.2	103.0	O K
120 min Winter	34.389	0.789	0.0	1.2	1.2	126.0	O K
180 min Winter	34.482	0.882	0.0	1.3	1.3	140.7	O K
240 min Winter	34.549	0.949	0.0	1.3	1.3	151.4	O K
360 min Winter	34.643	1.043	0.0	1.4	1.4	166.4	O K
480 min Winter	34.706	1.106	0.0	1.4	1.4	176.5	O K
600 min Winter	34.751	1.151	0.0	1.5	1.5	183.6	O K
720 min Winter	34.783	1.183	0.0	1.5	1.5	188.7	O K
960 min Winter	34.757	1.157	0.0	1.5	1.5	184.7	O K
1440 min Winter	34.688	1.088	0.0	1.4	1.4	173.7	O K
2160 min Winter	34.599	0.999	0.0	1.4	1.4	159.5	O K
2880 min Winter	34.514	0.914	0.0	1.3	1.3	145.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Summer	1.897	0.0	315.3	3576
7200 min Summer	1.603	0.0	333.0	4400
8640 min Summer	1.397	0.0	348.2	5192
10080 min Summer	1.244	0.0	361.4	5856
15 min Winter	140.274	0.0	66.4	19
30 min Winter	87.712	0.0	82.4	33
60 min Winter	54.845	0.0	105.7	62
120 min Winter	34.294	0.0	132.2	122
180 min Winter	26.058	0.0	150.5	180
240 min Winter	21.444	0.0	164.9	238
360 min Winter	16.294	0.0	186.9	356
480 min Winter	13.409	0.0	201.7	470
600 min Winter	11.528	0.0	207.0	584
720 min Winter	10.188	0.0	208.4	698
960 min Winter	8.012	0.0	206.2	914
1440 min Winter	5.710	0.0	200.4	1168
2160 min Winter	4.069	0.0	283.6	1620
2880 min Winter	3.200	0.0	297.2	2076

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Cascade Summary of Results for CS4.SRCX

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
4320 min Winter	34.401	0.801	0.0	1.2	1.2	127.8	O K
5760 min Winter	34.290	0.690	0.0	1.2	1.2	110.2	O K
7200 min Winter	34.180	0.580	0.0	1.2	1.2	92.6	O K
8640 min Winter	34.039	0.439	0.0	1.2	1.2	70.1	O K
10080 min Winter	33.926	0.326	0.0	1.2	1.2	52.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
4320 min Winter	2.357	0.0	326.7	2984
5760 min Winter	1.897	0.0	353.2	3864
7200 min Winter	1.603	0.0	373.0	4752
8640 min Winter	1.397	0.0	390.0	5456
10080 min Winter	1.244	0.0	404.9	6056

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Cascade Rainfall Details for CS4.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 469450 106750 SU 69450 06750
C (1km)	-0.029
D1 (1km)	0.456
D2 (1km)	0.298
D3 (1km)	0.379
E (1km)	0.310
F (1km)	2.242
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) 0.231

Time (mins) From:	To:	Area (ha)
0	4	0.231

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Cascade Model Details for CS4.SRCX

Storage is Online Cover Level (m) 36.000

Cellular Storage Structure

Invert Level (m) 33.600 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	168.0	168.0	1.201	0.0	230.2
1.200	168.0	230.2			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0055-1500-1200-1500
Design Head (m)	1.200
Design Flow (l/s)	1.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	55
Invert Level (m)	33.600
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	1.5	Kick-Flo®	0.493	1.0
Flush-Flo™	0.242	1.2	Mean Flow over Head Range	-	1.2

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	1.1	1.200	1.5	3.000	2.3	7.000	3.4
0.200	1.2	1.400	1.6	3.500	2.4	7.500	3.5
0.300	1.2	1.600	1.7	4.000	2.6	8.000	3.6
0.400	1.2	1.800	1.8	4.500	2.7	8.500	3.7
0.500	1.0	2.000	1.9	5.000	2.9	9.000	3.8
0.600	1.1	2.200	2.0	5.500	3.0	9.500	3.9
0.800	1.2	2.400	2.1	6.000	3.1		
1.000	1.4	2.600	2.1	6.500	3.3		

