Defence Infrastructure Organisation

Future Defence Storage and Redistribution Programme,

Redevelopment of MOD Bicester

Graven Hill: Drainage Strategy

BIC/OPA/DOC/15

September 2011

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Graven Hill: Drainage Strategy
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September 2011

AMEC Environment & Infrastructure
UK Limited

Report for

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1. Introduction

1.1 Purpose and Aim

1.1.1 AMEC Environment and Infrastructure UK Ltd (AMEC E&I)[1] has been commissioned by Defence Infrastructure Organisation (DIO)[2] to undertake a Drainage Strategy for a proposed mixed use development at Bicester Garrison, Oxfordshire. The area of study covers two distinct sites; C Site and Graven Hill Site. This report is for the Graven Hill Site only.

1.1.2 The strategy is based on an assessment that determines whether or not the existing infrastructure serving the existing site is adequate to accommodate the proposed development needs, or if any modifications/reinforcement works are required. This has been accomplished by initially identifying the existing surface water and foul water infrastructure across the site, which in turn has allowed an understanding of the existing constraints that this infrastructure imposes on the proposed development. A high level solution to serve the proposed development has then been identified.

1.2 Available Data

1.2.1 Drainage information has been obtained from a number of sources. The key sources are:

- a Utility Search;
- the data contained in the Establishment Development Plan for MOD Bicester, dated 15 August 2008;
- available data obtained from the Site Estate Team at MOD Bicester;
- available data from Kelda Water (Aquatrine Service Provider); and
- available data from Thames Water (Drainage Authority)

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[1] Following its acquisition by AMEC, Entec UK Ltd was integrated into AMEC Environment and Infrastructure in July 2011, all references are now to AMEC E&I.

[2] The Defence Infrastructure Organisation was formed on 1 April 2011 when the former Defence Estates was brought together with other property and infrastructure functions in the MOD to form a single organisation.

1.3 Format of the Assessment

1.3.1 The following sections of this assessment are structured to comply with the initial aims and objectives and are set out as follows.

Table 1.1 Format of the Assessment

Chapter in this Study	Description
Chapter 2: Background of the site	This Chapter provides general background information on the existing and proposed development.
Chapter 3:Understanding the existing Drainage Infrastructure	This Chapter describes the existing drainage infrastructure across the site and details the current demands and performance.
Chapter 4: Accommodating the Proposed Development	This Chapter identifies what changes are needed to the existing drainage regime to accommodate the proposed development.

2. Background

2.1 Context

2.1.1 The Ministry of Defence (MOD) currently occupies some 600ha of space around Graven Hill and Arncott Hill in Bicester. The opportunity provided by the Bicester Garrison Estate became the focus of the Treasury (HMT) Operational Efficiency Programme (OEP) in late 2008, which charged MOD with looking at its storage and distribution function, run by Defence Logistics Commodities & Services (LCS), (formerly the Defence Storage and Distribution Agency,) along with the estate it occupies, to determine whether there are any opportunities to release funds back to HMT. The OEP has explored a range of options for the future of LCS and the associated estate implications, including the strategic location and opportunities provided at Bicester as a core site.

2.1.2 Two sites within the Bicester Estate, known as C Site and Graven Hill, have been identified as being viable for redevelopment for storage intensification, mixed use development, employment and civilian housing. The Graven Hill site has been identified for disposal but C Site will still remain under MOD control/ownership and be solely used as part of the LCS operations.

2.1.3 The Graven Hill site is the closest to Bicester and has been identified as being the most sustainable for disposal in terms of future redevelopment for commercial and residential development. .

2.2 The MOD Bicester Sites

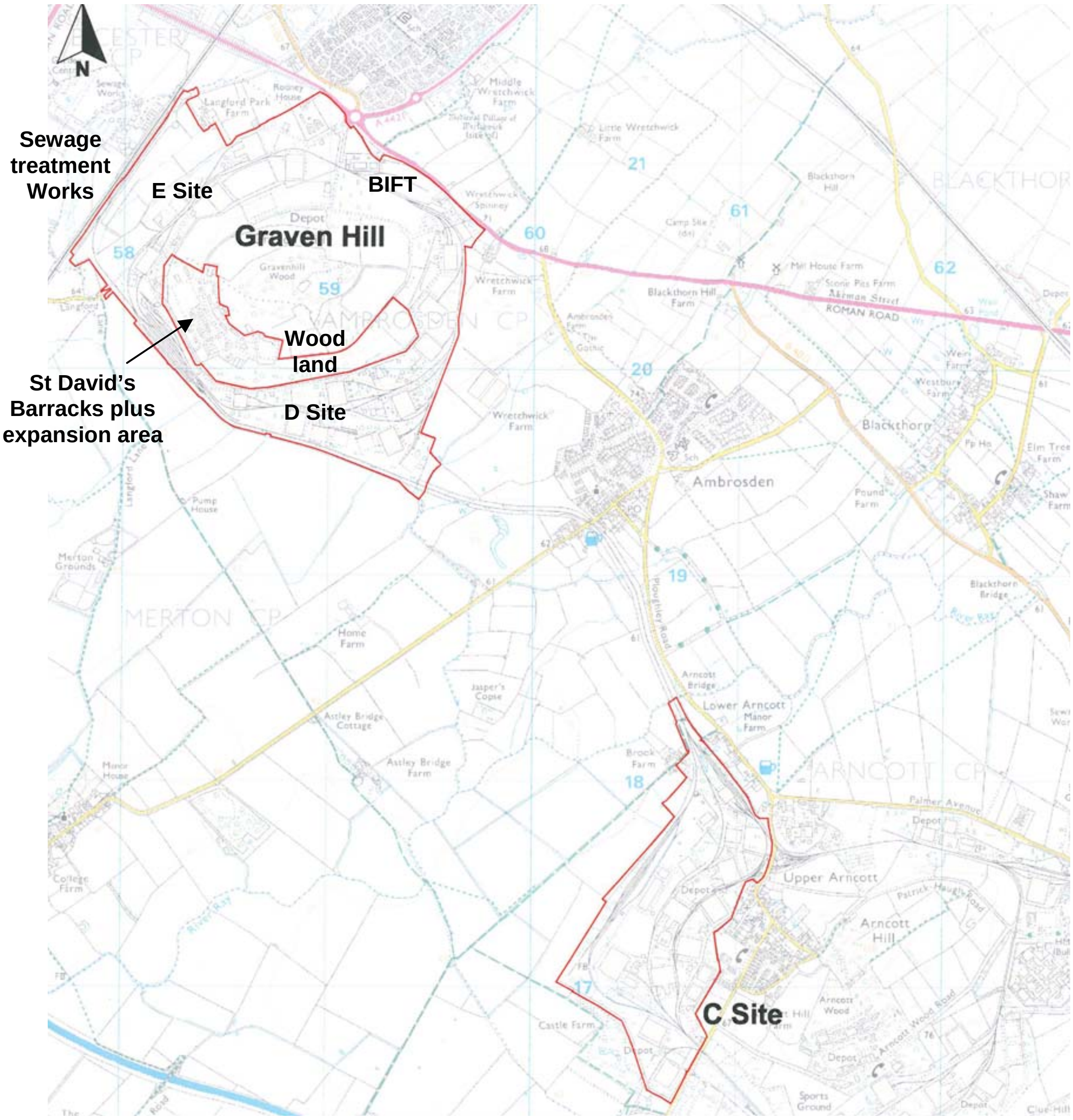
2.2.1 The two sites under consideration as part of this development study consist of two distinct and separate areas of the larger MOD Bicester area. Details are given as follows.

Table 2.1 MOD Bicester Sites

Site Name	Details
C Site	C Site is located to the west of Arncott Hill. C Site is rectangular, orientated in a northeast to southwest direction. C Site covers a total area of approximately 83ha but only 35ha of this (i.e. the northern section) is affected by the new development. The site slopes downwards from the east side to the west and lies at an elevation of between 65m and 75m AOD.
Graven Hill Site (consisting of D Site, E Site, Woodland area and St David's Barracks	D Site, together with E Site, forms a continuous 'ring' of land surrounding St David's Barracks on Graven Hill. D Site covers a total area of approximately 59ha on the north-west side of the ring. E Site covers a total area of approximately 79ha on the south- east side of the 'ring' and lies at an elevation of between 65m and 75m AOD.

Site Name	Details
	The woodland covers an area in the order of 26ha and lies at an elevation of between 85m and 113m. St David’s Barracks incorporates single living accommodation and associated facilities, stores and administrative buildings as well as a secured area for future expansion. The total area is approximately 30ha and also incorporates a wooded area. St David’s Barracks is outside of the planning application boundary. The Bicester International Freight Terminal (BIFT) provides hardstanding storage for shipping containers, served by rail and heavy goods vehicles.

Figure 2.1 Location Plan



2.3 Existing Development on Graven Hill Site

2.3.1 The Graven Hill site contains twelve large storage warehouses, most with road and rail access, intermittently spaced around E Site (broadly in the north-west) and D Site (which broadly corresponds to the south-east). The central, upper part of the Site consists of agricultural land and woodland.

2.3.2 Vehicular access to the site is in the north-east corner off the Aylesbury Road/ Wretchwick Way (A41/A4421) roundabout. There is a circulatory route surrounding D site and E Site known as Circular Road.

2.4 Proposed Development on Graven Hill Site

2.4.1 The proposed development at Graven Hill will comprise a mix of commercial and residential development plus associated community facilities. Public open space is also to be provided in line with Cherwell District Council (CDC) requirements, including existing woodland areas that will form part of an integrated landscape and open space network.

2.4.2 A breakdown of the proposed development is summarised in the following table.

Table 2.2 Proposed Development Build Area

Development Type	No of or Size
B8 Storage	18.6ha
B2 employment (40% of area is floor space)	5.7ha
Office	0.6ha
Housing	1,900 homes
Primary school	3.4ha
Hotel/pub/restaurant	1.5ha
Community facility	0.4ha
Retail	1.4ha
Location for potential use as an Energy Centre	0.9ha

2.4.3 Although the main site access will be taken from the A41 via an improved roundabout, the main existing internal road layout will be retained as far as possible but will be upgraded to suit the proposed development layout.

2.4.4 Figure 2.2 shows the proposed development.

Figure 2.2 Proposed Development Layout

3. Understanding the Existing Drainage Infrastructure

3.1 Surface Water - General

3.1.1 The existing surface water system on the Graven Hill site consists of a series of pipe work systems connecting the various buildings to a series of ditch systems located near or around the buildings. There are other open ditches located around the site which are either located next to road verges and at the ends of open green fields (presumably acting as a cut off trench to prevent surface water discharging further a field). There are also a number of small ponds located across the site but the function and performance of these are not currently known. However, they are not integral to the proposed drainage strategy.

3.1.2 Although discussions with the Estates Management Team at Graven Hill confirmed that these ditches were originally constructed when the site was built and were designed to catch run-off from the surrounding roads and hardstanding areas, many of these ditch systems are understood not to be lined and in some cases do not have any identifiable outfalls. Instead, surface water which collects in these ditch systems naturally infiltrates through the subsoil to some extent or evaporates.

3.1.3 Discussions held with Kelda confirmed that the existing ditch systems on site do not work very well, resulting in localised flooding around some buildings during intense storm events. As many of these ditches are not linked as part of the overall system and therefore do not convey the flows, this is causing the water to fill the ditch and overflow into the nearby area during repeat and severe storm events.

3.1.4 From discussions with Kelda and the Estates Management Team, it is known that areas prone to flooding include Building E1 and Building E2. Kelda believes this may be due to the land drain from Graven Hill, as the diameter of the pipe is large and the outfall ditch it enters does not have the required capacity to accommodate the flows. In addition, the train tracks on site act as a control structure, which restricts the natural flow of water causing it to back up in the system resulting in flooding.