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Cascade Summary of Results for CS5.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	CS8.SRCX	(None)

Half Drain Time : 1403 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	30.460	0.360	0.0	0.6	0.6	39.5	O K
30 min Summer	30.547	0.447	0.0	0.6	0.6	49.1	O K
60 min Summer	30.653	0.553	0.0	0.6	0.6	60.6	O K
120 min Summer	30.776	0.676	0.0	0.7	0.7	74.2	O K
180 min Summer	30.855	0.755	0.0	0.7	0.7	82.9	O K
240 min Summer	30.914	0.814	0.0	0.8	0.8	89.3	O K
360 min Summer	30.995	0.895	0.0	0.8	0.8	98.2	O K
480 min Summer	31.050	0.950	0.0	0.8	0.8	104.3	O K
600 min Summer	31.089	0.989	0.0	0.8	0.8	108.5	O K
720 min Summer	31.117	1.017	0.0	0.8	0.8	111.6	O K
960 min Summer	31.095	0.995	0.0	0.8	0.8	109.2	O K
1440 min Summer	31.047	0.947	0.0	0.8	0.8	103.9	O K
2160 min Summer	30.984	0.884	0.0	0.8	0.8	97.0	O K
2880 min Summer	30.929	0.829	0.0	0.8	0.8	91.0	O K
4320 min Summer	30.870	0.770	0.0	0.7	0.7	84.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.274	0.0	38.9	19
30 min Summer	87.712	0.0	47.7	34
60 min Summer	54.845	0.0	62.1	64
120 min Summer	34.294	0.0	77.6	124
180 min Summer	26.058	0.0	88.3	182
240 min Summer	21.444	0.0	96.6	242
360 min Summer	16.294	0.0	108.3	362
480 min Summer	13.409	0.0	112.6	482
600 min Summer	11.528	0.0	114.0	602
720 min Summer	10.188	0.0	114.9	720
960 min Summer	8.012	0.0	114.3	952
1440 min Summer	5.710	0.0	112.9	1168
2160 min Summer	4.069	0.0	166.6	1552
2880 min Summer	3.200	0.0	174.5	1960
4320 min Summer	2.357	0.0	189.4	2808

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Cascade Summary of Results for CS5.SRCX

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
5760 min Summer	30.813	0.713	0.0	0.7	0.7	78.3	O K
7200 min Summer	30.759	0.659	0.0	0.7	0.7	72.3	O K
8640 min Summer	30.707	0.607	0.0	0.7	0.7	66.6	O K
10080 min Summer	30.658	0.558	0.0	0.6	0.6	61.2	O K
15 min Winter	30.504	0.404	0.0	0.6	0.6	44.3	O K
30 min Winter	30.602	0.502	0.0	0.6	0.6	55.0	O K
60 min Winter	30.720	0.620	0.0	0.7	0.7	68.1	O K
120 min Winter	30.861	0.761	0.0	0.7	0.7	83.5	O K
180 min Winter	30.952	0.852	0.0	0.8	0.8	93.5	O K
240 min Winter	31.019	0.919	0.0	0.8	0.8	100.9	O K
360 min Winter	31.115	1.015	0.0	0.8	0.8	111.4	O K
480 min Winter	31.182	1.082	0.0	0.9	0.9	118.7	O K
600 min Winter	31.230	1.130	0.0	0.9	0.9	124.0	O K
720 min Winter	31.266	1.166	0.0	0.9	0.9	128.0	O K
960 min Winter	31.252	1.152	0.0	0.9	0.9	126.4	O K
1440 min Winter	31.197	1.097	0.0	0.9	0.9	120.4	O K
2160 min Winter	31.121	1.021	0.0	0.8	0.8	112.1	O K
2880 min Winter	31.050	0.950	0.0	0.8	0.8	104.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Summer	1.897	0.0	207.5	3632
7200 min Summer	1.603	0.0	219.2	4464
8640 min Summer	1.397	0.0	229.2	5272
10080 min Summer	1.244	0.0	237.8	6048
15 min Winter	140.274	0.0	43.3	19
30 min Winter	87.712	0.0	51.3	33
60 min Winter	54.845	0.0	69.5	62
120 min Winter	34.294	0.0	86.8	122
180 min Winter	26.058	0.0	98.5	180
240 min Winter	21.444	0.0	107.1	240
360 min Winter	16.294	0.0	114.4	356
480 min Winter	13.409	0.0	116.5	472
600 min Winter	11.528	0.0	118.3	586
720 min Winter	10.188	0.0	120.0	700
960 min Winter	8.012	0.0	120.7	922
1440 min Winter	5.710	0.0	120.1	1326
2160 min Winter	4.069	0.0	186.5	1644
2880 min Winter	3.200	0.0	195.3	2108