3.1.5 Thames Water records confirm that public surface water sewer systems are not present within or in the vicinity of the site boundary. Therefore, it is considered that all surface water flows from the site enter above ground watercourses and do not enter any public sewer system.

3.1.6 From studying the land contours and holding discussions with Kelda, it has been confirmed that there are six key outfall locations across the site. A site visit undertaken in March 2011 confirmed the location, the pipe diameter/ditch cross section and receiving watercourse for each. These details are summarised in Table 3.1.

Table 3.1 Surface Water Outfall Locations

Outfall Reference	Pipe Diameter or Ditch Cross Sectional Area	Receiving Watercourse	General Condition (Poor/Average/ Good)	Comments and Observations
SW 1	Ditch: $2m^2$	Langford Brook	Good	Discharge consent CATM.2739 was revoked in August 2006. 3No. 150mm diameter pipes located near to outfall, acting as a flow restriction.
SW 2	Ditch: $1.8m^2$	Langford Brook	Poor	Overgrown vegetation considered to be unintentionally restricting the outflow. The water level observed during the site visit was at the top of ditch.
SW 3	Pipe: Unknown	River Ray	Unknown	Discharge consent CATM.2741 has no end date and is valid indefinitely. Could not access site during visit to assess outfall location.
SW 4	Ditch: $1.65m^2$	River Ray	Average	Heavy reeds considered to be unintentionally restricting the outflow.
SW 5	Ditch: $2.19m^2$	River Ray	Poor	Overgrown vegetation considered to be unintentionally restricting the outflow.
SW 6	Unknown (Not surveyed)	Langford Brook	Unknown	Ditch location is assumed to be associated with St David's Barracks.

Notes

1.) Data collected from site visit undertaken in March 2011.

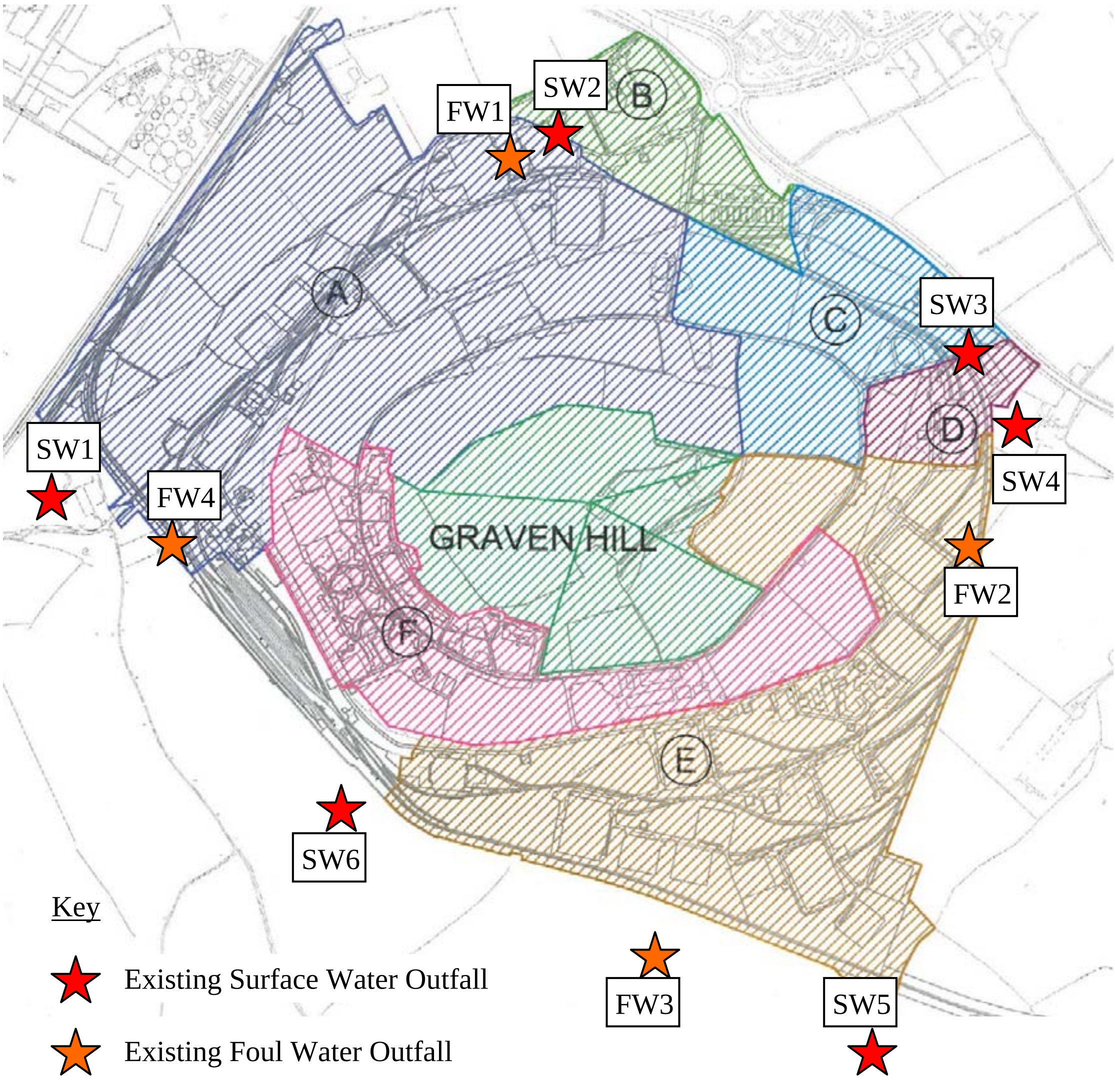
2.) Outfall references can be found on drawing 27808-CVD-172, found in Appendix B.

3.) Ditch cross sectional area based on approximate width at base, width at top of embankment and approximate depth measured from topographical survey.

3.1.7 The catchment flows have been calculated using a combination of methods dependant on the total catchment area. Where the catchment area is over 50ha the IoH 124 Mean Annual Flood method has been used and where the total catchment area is below 50ha the Interim Code of Practice (ICP) of SUDS Mean Annual Flood method has been used.

3.1.8 In order to understand this run-off rate in more detail, existing surface water run-off flows have been calculated by initially establishing the existing surface water catchment areas across the whole of Graven Hill. Areas have been measured from topographical survey information and inputted into the surface water run-off calculation. The catchments used (A to F) are illustrated in Figure 3.1, over page. Although the flows generated from the central area are considered to be minimal they have been included in the associated catchment as a hydrograph.

Figure 3.1 Graven Hill: Catchments



3.1.9 The key parameters for both methods are summarised in the Table 3.2, along with the input data and flow results for each catchment area.

Table 3.2 Greenfield Run-off Rates

Parameter	Catchment Reference					
	A	B	C	D	E#	F*
Total site area	70.66ha	11.7ha	19.7ha	5.53ha	60.77ha	23.6ha
Impermeable area	24.4ha (35%)	1.7ha (14%)	4.5ha (23%)	1.54ha (28%)	13.0 (21%)	13.0ha (55%)
SAAR (mm)	622	622	622	622	622	622
Soil Index (from Wallingford WRAP Map)	0.45	0.45	0.45	0.45	0.45	0.45
FSR Region	6	6	6	6	6	6
	Flow Results					
QBAR	453 l/s (6 l/s/ha)	57 l/s (5 l/s/ha)	110 l/s 6 l/s/ha)	33 l/s (6 l/s/ha)	323 l/s (5 l/s/ha)	204 l/s (9 l/s/ha)
1:1yr Flow	385 l/s	48 l/s	94 l/s	28 l/s	274 l/s	174 l/s
1:30yr Flow	897 l/s	122 l/s	228 l/s	67 l/s	672 l/s	379 l/s
1:100yr Flow	1127 l/s	163 l/s	294 l/s	86 l/s	874 l/s	456 l/s

Notes

1.) # Catchment E includes for a large area of St David's Barracks entering D Site drainage system.

2.) * Catchment F covers the SLAM development area and as such the flows leaving this catchment are considered to be controlled at a greenfield run-off rate equal to the site average of approximately green field run-off rate. This flow is considered to discharge through a dedicated outfall and as such does not enter the Site D/E drainage system.

3.1.10 Although the average QBAR run-off rate is in the order of 6 l/s/ha, it is recommended that a rate of 5 l/s/ha is used for controlling all run-off from the proposed development, in line with Oxfordshire County Council (OCC) requirements.

3.1.11 The stipulated flow rates per ha shown above will be used as a bench mark for the proposed strategy.

3.2 Foul Water - General

3.2.1 The on-site foul drainage is also operated and maintained by Kelda. All MOD assets are leased to Kelda for a 25 year PFI with approximately 16 years remaining.

3.2.2 Kelda have made historic records of pipe work on site that were passed to Kelda by the MOD at the start of their contract, which Kelda then upgrades as maintenance is carried out.

3.2.3 The public sewer network in the area is maintained and operated by Thames Water. Plans have been provided and some initial discussions have been held.

3.2.4 There is no sewage treatment on site and all foul water drainage ultimately connects into the Thames Water system before being treated at Bicester Sewage Treatment Works located northwest of E Site on the other side of the railway.

3.2.5 There appears to be four discharge points directly into the Thames Water system from Graven Hill. FW1 is the main discharge point for the site which is located to the north of E Site. FW2 is located adjacent to Building D9 in the north of the site and discharges by gravity southwards towards a Thames Water Pumping Station (FW3) located by Building D4 at the southern end of the site. The flow from Catchment A discharges into the Thames Water sewer at FW4 which also connects into this pumping station.

3.2.6 Thames Water has confirmed that the pipe entering this pump station is 375mm diameter and the pump is pumping flows at 60 l/s. From here the foul drainage is pumped around the western side of E Site to connect to the Sewage Treatment Works via outfall FW1.

3.2.7 The on-site MOD foul water drainage system is made up of both gravity sewers and pumping mains. Although the records received from Kelda show limited information, it is clear that there is a gravity system accommodating flows from the buildings which then connects into a pumping main before leaving the site and entering the Thames Water Sewage Treatment Works to the north of the site.

3.2.8 The majority of the underground foul drains are believed to have been constructed in 1941-43, in vitrified clay and are now deteriorating due to age. The current capacity is understood to be adequate as there are no major issues reported. If it is intended to re-use the drainage infrastructure for the developments, there would be a need to increase maintenance and a significant programme of expenditure may be needed in the future.

3.2.9 Kelda confirm that there are six grease traps located across the site but the exact location of these could not be identified.

3.2.10 There are a number of pumping stations positioned around the site. A regular maintenance programme is in place to check the pumps one to two times per week as it is appreciated that the foul water system is critical and should not be neglected in any way. Kelda confirm that the larger pumping stations have backup pumps and are ATEX compliant[3].

3.3 Foul Water - Existing Flow Calculations

3.3.1 In order to obtain a high level understanding of the theoretical existing demand, estimated loadings have been calculated based on building area and published data. As these calculations are indicative and preliminary, further detailed analysis is

[3] The ATEX Directive 94/9/EC was adopted by the European Union (EU) to facilitate free trade in the EU and the EEA by aligning the technical and legal requirements in the member states for products intended for use in potentially explosive atmospheres.

needed prior to entering the detailed design stage. The results are shown in Table 3.3, below.

Table 3.3 Estimated Existing Theoretical Flows

Development Type	Foul Water Drainage Flows	
	Average DWF (l/s)	Peak Flow (l/s)
Offices	0.75	4.50
Workshops	0.05	0.30
Storage	4.39	26.34
Emergency Services	0.02	0.12
Amenity Facilities	0.35	2.10
St David's Barracks Accommodation	1.75	10.50
Total	**7.31**	**43.86**

Notes

1. Refer to Appendix A for a breakdown of the loading calculations.
2. Loadings shown are indicative and preliminary only and are based on published data. As such further analysis required.
3. Peak flows have been taken as 6 x Dry Weather Flow (DWF) as this is the design criteria for adoptable drainage systems. However, actual peak flows are expected to be closer to 3 x DWF, which is similar to the existing water supply flows, although some allowance should be made for water storage.

4. Accommodating the Proposed Development Requirements

4.1 Surface Water - General

4.1.1 The surface water run-off generated from the additional impermeable area from the proposed development must be managed in accordance with Planning Policy Statement 25 (PPS 25). The preferred method of managing surface water run-off is by use of incorporating Sustainable Drainage Systems (SUDS) such as swales, ponds and wetlands etc. The Flood and Water Management Act 2010 has recently changed the way in which surface water drainage systems are managed and maintained. The SUDS Approval Body (SAB) will be responsible for the approval and adoption of SUDS which must meet the National Standards for sustainable drainage.

4.1.2 The SUDS solutions that will be introduced will aim to mimic the surface water flows prior to development and in accordance with PPS 25, reduce the flood risk to the site and elsewhere. SUDS are ideal forms of techniques and solutions to drain surface water in a sustainable way and provides particular focus on improving quality, and amenity value and reducing quantity of flows where considered appropriate especially nearer to its source.

4.2 Surface Water - SUDS Assessment

4.2.1 A high level SUDS assessment was carried out to identify the most appropriate form of SUDS solution/techniques to be used on site.

4.2.2 A copy of the SUDS assessment can be found in Appendix C.

4.2.3 The results of the SUDS assessment indicated that a minimum of two management trains should be considered to comply with the requirements of the CIRIA guide C697, "*The SUDS Manual*". As a result, SUDS techniques at source control and site control stages have been recommended with the most beneficial solutions being taken from the source control and retention SUDS groups.

4.2.4 The Building Regulations Part H and the Environment Agency encourages the use of infiltration techniques when dealing with uncontaminated surface water run-off. In this case however, due to the fact that the underlying ground conditions predominantly consist of clays and mudstones it was considered that direct infiltration into the ground is not viable for this site.

4.2.5 To confirm the opportunity for direct infiltration, soakaway testing was undertaken by May Gurney in August 2010 at two key locations identified within the site. Each soakaway trial pit covered an area of approximately 2.6m x 0.6m and was excavated up to 3m deep. All soakaway tests were conducted to standards set out in BRE Digest

365 'Soakaway Design'. The full May Gurney report can be found in Appendix C. Table 4.1, below, summarises the results for the trial pit taken.

Table 4.1 Soakaway Results

Pit Reference	Location	Ground Conditions	Maximum Layer Depth	Infiltration Rate
ST-D	Between building D4 and D7	Stiff sandy clay	From 150mm to 2.9m below ground level	Insufficient infiltration over 182 minutes to calculate infiltration rate
ST-E	North of building E15A	Stiff sandy clay	From 200mm to 3m below ground level	Insufficient infiltration over 270 minutes to calculate infiltration rate

Notes

1.) Pit references and location details are illustrated in May Gurney report found in Appendix C

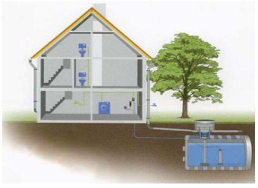
4.2.6 The testing showed that the infiltration rates obtained from the soakaway test indicated that the ground conditions in the upper soil layers may not have suitable properties to accommodate infiltration. Therefore, the use of soakaways to accommodate the surface water run-off is not considered feasible.

4.3 Surface Water - SUDS Solutions

4.3.1 With reference to the SUDS Assessment, the proposed solution must contain at least two treatment trains to control the predicted flows. Table 4.2, below, identifies possible solutions that could be implemented into the final surface water drainage system so that the quality of surface water leaving the site is enhanced and the quantity of surface water leaving the site is manageable by the off site systems.

Table 4.2 Possible SUDS Solutions

Stage	Technique	Possible Location	Example
Source Control	Permeable Paving (option with underground storage) To include high level overflow into pond or swale	Car parks and private driveways	

Stage	Technique	Possible Location	Example
	Rainwater harvesting	Buildings with internal needs for recycled water	
Site Control	Swale	Along highway edge in verge area. In green areas behind housing or car park	
	Filter trench	Along highway edge in verge area. In green areas behind housing or car park	
Wider strategic site control	Wet pond	Downstream of larger development	
	Detention basin	In park areas and school play ground	

4.3.2 To comply with the management train it is essential that source control techniques are included in the drainage system. Measures such as permeable paving are to be incorporated into areas of car parking and driveways so that surface water can infiltrate through the pavement layers and be temporarily stored before discharging to the drainage system. Where buildings can benefit from reusing clean surface water from roofs and uncontaminated hardstanding, it is recommended that rainwater recycling systems are used. This will have the benefit of saving potable water usage and can also reduce the rates and volumes of run-off for the less intense rainfall events.

4.3.3 Many swales have been incorporated into the proposed system as these can be located along the highway verge. In between the carriageway and the swale it is recommended that a filter strip is constructed so that the overland flows directed towards the swale can be pre-treated by removing particulate pollutants. Some of the proposed swales across the site are on the alignment of existing ditches and as such, the ditches should be redesigned.

4.3.4 In order to add amenity and environmental value to the SUDS solutions on site, it is recommended that wet ponds should be incorporated. Suggested locations are in the area where open fields are proposed and where land is available at the outfall.

4.3.5 The final composite SUDS solution including the layout of the strategic ponds is shown on drawing 27808-CVD-172 found in Appendix B.

4.3.6 The pond layout has been set out against topographical survey data and illustrates a possible layout that could be achieved. However, it is worth noting that the arrangement shown is not considered to be the final solution as further iterations and continued dialogue with the Environment Agency will be needed during the detailed design stage to refine the shape and detail of the ponds, as well as to consider the appropriate landscaping issues.

4.3.7 The use of pipe work along the main drainage runs should be replaced wherever possible by the installation of open channels/ditches. Drawing 27808-CVD-172 in Appendix B provides indicative locations.

4.3.8 Although the drainage Strategy sets out to achieve a 20% reduction in flow, it is recognised that the area of wet woodland located in the western corner of sub Catchment A could deteriorate if flows are reduced too much from this area. As such, it is envisaged to maintain a pipe/ditch connection to this area allowing 1 in 1 flows from the upstream attenuation pond to continue into this area.

4.4 Surface Water - Modelling Strategy

4.4.1 In relation to accommodating these SUDS solutions, a high level drainage model has been developed using WinDes® software. The purpose of this model is to determine the requirements of the strategic drainage system to accommodate the development aspirations and determine how to achieve 20% betterment in the flows.

4.4.2 The final model was established by undertaking the following steps.

- Step 1: Determining what to model. The modelled network follows the general road layout as indicated in the master plan. Area from the roads was entered at key nodes. Hydrographs were used to account for substantial green areas and entered in the model at key nodes. Nodes were also introduced to take account of the flows from key plot areas.

- Step 2: Optimising the size of the strategic ponds. Once the basic set up of the model was established, the optimum size of the strategic ponds was then established. This involved allowing unrestrained flows from the plot areas to firstly enter the network model, before altering the size of the penultimate pipe in the model (which simulated the strategic pond) to determine the necessary attenuation that would provide 20% betterment in the final outflow when compared against the existing calculated green field run-off rate. The strategic pond was sized to accommodate a 1 in100 year plus climate change event and the flow controlled by the use of a hydrobrake. The pond size was also checked against the available space as identified as part of the master planning process in order to help optimise the pond size.

- Step 3: Fixing the outflow from the plots. To fix the outflow from the individual plots, the inflow that enters the strategic pond as established under Step 2 was recorded, which in turn allowed a flow rate per ha to be established. This flow rate per ha was then distributed amongst the contributing plot areas to obtain the maximum allowable discharge from each plot.
- Step 4: modelling the restricted plot flows. This was achieved by installing a 'dummy' tank/hydrobrake arrangement at each plot node allowing the flow to be released at the rate identified under Step 3. Pipe sizes were altered to ensure flooding in the system does not occur

4.4.3 The model therefore provides an indication of the strategic attenuation requirements, maximum allowable discharge from individual plots and location of where contributing area needs to enter the system.

4.4.4 Although the main strategic drainage has been modelled as a piped system, when the project enters detailed design stage, the opportunity to replace this pipe work with open channels/ditches will be considered. Indicative locations of possible channel locations have been shown in drawing 27808-CVD-172 contained in Appendix B.

4.4.5 The results from this modelling process then need to be combined with the indicated SUDS techniques to provide the overall composite solution.

4.4.6 Global variables and simulation parameters used in the WinDes® modelling has been taken from the Flood Studies Report (FSR), written by the Institution of Civil Engineers and the National Environment Research Council.

4.4.7 The key parameters have been used summarised in the Table 4.3, below.

Table 4.3 Network Global Variables and Simulation Parameters

Model Parameters	Value
Return Period (yrs)	1 in 1, 1 in 30 and 1 in 100 + 30% climate change
Profile Type	Summer and Winter
Storm Duration (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
M5-60 (mm)	20.0
Ratio R	0.4
Volumetric Run-off Coefficient	0.75 (summer) and 0.85 (winter)

Model Parameters	Value
Percentage Impermeable	Varies for each catchment

Notes

1) Descriptions for each variable is as follows:

   a. Return Period - The return period is used when a rainfall profile is being used in lieu of a statistically generated rainfall profile. It allows the mean annual flood values to be calculated in relation to the expected frequency

   b. Storm Duration - Typical values used to represent common storm profiles

   c. M5-60 - Rainfall depth equal to a 1 in 5yr return period lasting 60 minutes

   d. Ratio R - Ratio of the rainfall depths from the 60 minute storm to the 2 day storm

   e. Volumetric Run-off - Proportion of catchment rainfall that enters the system

   f. Percentage Impermeable - Percentage of total area entered into Model as being impermeable

4.5 Surface Water - Modelling Results

4.5.1 Table 4.4, below, summarises the size of the strategic ponds required to accommodate the 1 in 100 year plus climate change events for each sub catchment, determined through the modelling process.

Table 4.4 Estimated Attenuation Volumes for Strategic Ponds

Catchment	Storage Type	Strategic Attenuation Volume Required
Catchment A	Online Pond	4,000m^3
	Online Pond	500m^3
Catchment B	Online Pond	935m^3
Catchment C	Online Pond	350m^3
Catchment D	Online Pond	100m^3
Catchment E	Online Pond	1,000m^3
	Online Pond	1,600m^3

Notes

1) The design of the ponds assumes that a permanent wet well will also be provided to help with improving the amenity value. However, the wet well will not contribute to the attenuation volume required.

2) Catchment F has not been included in the proposed drainage design as it is considered that the flows are controlled within St David's Barracks and discharge directly to an independent outfall.