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Cascade Summary of Results for CS5.SRCX

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
4320 min Winter	30.959	0.859	0.0	0.8	0.8	94.3	O K
5760 min Winter	30.871	0.771	0.0	0.7	0.7	84.6	O K
7200 min Winter	30.787	0.687	0.0	0.7	0.7	75.4	O K
8640 min Winter	30.709	0.609	0.0	0.7	0.7	66.9	O K
10080 min Winter	30.635	0.535	0.0	0.6	0.6	58.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
4320 min Winter	2.357	0.0	202.0	3024
5760 min Winter	1.897	0.0	232.4	3920
7200 min Winter	1.603	0.0	245.5	4760
8640 min Winter	1.397	0.0	256.7	5616
10080 min Winter	1.244	0.0	266.5	6456

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Cascade Rainfall Details for CS5.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 469450 106750 SU 69450 06750
C (1km)	-0.029
D1 (1km)	0.456
D2 (1km)	0.298
D3 (1km)	0.379
E (1km)	0.310
F (1km)	2.242
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) 0.152

Time (mins) From:	To:	Area (ha)
0	4	0.152

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Cascade Model Details for CS5.SRCX

Storage is Online Cover Level (m) 32.500

Cellular Storage Structure

Invert Level (m) 30.100 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	115.5	115.5	1.201	0.0	167.1
1.200	115.5	167.1			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0042-9000-1200-9000
Design Head (m)	1.200
Design Flow (l/s)	0.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	42
Invert Level (m)	30.100
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	0.9	Kick-Flo®	0.377	0.5
Flush-Flo™	0.186	0.6	Mean Flow over Head Range	-	0.7

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	0.6	1.200	0.9	3.000	1.4	7.000	2.0
0.200	0.6	1.400	1.0	3.500	1.5	7.500	2.1
0.300	0.6	1.600	1.0	4.000	1.5	8.000	2.1
0.400	0.6	1.800	1.1	4.500	1.6	8.500	2.2
0.500	0.6	2.000	1.1	5.000	1.7	9.000	2.2
0.600	0.7	2.200	1.2	5.500	1.8	9.500	2.3
0.800	0.7	2.400	1.2	6.000	1.9		
1.000	0.8	2.600	1.3	6.500	1.9		

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Cascade Summary of Results for CS6.SRCX

Upstream Structures	Outflow To	Overflow To
Basin 2.SRCX	CS8.SRCX	(None)