4.5.2 The maximum allowable discharge from each catchment is summarised as follows at Table 4.5.

Table 4.5 Maximum Allowable Flows from Catchments

Catchment	Sub-catchment ID	Sub-catchment Area (ha)	1 in1 yr flow restriction at each plot per ha	1 in 100 yr +CC flow restriction at each plot per ha	1 in 1 yr Max Allowable Flow	1 in 100 yr Max Allowable Flow
Catchment A	A1	1.040	2 l/s/ha	11 l/s/ha	2 l/s	11 l/s
	A2	1.560	2 l/s/ha	11 l/s/ha	3 l/s	17 l/s
	A3	5.730	2 l/s/ha	11 l/s/ha	11 l/s	63 l/s
	A4	3.600	2 l/s/ha	11 l/s/ha	7 l/s	40 l/s
	A5	4.400	2 l/s/ha	11 l/s/ha	9 l/s	48 l/s
	A6	1.830	2 l/s/ha	11 l/s/ha	4 l/s	20 l/s
	A7	0.800	2 l/s/ha	11 l/s/ha	2 l/s	9 l/s
	A8	2.460	2 l/s/ha	11 l/s/ha	5 l/s	27 l/s
	A9	3.680	2 l/s/ha	11 l/s/ha	7 l/s	40 l/s
	A10	1.540	2 l/s/ha	11 l/s/ha	3 l/s	17 l/s
		26.640			**53 l/s**	**292 l/s**
Catchment B	B1	0.473	2 l/s/ha	11 l/s/ha	1 l/s	5 l/s
	B2	0.470	2 l/s/ha	11 l/s/ha	1 l/s	5 l/s
	B3	0.940	2 l/s/ha	11 l/s/ha	2 l/s	10 l/s
	B4	0.520	2 l/s/ha	11 l/s/ha	1 l/s	6 l/s
	B5	0.420	2 l/s/ha	11 l/s/ha	1 l/s	5 l/s
		2.823			**6 l/s**	**31 l/s**
Catchment C	C1	1.570	2 l/s/ha	11 l/s/ha	2 l/s	17 l/s
	C2	2.000	2 l/s/ha	11 l/s/ha	4 l/s	22 l/s
	C3	1.550	2 l/s/ha	11 l/s/ha	3 l/s	17 l/s
	C4	2.860	2 l/s/ha	11 l/s/ha	6 l/s	31 l/s
	C5	1.260	2 l/s/ha	11 l/s/ha	3 l/s	14 l/s
		9.240			**14 l/s**	**101 l/s**
Catchment D	D1	0.112	2 l/s/ha	11 l/s/ha	1 l/s	2 l/s
	D2	2.270	2 l/s/ha	11 l/s/ha	5 l/s	25 l/s
		2.382			**6 l/s**	**27 l/s**
Catchment E	E1	4.950	7 l/s/ha	28 l/s/ha	35 l/s	138 l/s

Catchment	Sub-catchment ID	Sub-catchment Area (ha)	1 in1 yr flow restriction at each plot per ha	1 in 100 yr +CC flow restriction at each plot per ha	1 in 1 yr Max Allowable Flow	1 in 100 yr Max Allowable Flow
	E2	5.150	5 l/s/ha	16 l/s/ha	32 l/s	84 l/s
	E3	3.200	5 l/s/ha	16 l/s/ha	14 l/s	55 l/s
	E4	3.790	7 l/s/ha	28 l/s/ha	15 l/s	61 l/s
	E5	4.780	7 l/s/ha	28 l/s/ha	19 l/s	28 l/s
	E6	3.980	7 l/s/ha	28 l/s/ha	15 l/s	22 l/s
	E7	3.740	7 l/s/ha	28 l/s/ha	18 l/s	74 l/s
	E8	5.604	7 l/s/ha	28 l/s/ha	41 l/s	56 l/s
	E9	3.910	7 l/s/ha	28 l/s/ha	21 l/s	97 l/s
		39.104			**210 l/s**	**615 l/s**

4.5.3 The developer for each plot will be expected to comply with this maximum discharge requirement by incorporating SUDS into the final layout.

4.5.4 The modelling results can be found in Appendix E

4.6 Surface Water- Comparison of Flows from the Site

4.6.1 Table 4.6, below, provides a high level summary of the comparison of peak flows from each catchment area. The proposed flows are the total flow leaving the site generated from the sub-catchments, highway area and remaining green areas such as parks and fields. These flows are controlled by the use of strategically placed site control attenuation ponds, before being discharged to the outfall points.

Table 4.6 Comparison of Surface Water Flows

Catchment	Existing Run-off Flow at outfall	Proposed Flow at outfall	% Betterment in Flows achieved
Catchment A	1:1yr = 400 l/s	1:1yr = 308 l/s	92 l/s less or 23% less
	1:30yr = 947 l/s	1:30yr = 460 l/s	487 l/s less or 52% less
	1:100yr = 1203 l/s	1:100yr + 30% climate change = 527 l/s	676 l/s less or 56% less
Catchment B	1:1yr = 48 l/s	1:1yr = 28 l/s	20 l/s or 42% less
	1:30yr = 122 l/s	1:30yr = 74 l/s	48 l/s or 40% less
	1:100yr = 163 l/s	1:100yr + 30% climate change = 123 l/s	40 l/s or 25% less

Catchment	Existing Run-off Flow at outfall	Proposed Flow at outfall	% Betterment in Flows achieved
Catchment C	1:1yr = 94 l/s	1:1yr = 70 l/s	24 l/s or 25% less
	1:30yr = 228 l/s	1:30yr = 139 l/s	89 l/s or 40% less
	1:100yr = 294 l/s	1:100yr + 30% climate change = 234 l/s	60 l/s or 20% less
Catchment D	1:1yr = 28 l/s	1:1yr = 24 l/s	4 l/s or 15% less
	1:30yr = 67 l/s	1:30yr = 52 l/s	15 l/s or 22% less
	1:100yr = 86 l/s	1:100yr + 30% climate change = 63 l/s	23 l/s or 27% less
Catchment E	1:1yr = 274 l/s	1:1yr = 254 l/s	20 l/s or 7% less
	1:30yr = 672 l/s	1:30yr = 531 l/s	141 l/s or 21% less
	1:100yr = 874 l/s	1:100yr + 30% climate change = 635 l/s	239 l/s or 27% less
Catchment F	1:1yr = 174 l/s	1:1yr = Assumed to be 174 l/s	Assumed to be equal
	1:30yr = 379 l/s	1:30yr = Assumed to be 379 l/s	
	1:100yr = 456 l/s	1:100yr = Assumed to be 456 l/s	

Notes

1) * Catchment F covers the SLAM development area and as such the flows leaving this catchment are considered to be controlled at a green field run-off rate equal to the site average of approximately 6 l/s/ha. This flow is considered to discharge through a dedicated outfall and as such does not enter the Site D/E drainage system.

4.6.2 The results show that there will be a minimum decrease in peak flows of 20% across the whole site. This is in line with the Environment Agency requirements of achieving betterment of peak flows and volumes from the proposed development.

4.7 Foul Water - General

4.7.1 The foul water generated from the proposed development has been estimated based on guidance contained in Sewers for Adoption 6th Edition. As the master plan details the mix uses of the proposed site, foul water rates can be applied to calculate an estimated flow rate. As it can be assumed that the majority of water entering the building is used in applications where the dirty water is discharged to the foul system, the foul water flows will be the same as the water usage values.

4.7.2 The estimated potential loadings of serving the proposed development are shown below at Table 4.7. These loadings are based on development usages contained in Chapter 1 and on published data. As these calculations are indicative and preliminary, further detailed analysis is needed prior to entering the detailed design stage.

Table 4.7 Proposed Theoretical Flows

Development Type	Foul Water Drainage Flows	
	Average DWF (l/s)	**Peak Flow (l/s)**
Residential	13.3	79.8
B1 - Offices	0.5	2.7
B2 - Employment	0.3	2.1
B8 - Storage/Warehouse	2.3	13.7
Energy Centre	0.1	0.4
Primary School	1.2	7.3
Hotel Pub	0.6	3.9
Community Facility	0.1	0.9
Retail	0.5	3.1
St David's Barracks	1.8	10.5
Total	**20.7**	**124.3**

Notes

1) Refer to Appendix A for a breakdown of the loading calculations.

2) Loadings shown are indicative and preliminary only and are based on published data. As such further analysis required.

3) Peak flows have been taken as 6 x Dry Weather Flow (DWF) as this is the design criteria for adoptable drainage systems. However, actual peak flows are expected to be closer to 3 x DWF.

4.7.3 Although detailed modelling is required to understand the condition and performance of the existing foul water system, it is considered that the existing pumping stations and pumping main should be reused to accommodate foul flows generated from the proposed development.

4.7.4 Any existing gravity systems currently within the proposed development master plan will need to be removed or abandoned as part of the demolition works, so that a new gravity system can be installed around the proposed development to ensure that the drainage is to adoptable standards.

4.7.5 Thames Water has confirmed that a detailed assessment should be carried out at detailed design stage to determine if the existing network can accommodate the proposed development. If upgrading works are required then a budget estimate will be provided with details of the necessary upgrades.

4.7.6 It has been confirmed by Thames Water that if the sewerage treatment works needs to be upgraded to accommodate any additional flows, then all upgrading work costs will be covered by themselves.

4.7.7 With respect to reinforcing the existing network (pipe work or pumps) there are two options available. The first option involves carrying out an impact study to identify the true extent of any reinforcement works needed. This will then act as a baseline allowing the developer to enter into an agreement with Thames Water to carry out any necessary upgrading works. It may be possible for any offsite reinforcement work identified to be paid through the Thames Water Asset Management Programme, however this will only become more of a probability once the development receives planning permission and the detailed design of the scheme is more defined. If the development needs to be brought forward sooner then the developer may be expected to pay an upfront contribution. The second option involves requisitioning Thames Water to identify a point of connection and allow them to undertake the necessary design and installation. However, this option can be more expensive as more risk is taken on board by Thames Water.

4.7.8 It is assumed that Option 1 will be taken forward at this time and as such Thames Water has requested a full impact study to ascertain the true extent of any reinforcement works needed to accommodate the new development paying particular attention to the capacity issues.

4.7.9 Thames Water has confirmed that any reinforcement works needed at the Sewerage Treatment Works will be met directly by them at no cost to the developer. Such works would be programmed into their Asset Management Programme.

4.7.10 Drawing 27808-CVD-172 contained in Appendix B indicates the location of the proposed foul water sewer connection point to serve each catchment.

4.8 Foul Water - Comparison of Flows

4.8.1 Table 4.8 provides a comparison of the foul flows of the affected area of the site.

Table 4.8 Comparison of Foul Water Drainage Flow Rates

Development Affected	Building Area Affected (m^2)	Average DWF	Peak Flow (i.e. 6 x DWF)
Existing Buildings	134,672	7.3 l/s	43.8 l/s
Mixed Used Development	127,662	20.7 l/s	124.3 l/s
Difference		**+13.4 l/s**	**+80.5 l/s**

4.8.2 The foul flow calculations indicate that there is likely to be an increase in the dry weather flow as a result of the proposed development. To date, no foul drainage modelling has been carried out to ascertain the extent of any changes needed to the existing public sewer network to accommodate this increase in flow. However, initial discussions with Thames Water have indicated that any increase in flow is expected to require some reinforcement of the surrounding pumping stations.

4.8.3 It is considered that many existing gravity systems which are affected by the proposed development will need to be removed or abandoned as part of proposed works. As such, a new gravity system will need to be installed around the proposed development with a connection made into the existing public sewer system. The existing pump station located adjacent to Building D4 will need relocating further south (avoiding the proposed development footprint) to achieve this.

4.8.4 As Thames Water's immediate concerns with accommodating the proposed development relate to the potential capacity issues at the pumping stations and sewage treatment works, Thames Water has requested that a full Drainage Impact Assessment of the public foul sewer network is undertaken to ascertain the true extent of any reinforcement works and phasing implications of any identified solution.

4.8.5 A brief scope of the works as provided by Thames Water is indicated as follows.

- Confirm the current model includes any recent changes to the network.
- Carry out a manhole survey to confirm levels and pipe sizes.
- Carry out four pumping station surveys.
- Update foul model with asset details and survey results.
- Confirm verification of the model is still valid with new survey data.
- Check current performance of the network - 20 year design standard.
- Review and assign the inflow point and assess the impact of the development on the system against the 20 year design standard.
- Use the model to develop solutions, if required, to allow the development inflows into the system while maintaining a 'no detriment' situation to the network. This will include assessing what flows can be accepted by the existing system without causing a 'detriment' situation to the network.
- Report.