Half Drain Time : 277 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	28.554	0.454	0.0	13.0	13.0	160.5	O K
30 min Summer	28.660	0.560	0.0	13.0	13.0	198.1	O K
60 min Summer	28.784	0.684	0.0	13.0	13.0	241.6	O K
120 min Summer	28.923	0.823	0.0	13.0	13.0	290.8	O K
180 min Summer	28.999	0.899	0.0	13.0	13.0	317.6	O K
240 min Summer	29.046	0.946	0.0	13.0	13.0	334.2	O K
360 min Summer	29.096	0.996	0.0	13.0	13.0	351.8	O K
480 min Summer	29.118	1.018	0.0	13.0	13.0	359.9	O K
600 min Summer	29.132	1.032	0.0	13.0	13.0	364.8	O K
720 min Summer	29.140	1.040	0.0	13.0	13.0	367.5	O K
960 min Summer	29.087	0.987	0.0	13.0	13.0	348.7	O K
1440 min Summer	28.984	0.884	0.0	13.0	13.0	312.5	O K
2160 min Summer	28.804	0.704	0.0	13.0	13.0	248.8	O K
2880 min Summer	28.660	0.560	0.0	13.0	13.0	197.7	O K
4320 min Summer	28.497	0.397	0.0	13.0	13.0	140.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.274	0.0	522.2	19
30 min Summer	87.712	0.0	631.9	33
60 min Summer	54.845	0.0	857.9	62
120 min Summer	34.294	0.0	1067.0	122
180 min Summer	26.058	0.0	1199.1	182
240 min Summer	21.444	0.0	1272.0	242
360 min Summer	16.294	0.0	1321.5	360
480 min Summer	13.409	0.0	1351.4	418
600 min Summer	11.528	0.0	1377.6	482
720 min Summer	10.188	0.0	1402.8	550
960 min Summer	8.012	0.0	1418.8	684
1440 min Summer	5.710	0.0	1442.3	966
2160 min Summer	4.069	0.0	2297.0	1344
2880 min Summer	3.200	0.0	2358.6	1700
4320 min Summer	2.357	0.0	2304.8	2376

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Cascade Summary of Results for CS6.SRCX

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
5760 min Summer	28.399	0.299	0.0	12.9	12.9	105.7	O K
7200 min Summer	28.338	0.238	0.0	12.6	12.6	84.2	O K
8640 min Summer	28.300	0.200	0.0	12.2	12.2	70.6	O K
10080 min Summer	28.278	0.178	0.0	12.0	12.0	62.9	O K
15 min Winter	28.610	0.510	0.0	13.0	13.0	180.2	O K
30 min Winter	28.730	0.630	0.0	13.0	13.0	222.6	O K
60 min Winter	28.871	0.771	0.0	13.0	13.0	272.6	O K
120 min Winter	29.027	0.927	0.0	13.0	13.0	327.5	O K
180 min Winter	29.115	1.015	0.0	13.0	13.0	358.8	O K
240 min Winter	29.172	1.072	0.0	13.0	13.0	379.0	O K
360 min Winter	29.238	1.138	0.0	13.0	13.0	402.1	O K
480 min Winter	29.267	1.167	0.0	13.0	13.0	412.5	O K
600 min Winter	29.278	1.178	0.0	13.0	13.0	416.2	O K
720 min Winter	29.285	1.185	0.0	13.0	13.0	418.8	O K
960 min Winter	29.218	1.118	0.0	13.0	13.0	395.2	O K
1440 min Winter	29.081	0.981	0.0	13.0	13.0	346.5	O K
2160 min Winter	28.823	0.723	0.0	13.0	13.0	255.4	O K
2880 min Winter	28.595	0.495	0.0	13.0	13.0	175.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Summer	1.897	0.0	2893.4	3064
7200 min Summer	1.603	0.0	3055.6	3752
8640 min Summer	1.397	0.0	3194.1	4416
10080 min Summer	1.244	0.0	3314.0	5144
15 min Winter	140.274	0.0	578.8	18
30 min Winter	87.712	0.0	676.9	33
60 min Winter	54.845	0.0	959.4	62
120 min Winter	34.294	0.0	1182.5	120
180 min Winter	26.058	0.0	1285.1	178
240 min Winter	21.444	0.0	1321.0	236
360 min Winter	16.294	0.0	1366.5	346
480 min Winter	13.409	0.0	1405.7	454
600 min Winter	11.528	0.0	1443.6	548
720 min Winter	10.188	0.0	1482.1	572
960 min Winter	8.012	0.0	1513.2	730
1440 min Winter	5.710	0.0	1555.6	1042
2160 min Winter	4.069	0.0	2493.7	1472
2880 min Winter	3.200	0.0	2485.5	1788

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Cascade Summary of Results for CS6.SRCX

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
4320 min Winter	28.384	0.284	0.0	12.9	12.9	100.4	O K
5760 min Winter	28.300	0.200	0.0	12.2	12.2	70.6	O K
7200 min Winter	28.270	0.170	0.0	11.6	11.6	60.1	O K
8640 min Winter	28.260	0.160	0.0	10.9	10.9	56.5	O K
10080 min Winter	28.253	0.153	0.0	10.4	10.4	53.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
4320 min Winter	2.357	0.0	2448.8	2336
5760 min Winter	1.897	0.0	3240.5	3000
7200 min Winter	1.603	0.0	3421.7	3624
8640 min Winter	1.397	0.0	3576.2	4376
10080 min Winter	1.244	0.0	3711.3	5064

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Cascade Rainfall Details for CS6.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 469450 106750 SU 69450 06750
C (1km)	-0.029
D1 (1km)	0.456
D2 (1km)	0.298
D3 (1km)	0.379
E (1km)	0.310
F (1km)	2.242
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) 0.628

Time (mins) From:	To:	Area (ha)
0	4	0.628

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Cascade Model Details for CS6.SRCX

Storage is Online Cover Level (m) 30.500

Cellular Storage Structure

Invert Level (m) 28.100 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	372.0	372.0	1.201	0.0	464.6
1.200	372.0	464.6			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0161-1300-1200-1300
Design Head (m)	1.200
Design Flow (l/s)	13.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	161
Invert Level (m)	28.100
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	13.0	Kick-Flo®	0.796	10.7
Flush-Flo™	0.362	13.0	Mean Flow over Head Range	-	11.2

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	5.8	1.200	13.0	3.000	20.1	7.000	30.2
0.200	12.2	1.400	14.0	3.500	21.6	7.500	31.2
0.300	12.9	1.600	14.9	4.000	23.1	8.000	32.2
0.400	13.0	1.800	15.8	4.500	24.4	8.500	33.2
0.500	12.8	2.000	16.6	5.000	25.7	9.000	34.1
0.600	12.5	2.200	17.3	5.500	26.9	9.500	35.0
0.800	10.7	2.400	18.1	6.000	28.0		
1.000	11.9	2.600	18.8	6.500	29.1		

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Cascade Summary of Results for CS7.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	CS8.SRCX	(None)

Half Drain Time : 1342 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	29.968	0.368	0.0	2.0	2.0	96.1	O K
30 min Summer	30.056	0.456	0.0	2.0	2.0	119.3	O K
60 min Summer	30.164	0.564	0.0	2.0	2.0	147.3	O K
120 min Summer	30.291	0.691	0.0	2.0	2.0	180.4	O K
180 min Summer	30.371	0.771	0.0	2.0	2.0	201.5	O K
240 min Summer	30.430	0.830	0.0	2.0	2.0	216.8	O K
360 min Summer	30.511	0.911	0.0	2.0	2.0	238.1	O K
480 min Summer	30.565	0.965	0.0	2.0	2.0	252.2	O K
600 min Summer	30.603	1.003	0.0	2.0	2.0	262.0	O K
720 min Summer	30.629	1.029	0.0	2.1	2.1	268.9	O K
960 min Summer	30.604	1.004	0.0	2.0	2.0	262.2	O K
1440 min Summer	30.549	0.949	0.0	2.0	2.0	248.0	O K
2160 min Summer	30.479	0.879	0.0	2.0	2.0	229.7	O K
2880 min Summer	30.418	0.818	0.0	2.0	2.0	213.7	O K
4320 min Summer	30.345	0.745	0.0	2.0	2.0	194.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.274	0.0	94.4	19
30 min Summer	87.712	0.0	117.7	34
60 min Summer	54.845	0.0	151.2	64
120 min Summer	34.294	0.0	189.0	124
180 min Summer	26.058	0.0	215.2	182
240 min Summer	21.444	0.0	235.8	242
360 min Summer	16.294	0.0	267.7	362
480 min Summer	13.409	0.0	291.3	482
600 min Summer	11.528	0.0	307.0	602
720 min Summer	10.188	0.0	312.2	720
960 min Summer	8.012	0.0	308.5	952
1440 min Summer	5.710	0.0	295.8	1168
2160 min Summer	4.069	0.0	406.3	1552
2880 min Summer	3.200	0.0	425.7	1960
4320 min Summer	2.357	0.0	468.2	2808

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Cascade Summary of Results for CS7.SRCX