4.8.6 It is therefore recommended that Thames Water is instructed to undertake this assessment as they already have an established foul drainage model and access to key flow data. Thames Water has also let it be known that they require further survey work to be carried out at the pumping stations so that true performance, confirmation of capacity and confirmation of any known issues can be properly assessed.

4.8.7 However, Thames Water has confirmed via email that they will not object to the outline planning application as long as assurances are given that the Drainage Impact Assessment is addressed at the next stage of the design process. Reference should be made to the key correspondence in Appendix D for further details

4.8.8 If the development requires modification/reinforcement works to be carried out at any public sewage treatment works then the cost for this is likely to be met by Thames Water as part of their ongoing AMP commitments and may not require any contribution from the developer.

4.8.9 Thames Water will allow the proposed development to be phased in accordingly so that the need for any local reinforcement works to pumping stations or the existing adopted network can be programmed and planned accordingly hence controlling any capital expenditure.

5. Conclusions

5.1.1 AMEC has been commissioned by Defence Infrastructure Organisation (DIO) to undertake a Drainage Strategy of a proposed development at MOD Bicester, Oxfordshire. The area of study covers two distinct sites; C Site and Graven Hill Site. This assessment is for Graven Hill only.

5.1.2 The purpose of the Strategy was to identify an appropriate solution that would accommodate the proposed master plan development while taking account of surface water and foul water flows.

5.1.3 The key findings with respect to the surface water and the foul water issues are summarised below.

5.2 Surface Water Findings

5.2.1 The existing infrastructure that is currently present on the site is not deemed adequate to accommodate the proposed development as it is non compliant with planning requirements (Planning Policy Statement; PPS 25) and does not have the capacity to accommodate the proposed increase in impermeable area. Furthermore, the existing layout would be affected by the proposed development layout. However, outfall positions are expected to be retained.

5.2.2 The new development results in an increase in impermeable area for each of the key catchments. This is summarised in Table 5.1, below.

Table 5.1 Summary of Impermeable Areas

Catchment	Aimp before development (ha)	Aimp after development (ha)	Change in Aimp
Catchment A	24.40	28.82	18% increase (4.42ha)
Catchment B	1.70	3.77	122% increase (2.07ha)
Catchment C	4.50	10.87	142% increase (6.37ha)
Catchment D	1.54	2.74	78% increase (1.20ha)
Catchment E	13.00	41.07	216% increase (28.07ha)

5.2.3 To accommodate the change in area and to ensure compliance with PPS 25, a fully integrated SUDS solution is required to provide betterment with respect to quality, quantity and amenity value. With respect to quantity, a 20% reduction in overall flow is envisaged from the site. However, this can only be made possible if the plot developers restrict plot flows to the rates indicted in this strategy and strategic SUDS solutions are introduced. Drawing 27808-CVD-172 included in Appendix B shows the proposed high level strategic SUDS solution while the appropriate SUDS techniques have been identified as part of the SUDS Assessment contained in Appendix C

5.2.4 A summary of the change in flows is shown at Table 5.2, below.

Table 5.2 Comparison of Surface Water Flows

Catchment	Existing Run-off Flow at outfall	Proposed Flow at outfall	% Betterment in Flows achieved
Catchment A	1:1yr = 400 l/s	1:1yr = 308 l/s	92 l/s less or 23% less
	1:30yr = 947 l/s	1:30yr = 460 l/s	487 l/s less or 52% less
	1:100yr = 1203 l/s	1:100yr + 30% climate change = 527 l/s	676 l/s less or 56% less
Catchment B	1:1yr = 48 l/s	1:1yr = 28 l/s	20 l/s or 42% less
	1:30yr = 122 l/s	1:30yr = 74 l/s	48 l/s or 40% less
	1:100yr = 163 l/s	1:100yr + 30% climate change = 123 l/s	40 l/s or 25% less
Catchment C	1:1yr = 94 l/s	1:1yr = 70 l/s	24 l/s or 25% less
	1:30yr = 228 l/s	1:30yr = 139 l/s	89 l/s or 40% less
	1:100yr = 294 l/s	1:100yr + 30% climate change = 234 l/s	60 l/s or 20% less
Catchment D	1:1yr = 28 l/s	1:1yr = 24 l/s	4 l/s or 15% less
	1:30yr = 67 l/s	1:30yr = 52 l/s	15 l/s or 22% less
	1:100yr = 86 l/s	1:100yr + 30% climate change = 63 l/s	23 l/s or 27% less
Catchment E	1:1yr = 274 l/s	1:1yr = 254 l/s	20 l/s or 7% less
	1:30yr = 672 l/s	1:30yr = 531 l/s	141 l/s or 21% less
	1:100yr = 874 l/s	1:100yr + 30% climate change = 635 l/s	239 l/s or 27% less
Catchment F	1:1yr = 174 l/s	1:1yr = Assumed to be 174 l/s	Assumed to be equal
	1:30yr = 379 l/s	1:30yr = Assumed to be 379 l/s	
	1:100yr = 456 l/s	1:100yr = Assumed to be 456 l/s	

Notes

1) * Catchment F covers the SLAM development area and as such the flows leaving this catchment are considered to be controlled at a green field run-off rate equal to the site average of approximately 6 l/s/ha. This flow is considered to discharge through a dedicated outfall and as such does not enter the Site D/E drainage system

5.3 Foul Water Findings

5.3.1 The loading calculations show there is a 13.4 l/s increase in dry weather flow expected as a result of the new development.

5.3.2 The proposed development is intended to be accommodated using the existing public foul sewer network, which is located at various points around the site. Although Catchments A, C and D are expected to connect into the existing gravity network via a direct gravity connection, Catchment B will require a new pumping station and pumping main to discharge flows to the nearest public sewer. Drawing 27808-CVD-172 at Appendix B provides details of likely connection points.

5.3.3 There are known capacity issues associated with the existing foul water network. As such, Thames Water requires a Drainage Impact Assessment undertaking to understand the true extent of any necessary reinforcement works. Currently, reinforcement works at the key pumping stations is anticipated. However, Thames Water has confirmed they will not object at this stage to any outline planning application, provided assurances are given that the Drainage Impact Assessment will be carried out at the next stage of the design process.

Appendix A
Loading Calculations

IH 124 Mean Annual Flood

Input

Return Period (years)	100	Soil	0.450
Area (ha)	70.660	Urban	0.350
SAAR (mm)	622	Region Number	Region 6

Results	**l/s**
QBAR Rural	260.3
QBAR Urban	453.1
Q100 years	1127.2
Q1 year	385.1
Q2 years	427.9
Q5 years	593.9
Q10 years	716.1
Q20 years	833.0
Q25 years	871.0
Q30 years	896.7
Q50 years	976.1
Q100 years	1127.2
Q200 years	1267.6
Q250 years	1311.3
Q1000 years	1607.2

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.450
Area (ha)	11.700	Urban	0.140
SAAR (mm)	622	Region Number	Region 6

Results	**l/s**
QBAR Rural	44.8
QBAR Urban	56.9
Q100 years	162.8
Q1 year	48.4
Q30 years	121.9
Q100 years	162.8

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.450
Area (ha)	19.700	Urban	0.230
SAAR (mm)	622	Region Number	Region 6

Results	**l/s**
QBAR Rural	75.4
QBAR Urban	110.3
Q100 years	293.9
Q1 year	93.7
Q30 years	227.5
Q100 years	293.9

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.450
Area (ha)	5.530	Urban	0.280
SAAR (mm)	622	Region Number	Region 6

Results	**l/s**
QBAR Rural	21.2
QBAR Urban	33.3
Q100 years	86.1
Q1 year	28.3
Q30 years	67.5
Q100 years	86.1

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.450
Area (ha)	60.770	Urban	0.210
SAAR (mm)	622	Region Number	Region 6

Results	**l/s**
QBAR Rural	227.6
QBAR Urban	322.9
Q100 years	874.3
Q1 year	274.5
Q30 years	672.1
Q100 years	874.3

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.450
Area (ha)	23.600	Urban	0.550
SAAR (mm)	622	Region Number	Region 6

Results	**l/s**
QBAR Rural	90.3
QBAR Urban	204.2
Q100 years	456.2
Q1 year	173.6
Q30 years	378.7
Q100 years	456.2

Existing Foul Water Calcs For Bicester Garrison Affected By The New Development

05/08/2011

Site	Type	Area m2	No of floors	Foul Loading l/s/ha	No of people	Foul Loading l/s/person	Average Loading l/s	6x for peak Loading l/s	
C	workshop	2,350	1	0.46	-	-	0.1	0.6	
	storage	32,563	1	0.34	-	-	1.1	6.6	
	Emergency Services	0	1	0.46	-	-	0.0	0.0	
	classroom	0	1	1.74	-	-	0.0	0.0	
	canteen	100	1	1.85	-	-	0.0	0.1	
	club	0	1	1.85			0.0	0.0	
		35,013					**1.2**	**7.4**	**l/s**
Graven Hill	offices	2,143	2	1.74	-	-	0.75	4.5	
	workshop	1,094	1	0.46	-	-	0.05	0.3	
	storage	129,000	1	0.34	-	-	4.39	26.3	
	Emergency Services	430	1	0.46	-	-	0.02	0.1	
	classroom	1,665	1	1.74	-	-	0.29	1.7	
	canteen	0	1	1.85	-	-	0.00	0.0	
	club	340	1	1.85	-	-	0.06	0.4	
	St David's Accommodation	-	-	-	378	0.00462	1.75	10.5	
							7.3	**43.8**	**l/s**

Notes

1. Domestic foul water flows from St Davids = 378 people using 200 l/d/person divided by 12 divided by 3600
2. Workshop flows=0.46 l/s/ha based on 200 l/d/person and 100 people per ha divided by 12 divided by 3600
3. Canteen and club flows =1.85 l/s/ha based on 200 l/d/person and 400 people per ha divided by 12 divided by 3600
4. Flows from storage area =0.34 l/s/ha based on 150 l/100m2/day (ref foul sewer design flow by Peter Jones Surveyor magazine) divided by 12 divided by 3600
5. Flows from offices and classrooms = 1.74 l/s/ha based on 750 l/100m2/day (ref foul sewer design flow by Peter Jones Surveyor magazine) divided by 12 divided by 3600

Proposed Foul Water Flow Calcs For Bicester Garrison

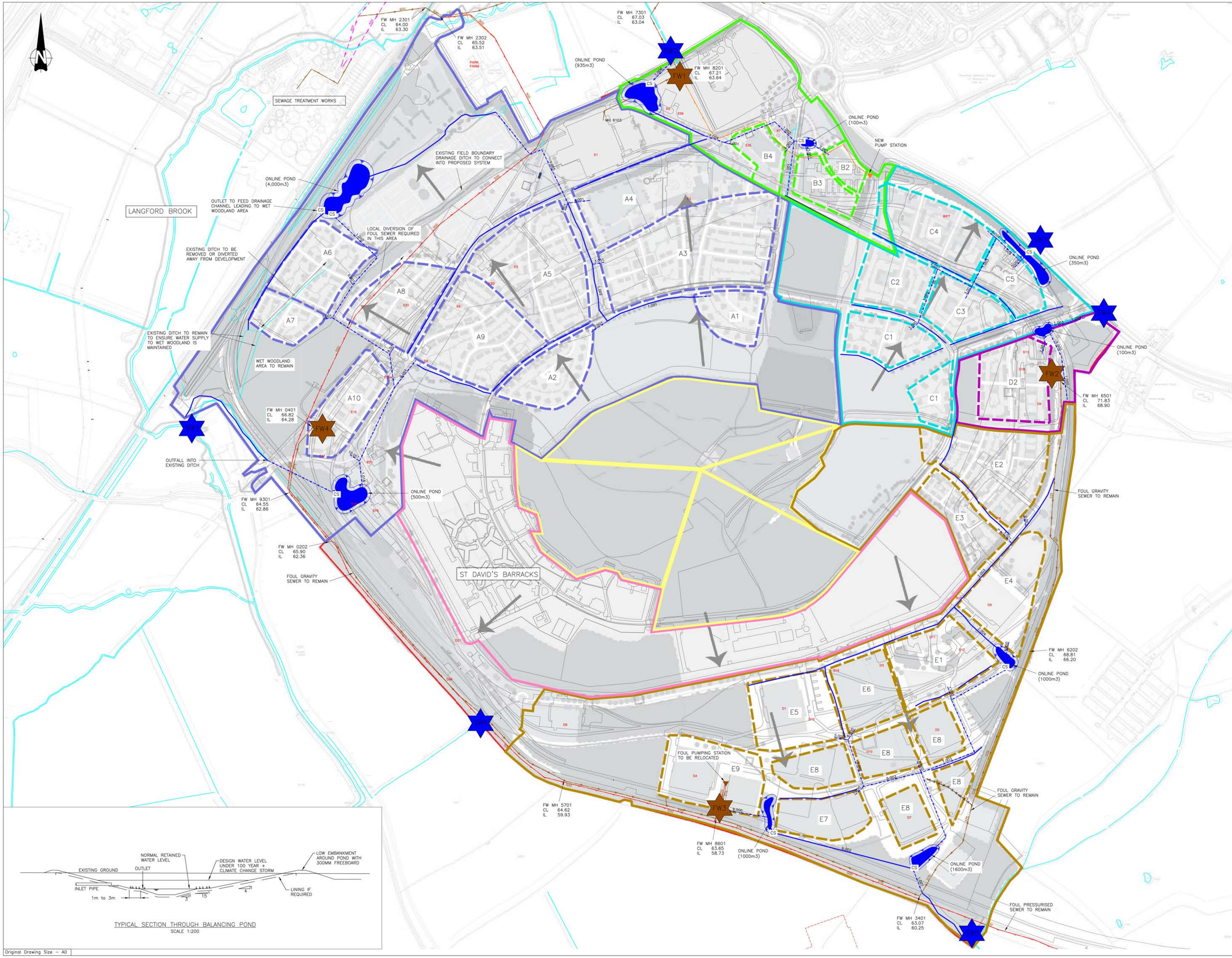
05/08/2011

Site	Type	Area m2	No of Dwellings	No of people	Residential Loading l/s/dwelling or person	Domestic (excl houses) Loading l/s/ha	Average Loading l/s	6x for peak Loading l/s	
C	B8 - storage/warehouse	70,400	-		-	0.34	2.4	14.4	
	offices	1,200	-		-	2.08	0.2	1.5	
							2.6	**15.9**	**l/s**
Graven Hill	Residential	-	1,900		0.007	-	13.3	79.8	
	B1 - offices	2,182	-		-	2.08	0.5	2.7	
	B2 employment	20,520				0.17	0.3	2.1	
	B8 - storage/warehouse	66,960				0.34	2.3	13.7	
	Energy Centre	3,600	-		-	0.17	0.1	0.4	
	Primary school	13,600				0.89	1.2	7.3	
	Hotel Pub	12,000				0.54	0.6	3.9	
	Community facility	3,200				0.46	0.1	0.9	
	Retail	5,600				0.93	0.5	3.1	
	St David's Accommodation	-	-	378	0.00462	-	1.75	10.5	
							20.7	**124.3**	**l/s**
							23.4	**140.1**	**l/s**

Notes

1. Domestic flow from warehouses= 0.17 l/s/ha based on 150 l/d/100m2 (as stated in 'foul sewer design flow data file' by Peter Jones Surveyor magazine) divided by 12hr day divided by 3600
2. Domestic flow from schools= 0.89 l/s/ha based on 80 l/head/d (as stated in 'foul sewer design flow data file' by Peter Jones Surveyor magazine) 400 pupils per ha divided by 10hr day divided by 3600
3. Domestic flow from offices = 2.08 l/s/ha based on 750 l/d/100m2 (as stated in 'foul sewer design flow data file' by Peter Jones Surveyor magazine) divided by 10hr day divided by 3600
4. Domestic flow from community centre = 0.46 l/s/ha based on 50 l/head/d (as stated in 'foul sewer design flow data file' by Peter Jones Surveyor magazine) 400 people per ha divided by 12hr day divided by 3600
5. Domestic flow from retail= 0.93 l/s/ha based on 400 l/d/100m2 (as stated in 'foul sewer design flow data file' by Peter Jones Surveyor magazine) divided by 12hr day divided by 3600
6. Domestic flow from energy centre= 0.17 l/s/ha based on 150 l/d/100m2 (guess based on Peter Jones Magazine) divided by 24hr day divided by 3600
7. Flows from site C are higher than expected due to the size of the warehouses
8. Domestic foul flows from dwellings =0.007l/s/unit based on 4000 l/unit/day divided by peaking factor of 6 divided by 24 divided by 3600
9. hotel loading of 0.54l/s/ha based on 550l/day/room. Assume 100 bed hotel with 20 employees at 50l/day/employee as stated in 'foul sewer design flow data file' by Peter Jones Surveyor magazine=56,000 l/d. Divide this flow by the area/24/3600
10. Domestic flow from B2 employment= 0.17 l/s/ha based on 150 l/d/100m2 (as stated in 'foul sewer design flow data file' by Peter Jones Surveyor magazine) divided by 24hr day divided by 3600

Appendix B
Drawings



DESCRIPTION

REV	DATE		DWN	CHK	APP
A	AUG 2011	FIRST ISSUE	PC	NW	DK

REVISIONS

REV	DATE		DWN	CHK	APP

NOTES

1. EXISTING FOUL WATER DRAINAGE ROUTES, COVER LEVELS AND INVERT LEVELS SHOWN HAVE BEEN TAKEN FROM THAMES WATER RECORDS
2. DRAINAGE ROUTES SHOWN ARE INDICATIVE ONLY. ALL DRAINAGE ROUTES TO BE FINALISED AT DETAILED DESIGN STAGE
3. DRAWING TO BE READ IN CONJUNCTION WITH AMEC GRAVEN HILL SITE DRAINAGE STRATEGY (27808/RR234)
4. SUMMARY OF OUTFALLS

CATCHMENT (WITH KEY)	DISCHARGES TO SW OUTFALL	CONNECTS INTO FW PIPE
A	SW1	FW1
B	SW2	FW1
C	SW3	FW1
D	SW4	FW2
E	SW5	FW3
F	SW6	FW3

5. DETAILS SHOWN ON THIS DRAWING HAVE BEEN PROVIDED IN GOOD FAITH BY EACH STATUTORY UNDERTAKER. NO LIABILITY OF ANY KIND IS ACCEPTED BY THE OPERATOR, ITS AGENTS OR SERVANTS FOR ANY ERROR OR OMISSION. THE INFORMATION IS GIVEN WITHOUT OBLIGATION, OR WARRANTY AND AS A RESULT THE ACCURACY OF THE INFORMATION SHOWN CANNOT BE GUARANTEED.
6. THE LOCATION OF ALL PROPOSED SERVICES SHOWN NEED TO BE CONFIRMED WITH THE RELEVANT STATUTORY UNDERTAKER PRIOR TO ANY WORKS COMMENCING ON SITE.

KEY

- SITE BOUNDARY
- D5 — EXISTING BUILDING REFERENCE
- E4 — SUBCATCHMENT REFERENCE
- GENERAL DIRECTION OF OVERLAND FLOW
- EXISTING FOUL DRAINAGE (GRAVITY) – THAMES WATER
- EXISTING FOUL DRAINAGE (PRESSURISED) – THAMES WATER
- EXISTING COMBINED DRAINAGE – THAMES WATER
- EXISTING SURFACE WATER DRAINAGE – THAMES WATER
- EXISTING SURFACE WATER DRAINAGE CHANNEL
- EXISTING FOUL PUMPING STATION – THAMES WATER
- 1.001 — PROPOSED SURFACE WATER DRAINAGE ROUTE WITH MODEL PIPE REFERENCE
- PROPOSED SURFACE WATER SWALE
- PROPOSED SURFACE WATER ATTENUATION POND
- CS — PROPOSED SURFACE WATER CONTROL STRUCTURE
- PROPOSED SURFACE WATER DRAINAGE OUTFALL
- PROPOSED FOUL WATER DRAINAGE OUTFALL
- PROPOSED FOUL WATER PUMPING STATION
- PROPOSED FOUL WATER PRESSURISED MAIN
- EXISTING FOUL PIPE TO BE REMOVED

SCALES: 1:2500 @ A0

PROJECT TITLE:
REDEVELOPMENT OF MoD BICESTER

DRAWING TITLE:
GRAVEN HILL
DRAINAGE STRATEGY

CLIENT:
Defence Infrastructure Organisation

GABLES HOUSE, KENILWORTH ROAD, LEAMINGTON SPA, WARWICKSHIRE CV32 6JX.
TEL: (01926) 439000 FAX: (01926) 439010

DRAWING No.
23752–CVD–172

Appendix C
SUDS Assessment and Supporting Data

Defence Infrastructure Organisation

Future Defence Storage and Distribution Programme - Redevelopment of MoD Bicester

Graven Hill: SUDS Assessment

August 2011

AMEC Environment & Infrastructure
UK Limited

Defence Infrastructure Organisation

Future Defence Storage and Distribution Programme - Redevelopment of MoD Bicester

Graven Hill: SuDS Assessment

August 2011

AMEC Environment & Infrastructure UK Limited

Report for

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Doc Reg No. 27808rrCl019i1

h:\projects-mod\ea-210\#27000\27808 bicester planning support\1 client\reports\infrastructure\drainage\graven hill\annex c - SuDS assessment & supporting data\cl022 e site SuDS assessment 15.08.11.doc

Document Revisions

No.	Details	Date
1	SUDS Assessment	15/08/11

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1. Introduction

1.1 Purpose

1.1.1 This Sustainable Drainage System (SUDS) assessment forms part of the investigations carried out in preparation of the Drainage Strategy for Graven Hill and sets out to provide a high level comprehensive assessment of the different SUDS techniques and solutions which may or may not be appropriate for the proposed development. The assessment addresses the quality, quantity and amenity impact on the future development proposals as well as the opportunity to combine various SUDS techniques to produce a recognised Management/Treatment Train solution.

1.1.2 The results from this assessment should be used during the detailed design stage.

1.1.3 It should be emphasised that this assessment is a preliminary assessment of the suitability of various SUDS solutions and should not be taken as a definitive final solution. When the detailed design is complete or further site investigation is commissioned it may be necessary to re-assess the SUDS selection process.

1.1.4 The assessment covers the complete site development as one entity, the results of which inform AMEC's Drainage Strategy for the Graven Hill site (document reference: BIC/OPA/DOC/15).