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
5760 min Summer	30.271	0.671	0.0	2.0	2.0	175.4	O K
7200 min Summer	30.186	0.586	0.0	2.0	2.0	153.0	O K
8640 min Summer	30.099	0.499	0.0	2.0	2.0	130.4	O K
10080 min Summer	30.028	0.428	0.0	2.0	2.0	111.9	O K
15 min Winter	30.012	0.412	0.0	2.0	2.0	107.8	O K
30 min Winter	30.112	0.512	0.0	2.0	2.0	133.9	O K
60 min Winter	30.234	0.634	0.0	2.0	2.0	165.6	O K
120 min Winter	30.377	0.777	0.0	2.0	2.0	203.0	O K
180 min Winter	30.469	0.869	0.0	2.0	2.0	227.1	O K
240 min Winter	30.537	0.937	0.0	2.0	2.0	244.8	O K
360 min Winter	30.633	1.033	0.0	2.1	2.1	269.9	O K
480 min Winter	30.698	1.098	0.0	2.1	2.1	287.0	O K
600 min Winter	30.745	1.145	0.0	2.2	2.2	299.3	O K
720 min Winter	30.780	1.180	0.0	2.2	2.2	308.3	O K
960 min Winter	30.761	1.161	0.0	2.2	2.2	303.3	O K
1440 min Winter	30.698	1.098	0.0	2.1	2.1	286.8	O K
2160 min Winter	30.611	1.011	0.0	2.0	2.0	264.2	O K
2880 min Winter	30.529	0.929	0.0	2.0	2.0	242.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Summer	1.897	0.0	506.3	3632
7200 min Summer	1.603	0.0	534.7	4464
8640 min Summer	1.397	0.0	559.0	5104
10080 min Summer	1.244	0.0	579.9	5848
15 min Winter	140.274	0.0	105.7	19
30 min Winter	87.712	0.0	131.2	33
60 min Winter	54.845	0.0	169.3	62
120 min Winter	34.294	0.0	211.5	122
180 min Winter	26.058	0.0	240.7	180
240 min Winter	21.444	0.0	263.4	240
360 min Winter	16.294	0.0	297.1	356
480 min Winter	13.409	0.0	315.6	472
600 min Winter	11.528	0.0	319.2	586
720 min Winter	10.188	0.0	319.5	700
960 min Winter	8.012	0.0	315.0	922
1440 min Winter	5.710	0.0	304.3	1324
2160 min Winter	4.069	0.0	455.0	1644
2880 min Winter	3.200	0.0	476.6	2108

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Cascade Summary of Results for CS7.SRCX

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
4320 min Winter	30.417	0.817	0.0	2.0	2.0	213.5	O K
5760 min Winter	30.302	0.702	0.0	2.0	2.0	183.4	O K
7200 min Winter	30.161	0.561	0.0	2.0	2.0	146.6	O K
8640 min Winter	30.033	0.433	0.0	2.0	2.0	113.0	O K
10080 min Winter	29.936	0.336	0.0	2.0	2.0	87.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
4320 min Winter	2.357	0.0	521.2	3028
5760 min Winter	1.897	0.0	567.0	3928
7200 min Winter	1.603	0.0	598.9	4752
8640 min Winter	1.397	0.0	626.2	5368
10080 min Winter	1.244	0.0	649.8	6048

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Cascade Rainfall Details for CS7.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 469450 106750 SU 69450 06750
C (1km)	-0.029
D1 (1km)	0.456
D2 (1km)	0.298
D3 (1km)	0.379
E (1km)	0.310
F (1km)	2.242
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) 0.371

Time (mins) From:	To:	Area (ha)
0	4	0.371

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Cascade Model Details for CS7.SRCX

Storage is Online Cover Level (m) 32.000

Cellular Storage Structure

Invert Level (m) 29.600 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	275.0	275.0	1.201	0.0	354.6
1.200	275.0	354.6			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0068-2200-1200-2200
Design Head (m)	1.200
Design Flow (l/s)	2.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	68
Invert Level (m)	29.600
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	2.2	Kick-Flo®	0.602	1.6
Flush-Flo™	0.297	2.0	Mean Flow over Head Range	-	1.8

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	1.7	1.200	2.2	3.000	3.4	7.000	5.0
0.200	1.9	1.400	2.4	3.500	3.6	7.500	5.1
0.300	2.0	1.600	2.5	4.000	3.8	8.000	5.3
0.400	2.0	1.800	2.6	4.500	4.0	8.500	5.5
0.500	1.9	2.000	2.8	5.000	4.3	9.000	5.6
0.600	1.6	2.200	2.9	5.500	4.4	9.500	5.8
0.800	1.8	2.400	3.0	6.000	4.6		
1.000	2.0	2.600	3.1	6.500	4.8		

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Cascade Summary of Results for CS8.SRCX

Upstream Structures	Outflow To	Overflow To
Basin 3.SRCX CS2.SRCX CS3.SRCX Basin 1.SRCX CS1a.SRCX CS1b.SRCX CS4.SRCX CS5.SRCX CS6.SRCX Basin 2.SRCX CS7.SRCX	(None)	(None)

Half Drain Time : 399 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	27.787	0.487	0.0	67.9	67.9	990.6	O K
30 min Summer	27.904	0.604	0.0	68.1	68.1	1229.9	O K
60 min Summer	28.046	0.746	0.0	68.1	68.1	1518.9	O K
120 min Summer	28.213	0.913	0.0	68.1	68.1	1858.6	O K
180 min Summer	28.323	1.023	0.0	68.1	68.1	2081.4	O K
240 min Summer	28.406	1.106	0.0	68.1	68.1	2249.9	O K
360 min Summer	28.530	1.230	0.0	68.1	68.1	2503.2	O K
480 min Summer	28.607	1.307	0.0	68.1	68.1	2660.4	O K
600 min Summer	28.658	1.358	0.0	68.1	68.1	2763.0	O K
720 min Summer	28.691	1.391	0.0	68.1	68.1	2829.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.274	0.0	2638.6	19
30 min Summer	87.712	0.0	3259.2	34
60 min Summer	54.845	0.0	4354.6	64
120 min Summer	34.294	0.0	5428.2	122
180 min Summer	26.058	0.0	6142.7	182
240 min Summer	21.444	0.0	6671.6	242
360 min Summer	16.294	0.0	7453.6	362
480 min Summer	13.409	0.0	8029.3	482
600 min Summer	11.528	0.0	8434.6	600
720 min Summer	10.188	0.0	8714.3	720

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Cascade Summary of Results for CS8.SRCX

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
960 min Summer	28.654	1.354	0.0	68.1	68.1	2754.6	O K
1440 min Summer	28.578	1.278	0.0	68.1	68.1	2600.1	O K
2160 min Summer	28.469	1.169	0.0	68.1	68.1	2378.7	O K
2880 min Summer	28.335	1.035	0.0	68.1	68.1	2106.3	O K
4320 min Summer	28.186	0.886	0.0	68.1	68.1	1802.0	O K
5760 min Summer	28.058	0.758	0.0	68.1	68.1	1541.6	O K
7200 min Summer	27.943	0.643	0.0	68.1	68.1	1308.7	O K
8640 min Summer	27.848	0.548	0.0	68.1	68.1	1115.9	O K
10080 min Summer	27.772	0.472	0.0	67.8	67.8	960.8	O K
15 min Winter	27.845	0.545	0.0	68.1	68.1	1109.8	O K
30 min Winter	27.978	0.678	0.0	68.1	68.1	1379.1	O K
60 min Winter	28.137	0.837	0.0	68.1	68.1	1703.5	O K
120 min Winter	28.327	1.027	0.0	68.1	68.1	2090.2	O K
180 min Winter	28.455	1.155	0.0	68.1	68.1	2351.2	O K
240 min Winter	28.552	1.252	0.0	68.1	68.1	2547.5	O K
360 min Winter	28.684	1.384	0.0	68.1	68.1	2817.2	O K
480 min Winter	28.772	1.472	0.0	68.1	68.1	2996.3	O K
600 min Winter	28.834	1.534	0.0	68.1	68.1	3120.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
960 min Summer	8.012	0.0	8895.2	860
1440 min Summer	5.710	0.0	9061.0	1108
2160 min Summer	4.069	0.0	11738.2	1536
2880 min Summer	3.200	0.0	12215.2	1872
4320 min Summer	2.357	0.0	13130.8	2632
5760 min Summer	1.897	0.0	14751.7	3352
7200 min Summer	1.603	0.0	15577.2	4072
8640 min Summer	1.397	0.0	16279.5	4752
10080 min Summer	1.244	0.0	16876.1	5448
15 min Winter	140.274	0.0	2943.7	19
30 min Winter	87.712	0.0	3602.0	33
60 min Winter	54.845	0.0	4873.3	62
120 min Winter	34.294	0.0	6046.2	122
180 min Winter	26.058	0.0	6795.6	180
240 min Winter	21.444	0.0	7354.8	238
360 min Winter	16.294	0.0	8177.7	356
480 min Winter	13.409	0.0	8690.7	470
600 min Winter	11.528	0.0	9056.0	584