1.2 SUDS Options

1.2.1 This SUDS selection process is based on the guidance given in the SUDS manual produced by CIRIA C697 dated 2007.

1.2.2 Table 1.1, below, lists the SUDS techniques identified for consideration in the Manual.

Table 1.1 SUDS Options

SuDS Group	SUDS Technique
Retention	Retention Pond
	Subsurface Storage
Wetland	Shallow wetland
	Extended detention wetland
	Pond/wetland
	Pocket wetland
	Submerged gravel wetland

SuDS Group	SUDS Technique
	Wetland channel
Infiltration	Infiltration basin
	Infiltration trench
	Soakaway
Filtration	Surface sand filter
	Sub surface sand filter
	Perimeter sand filter
	Bio-retention / filter strip
	Filter trench
Detention	Detention Basin
Open channels	Conveyance swale
	Enhanced dry swale
	Enhanced wet swale
Source Control	Green roof
	Rain water harvesting
	Pervious pavements
	Soakaway
	Bio-retention

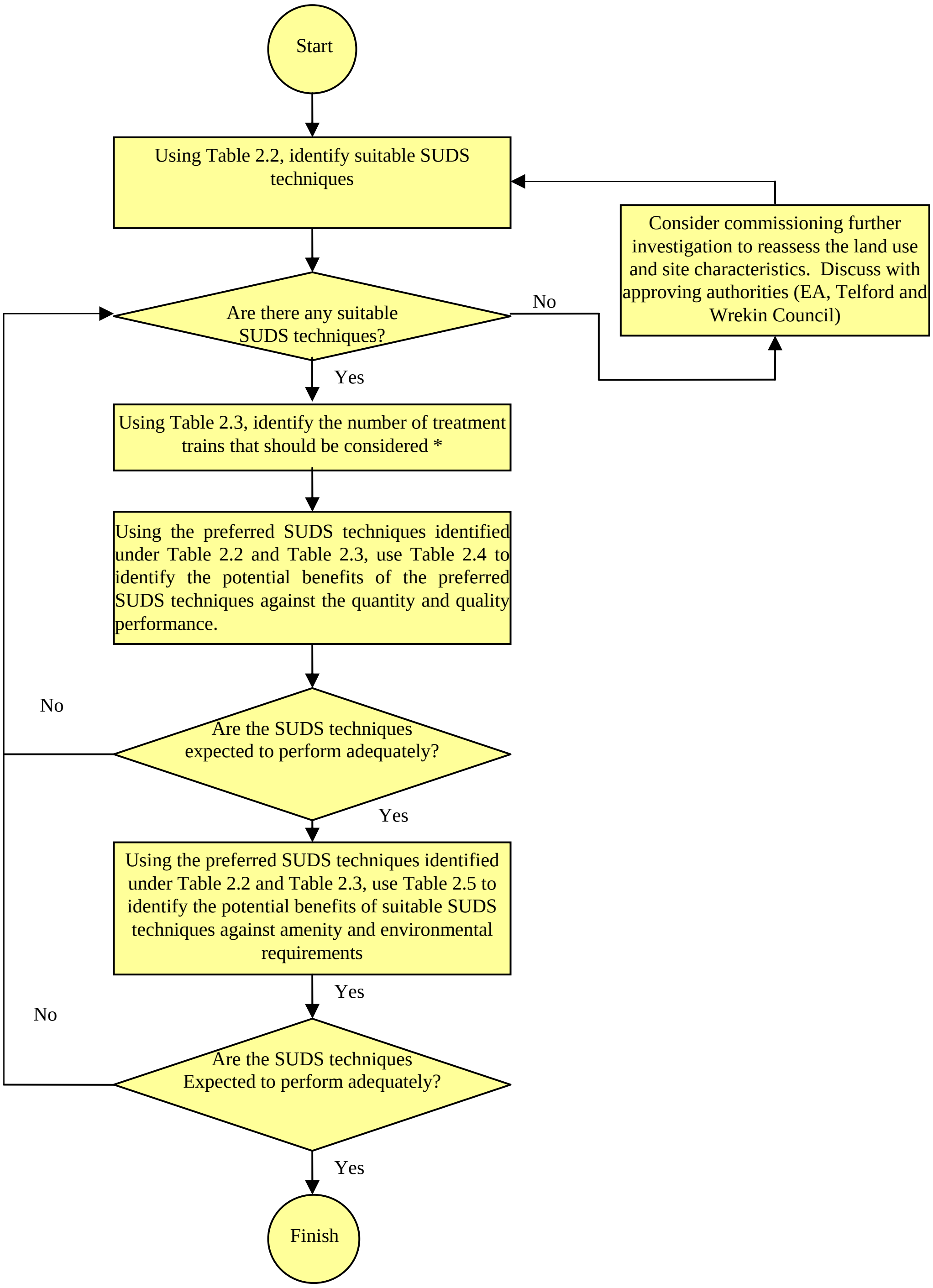
1.2.3 The Manual identifies five key areas in which to assess the suitability of these SUDS techniques.

1.2.4 The five key areas that are considered when making an assessment of appropriate SUDS techniques are:

- Land use characteristics;
- Site characteristics;
- Catchment characteristics;
- Quantity and quality performance requirements; and
- Amenity and environmental requirements.

1.3 Approach to the Assessment

1.3.1 The following flow chart identifies the approach that has been taken to address the key areas.



* The design of a SUDS scheme will normally require the use of two or more techniques that are linked together. Each technique will perform uniquely with regard to water quality treatment and storm water attenuation. To achieve the best results, treatment trains should be combined to form a SUDS management train.

2. SUDS Assessment

2.1 Key Parameters used in the Assessment

2.1.1 This assessment has been completed by understanding key parameters of the site conditions so that the most appropriate techniques can be selected. These parameters are shown below at Table 2.1.

Table 2.1 Assessment Parameters

Parameter	Comments	Reference
Land use	Mixed use of residential, commercial and employment.	AMEC Concept Masterplan.
Permeability of soil	The soil is considered to be impermeable for the first 3m, based on initial findings from the soakaway tests.	May Gurney soakaway test results.
Area of development	The site has an overall area of 79.7ha.	Measured from plans.
Depth of water table	Greater than 3m.	May Gurney soakaway test results indicated that ground water was not present.
Slope of site	Longitudinal slope of the site has been taken as being approximately 0.52%.	Approximation taken from topographical information
Available head	Available head is the elevation from inflow to outflow to allow certain SUDS techniques to operate under gravity. From topographical information the available head has been assessed as being 6m over a length of 1,150m. Therefore for the purpose of this assessment the available head is considered to be 0m - 1m.	Estimated from plans and site visit.
Available space for SUDS	Medium. Classed as medium due to some areas of greenfield towards the outfall and green corridors along the highway verge. Space has been made available during the masterplan design.	AMEC Concept Masterplan.
Receiving water sensitivity	Receiving water sensitivity quality (i.e. chemistry and biology) has been assessed as medium.	AMEC draft Flood Risk Assessment.
Run-off catchment characteristic	For typical developments such as this the development will fall into the category of residential roads, parking areas, commercial zones.	Taken from SUDS Manual 5.2.3:Table 5.6.

2.2 Number of Treatment Trains and Identification of Possible SUDS Techniques

Table 2.2 Recommended Number of Treatment Trains (based on Table 5.6 of the SUDS Manual)

Run-off catchment characteristic	Receiving water sensitivity		
	Low	Medium	High
Roofs only	1	1	1
Residential roads, parking areas, commercial zones	2	2	3
Refuse collection/ industrial areas/ loading bays/ lorry parks/ highways	3	3	4

Notes

Recommended number of treatment trains for this site

2.2.1 The number of treatment train components required for this site is a minimum of 2. In order to treat surface water generated from the site as affectively as possible it is recommended that the site is split into smaller catchment areas so that flows are controlled and managed before reaching the final outfall location.

2.2.2 This recommendation is based on guidance identified in CIRIA C697 and covers prevention, source control site control and regional control measures

2.2.3 Table 2.3, overpage, shows the preliminary SUDS technique results for this site based on the key assessment parameters identified in Table 2.1 above.

2.2.4 The SUDS techniques considered suitable are shown highlighted in grey in Table 2.3. Any SUDS techniques considered unsuitable at this time are shown crossed out.

Table 2.3 Land Use and Site Use Characteristics (based on Table 5.4 of the SUDS Manual)

SUDS Group	Technique	SUDS selection criteria							
		Land use characteristics	Site Characteristics						
		Industrial development/Hotspots	Soils	Area Draining to a single SUDS component	Minimum depth to water table	Site Slope	Available head	Available space	Suitability of SUDS
		Low density	Impermeable	>2 ha	> 1m	0 to 5 %	0 to 1m	Medium	Suitable or unsuitable
Retention	Retention pond	Yes	Yes	Yes (5)	Yes	Yes	Yes	Yes	Suitable
	Subsurface Storage	Yes	Yes	Yes (5)	Yes	Yes	Yes	Yes	Suitable
Wetland	Shallow Wetland	Yes	Yes(2)	Yes (6)	Yes(2)	Yes	Yes	Yes	Suitable
	Extended detention wetland	Yes	Yes(2)	Yes (6)	Yes(2)	Yes	Yes	Yes	Suitable
	Pond/wetland	Yes	Yes(2)	Yes (6)	Yes(2)	Yes	Yes	Yes	Suitable
	Pocket Wetland	Yes	Yes(2)	Yes (7)	Yes(2)	Yes	Yes	Yes	Suitable
	Submerged gravel wetland	Yes	Yes(2)	Yes (6)	Yes(2)	Yes	Yes	Yes	Suitable
	Wetland Channel	Yes	Yes(2)	Yes (6)	Yes(2)	Yes	Yes	Yes	Suitable
Infiltration	~~Infiltration trench~~	Yes	No	Yes (7)	Yes	Yes	No	Yes	Unsuitable
	~~Infiltration basin~~	Yes	No	Yes (5)	Yes	Yes	No	Yes	Unsuitable
	~~Soakaway~~	Yes	No	Yes (7)	Yes	Yes	No	Yes	Unsuitable
Filtration	~~Surface sand filter~~	Yes	Yes	Yes (5)	Yes	Yes	No	Yes	Unsuitable
	~~Sub surface sand filter~~	Yes	Yes	Yes (7)	Yes	Yes	No	Yes	Unsuitable
	Perimeter sand filter	Yes	Yes	Yes (7)	Yes	Yes	Yes	Yes	Suitable
	Bio-retention/ filter strip	Yes	Yes	Yes (7)	Yes	Yes	Yes	Yes	Suitable
	Filter trench	Yes	Yes	Yes (7)	Yes	Yes	Yes	Yes	Suitable
Detention	~~Detention basin~~	Yes	Yes	Yes (5)	Yes	Yes	No	Yes	Unsuitable
Open channels	Conveyance swale	Yes	Yes	Yes (7)	Yes	Yes	Yes	Yes	Suitable
	Enhanced dry swale	Yes	Yes	Yes (7)	Yes	Yes	Yes	Yes	Suitable
	Enhanced wet swale	Yes	Yes (4)	Yes (7)	Yes	Yes	Yes	Yes	Suitable

SUDS Group	Technique	SUDS selection criteria							
		Land use characteristics	Site Characteristics						
		Industrial development/Hotspots	Soils	Area Draining to a single SUDS component	Minimum depth to water table	Site Slope	Available head	Available space	Suitability of SUDS
		Low density	Impermeable	>2 ha	> 1m	0 to 5 %	0 to 1m	Medium	Suitable or unsuitable
Source control	Green roof	Yes	Yes	Yes (7)	Yes	Yes	Yes	Yes	Suitable
	Rain water harvesting	Yes	Yes	Yes (7)	Yes	Yes	Yes	n/a	Suitable
	Pervious pavements	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Suitable

Notes

(1) with liner

(2) with surface base flow

(3) unless follows contours

(4) with linear and constant base flow or high ground water table

(5) possible but not recommended (implies appropriate management train not in place).

(6) where high flows are diverted around SuDS component

(7) solution can only work if the smaller catchment area is less than 2ha

2.3 Quantity, Quality and Amenity Impact on SUDS Techniques Identified.

2.3.1 Now that the number of treatment trains is known from Table 2.2 and a suitable set of SUDS techniques have been selected from Table 2.3, it is possible to identify the quantity and quality performance as well as the amenity impact of this selection. This in turn will provide an insight into the overall SUDS solution that is best suited for the site.

2.3.2 This is done by assessing the suitable techniques against the criteria set out in the SUDS Manual, the results of the assessment is shown in Table 2.4.