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Cascade Summary of Results for CS8.SRCX

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
720 min Winter	28.877	1.577	0.0	68.1	68.1	3208.4	O K
960 min Winter	28.844	1.544	0.0	68.1	68.1	3141.5	O K
1440 min Winter	28.748	1.448	0.0	68.1	68.1	2946.1	O K
2160 min Winter	28.616	1.316	0.0	68.1	68.1	2678.5	O K
2880 min Winter	28.467	1.167	0.0	68.1	68.1	2374.2	O K
4320 min Winter	28.170	0.870	0.0	68.1	68.1	1770.2	O K
5760 min Winter	27.957	0.657	0.0	68.1	68.1	1336.3	O K
7200 min Winter	27.802	0.502	0.0	68.0	68.0	1020.6	O K
8640 min Winter	27.697	0.397	0.0	66.7	66.7	807.2	O K
10080 min Winter	27.632	0.332	0.0	65.1	65.1	675.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
720 min Winter	10.188	0.0	9357.7	696
960 min Winter	8.012	0.0	9549.1	912
1440 min Winter	5.710	0.0	9738.2	1154
2160 min Winter	4.069	0.0	13030.4	1624
2880 min Winter	3.200	0.0	13523.9	2136
4320 min Winter	2.357	0.0	14485.1	2808
5760 min Winter	1.897	0.0	16522.0	3456
7200 min Winter	1.603	0.0	17445.2	4112
8640 min Winter	1.397	0.0	18231.4	4760
10080 min Winter	1.244	0.0	18909.8	5344

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Cascade Rainfall Details for CS8.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 469450 106750 SU 69450 06750
C (1km)	-0.029
D1 (1km)	0.456
D2 (1km)	0.298
D3 (1km)	0.379
E (1km)	0.310
F (1km)	2.242
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) 3.811

Time (mins) From:	To:	Area (ha)
0	4	3.811

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Cascade Model Details for CS8.SRCX

Storage is Online Cover Level (m) 29.500

Cellular Storage Structure

Invert Level (m) 27.300 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	2142.0	2142.0	1.601	0.0	2438.3
1.600	2142.0	2438.2			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0329-6810-1600-6810
Design Head (m)	1.600
Design Flow (l/s)	68.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	329
Invert Level (m)	27.300
Minimum Outlet Pipe Diameter (mm)	375
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.600	68.1	Kick-Flo®	1.154	58.2
Flush-Flo™	0.557	68.1	Mean Flow over Head Range	-	57.2

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	9.7	1.200	59.3	3.000	92.4	7.000	139.6
0.200	33.5	1.400	63.8	3.500	99.5	7.500	144.4
0.300	59.7	1.600	68.1	4.000	106.2	8.000	149.0
0.400	66.8	1.800	72.1	4.500	112.5	8.500	153.5
0.500	68.0	2.000	75.9	5.000	118.4	9.000	157.8
0.600	68.0	2.200	79.4	5.500	124.1	9.500	162.1
0.800	66.6	2.400	82.9	6.000	129.5		
1.000	63.7	2.600	86.2	6.500	134.6		

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