2.3.3 With reference to this table, the SUDS techniques considered suitable against this criteria are shown highlighted in grey. Any SUDS techniques considered unsuitable at this time are shown crossed out.

Table 2.4 Quantity and Quality Performance Selection Table (Based on Table 5.7 of the SUDS Manual)

		WATER QUALITY TREATMENT POTENTIAL					HYDRAULIC CONTROL			
								Suitability for flow rate control (probability)		
SuDS Group	Technique	Total suspended solids removal	Heavy metals removal	Nutrient removal (Phosphorous, nitrogen) removal	Bacteria removal	Capacity to treat fine suspended sediments and dissolved pollutants	Run-off volume reduction	0.5 (1/2 Yr)	0.1 - 0.3 (10/30 yr)	0.01 (100 Yr)
Retention	Retention pond	High	Medium	Medium	Medium	High	Low	High	High	High
	Subsurface Storage	Low	Low	Low	Low	Low	Low	High	High	High
Wetland	Shallow Wetland	High	Medium	High	Medium	High	Low	High	Medium	Low
	Extended detention wetland	High	Medium	High	Medium	High	Low	High	Medium	Low
	Pond/wetland	High	Medium	High	Medium	High	Low	High	Medium	Low
	Pocket Wetland	High	Medium	High	Medium	High	Low	High	Medium	Low
	Submerged gravel wetland	High	Medium	High	Medium	High	Low	High	Medium	Low
	Wetland Channel	High	Medium	High	Medium	High	Low	High	Medium	Low
Infiltration	Infiltration trench	High	High	High	Medium	High	High	High	High	Low
	Infiltration basin	High	High	High	Medium	High	High	High	High	High
	Soakaway	High	High	High	Medium	High	High	High	High	Low
Filtration	Surface sand filter	High	High	High	Medium	High	Low	High	Medium	Low
	Sub surface sand filter	High	High	High	Medium	High	Low	High	Medium	Low
	Perimeter sand filter	High	High	High	Medium	High	Low	High	Medium	Low
	Bio-retention/ filter strip	High	High	High	Medium	High	Low	High	Medium	Low

SuDS Group	Technique	WATER QUALITY TREATMENT POTENTIAL					HYDRAULIC CONTROL			
		Total suspended solids removal	Heavy metals removal	Nutrient removal (Phosphorous, nitrogen) removal	Bacteria removal	Capacity to treat fine suspended sediments and dissolved pollutants	Run-off volume reduction	Suitability for flow rate control (probability) 0.5 (1/2 Yr)	0.1 - 0.3 (10/30 yr)	0.01 (100 Yr)
	Filter trench	High	High	High	Medium	High	Low	High	High	Low
Detention	Detention basin	Medium	Medium	Low	Low	Low	Low	High	High	High
Open channels	~~Conveyance swale~~	High	Medium	Medium	Medium	High	Medium	High	High	High
	~~Enhanced dry swale~~	High	High	High	Medium	High	Medium	High	High	High
	~~Enhanced wet swale~~	High	High	Medium	High	High	Low	High	High	High
Source control	Green roof	n/a	n/a	n/a	n/a	High	High	High	High	Low
	Rain water harvesting	Medium	Low	Low	Low	n/a	Medium	Medium	High	Low
	Pervious pavements	High	High	High	High	High	High	High	High	Low

High = High potential

Medium = Medium potential

Low = Low potential

Table 2.5 Community and Environmental Factors (Based on Table 5.9 of the SUDS Manual)

SuDS Group	Technique	Maintenance	Community acceptability	Cost	Habitat creation potential
Retention	Retention pond	Medium	High*	Medium	High
	Subsurface Storage	Low	High	Medium	Low
Wetland	Shallow Wetland	High	High*	High	High
	Extended detention wetland	High	High*	High	High
	Pond/wetland	High	High*	High	High
	Pocket Wetland	High	Medium*	High	High
	Submerged gravel wetland	Medium	Low	High	Medium
	Wetland Channel	High	High*	High	High
Infiltration	Infiltration trench	Low	Medium	Low	Low
	Infiltration basin	Medium	High*	Low	Medium
	Soakaway	Low	Medium	Medium	Low
Filtration	Surface sand filter	Medium	Low	High	Medium
	Sub surface sand filter	Medium	Low	High	Low
	Perimeter sand filter	Medium	Low	High	Low
	Bio-retention/ filter strip	High	High	Medium	High
	Filter trench	Medium	Medium	Medium	Low
Detention	Detention basin	Low	High*	Low	Medium
~~Open channels~~	~~Conveyance swale~~	Low	Medium*	Low	Medium

SuDS Group	Technique	Maintenance	Community acceptability	Cost	Habitat creation potential
	~~Enhanced dry swale~~	Low	Medium*	Medium	Medium
	~~Enhanced wet swale~~	Medium	Medium*	Medium	High
Source control	Green roof	High	High	High	High
	Rain water harvesting	High	Medium*	High	Low
	Pervious pavements	Medium	Medium	Medium	Low

*There may be some public safety concerns associated with open water that require addressing at design stage.

Defence Infrastructure Organisation amec

2.4 Possible SUDS Solutions

2.4.1 Based on the findings from the assessment there are several permutations that may be considered feasible. Table 2.6, below, summarises the most appropriate solutions in terms of there effectiveness and practicality based on a minimum of two management trains.

Table 2.6 Possible SUDS Solutions which contain a minimum of two management trains

SUDS Group	Possible SUDS solution identified with three management trains	Feasible	Practicality of incorporating the SUDS solution into the detailed design?
Source Control and Retention	Pervious pavement or channel drain with subsurface storage as source control. Ponds to store flows as site control	Yes	Good. Pervious paving or channel drain could be used in car parking areas. However maintenance issues need to be taken into account. Ponds can be located in available green space to enhance public areas
Filtration and Retention	Filter strip/trench as source control along highway or back of hardstanding areas. Ponds to store flows as site control	Yes	Good. Filter strip/trench could be used along highways and at the back of hardstanding areas such as car/lorry parks and outdoor storage areas. Swales can be located along highway verges and ponds can be located in available green space, in the vicinity of the final outfall location
Source Control and Detention/Wet Land	Rain water harvesting as source control. Detention basin/wet land to store excessive flows as site control	Yes	Average to Good. Rain water harvesting included into plot drainage to collect non-contaminated flows from roof areas. This can be reused as part of any industrial needs. Swales can be located along highway verges and detention basins can be placed in high risk areas of flooding to allow swales to overflow in critical storm events.

2.4.2 In order to maintain a sustainable development it is considered that rain water harvesting (or grey water recycling) should be used where buildings have a large roof area. The water collected can be used for non-potable uses such as toilet flushing, process uses and vehicle wash down areas.

3. Conclusions and Recommendations

3.1.1 This Sustainable Drainage System (SUDS) assessment covers the complete site development as one entity, the results of which inform AMEC's Drainage Strategy (document reference: BIC/OPA/DOC/15) for the proposed development at Graven Hill.

3.1.2 The assessment has shown that when an effective management train (Table 2.2 suggests a minimum of two management train combinations) is combined with appropriate SUDS techniques (see Table 2.3), an effective overall solution can be produced that addresses both storm water management and water quality treatment issues (see Table 2.4) as well as community and environmental factors (see Table 2.5).

3.1.3 Although there are several SUDS permutations that can be considered feasible, it is recommended that a combined SUDS solution involving source control, open channels and retention is taken forward into detailed design. Using rain water harvesting (or grey water recycling) on buildings with a large roof area is considered to be essential to providing a sustainable development, as the water collected can be used for buildings needs such as toilet flushing, process use and vehicle wash down areas.

3.1.4 Infiltration should be dismissed due to the ultra low infiltration properties of the existing ground strata, as identified during soakaway tests undertaken by May Gurney on 24 August 2010.

3.1.5 Although Table 2.6 provides details of the preferred SUDS solutions, the identified combinations should not be taken as a definitive final solution as it is possible that other issues currently unknown at this time may have a bearing on the results. When the detailed design of the masterplan is complete it may be necessary to re-assess the SUDS selection as more space may be available to allow for a different SUDS system to be included.

DESCRIPTION

REV	DATE		DRN	CHK	APP
A	JUL 2010	FIRST ISSUE	MS	MH	MW

REVISIONS

REV	DATE		DRN	CHK	APP
B	JULY 2010	TRIAL HOLE LOCATIONS AMENDED	MS	MW	MW

NOTES

1. SOAKAWAY LOCATIONS SHOWN ARE APPROXIMATE AND MAY ALTER DEPENDING ON GROUND CONDITIONS AND LOCATION OF SERVICES.

GENERAL KEY

- SITE BOUNDARY
- ×C SOAKAWAY LOCATION
- ×G ADDITIONAL SOAKAWAY LOCATION

SCALES: 1:2500 @ A1

PROJECT TITLE:
BICESTER PLANNING SUPPORT

DRAWING TITLE:
SITE D
PROPOSED SOAKAWAY LOCATIONS

CLIENT:
DE
DEFENCE ESTATES

CABLES HOUSE, KENILWORTH ROAD
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DRAWING No.
27808-CVD-007/B

Geotechnical - Site Investigation
Ayton Road, Wymondham, Norfolk, NR18 0RH Tel: 01953 609844 Fax: 01953 609819

Trial Pit Soakaway Test to BRE Digest 365

Site:	Bicester - Trial Trenches and Soakaways Tests	Job No:	SI1638	
Operator:	John Tomalin	Trial Pit No.:	ST - D	
Test Depth (m):	3.10	Date:	25.08.2010	
Test Width (m):	0.60	Groundwater level before test (m):		Dry
Test Length (m):	2.90	Water level start (m):		1.010
Test No:	1 of 1	Water level finish (m):		1.010

Time (Minutes)	Water Depth (m)	Level Drop (m)
0	1.01	0.000
2	1.01	0.000
32	1.01	0.000
62	1.01	0.000
92	1.01	0.000
122	1.01	0.000
152	1.01	0.000
182	1.01	0.000

Insufficent infiltration over 182 minutes to calulate infilrtation rate

MAY GURNEY
May Gurney Limited
Geotechnical - Site Investigation
Ayton Road, Wymondham
NR18 0RH
Tel: 01953 609856 Fax: 01953 609819
Web: www.maygurney.co.uk

Trial Pit Record

ST - D
Sheet 1 of 1

Project: Bicester-Trial Trenches and Soakaways

Project ID: SI1638

Client: Entec UK Limited
Engineer: N/A

Ground Level:
Coordinates: -

Orientation of Trial Pit:
Length: 3.10 Width: 0.60 Depth: 2.90

Description	Legend	Depth (m)	O.D. Level	Water	Sample / Test Type	Sample / Test Depth (m)	Remarks and Test Results PID (ppm)
Firm greyish brown slightly gravelly sandy CLAY. Gravel is angular to subangular fine to coarse limestone.		0.15					
Stiff to very stiff slightyl sandy slightly gravelly CLAY. Gravel is angular to subangular fine and medium limestone.		0.60					
Stiff brown slightly sandy CLAY. ...From 0.80mbgl becoming mottled brown and greyish brown ...From 1.10mbgl mottled grey brown and grey. ...At 1.50mbgl sub horizontal polished fissure planes.		1.80					
Stiff grey brown and grey slighty sandy CLAY with orange brown sandy CLAY pockets. Rare weak sand size calcareous concretions.		2.50					
Stiff grey CLAY, locally closely fissured with occasional gypsum crystals.		2.90					

End of Trial Pit at 2.90 m

Client: Entec UK Limited
Engineer: N/A
Contractor: May Gurney Geotechnical
Date: 25/08/2010
Plant: JCB 3CX

Logged By: J. Tomalin
Checked By: P. Lewin

Water Level Observations

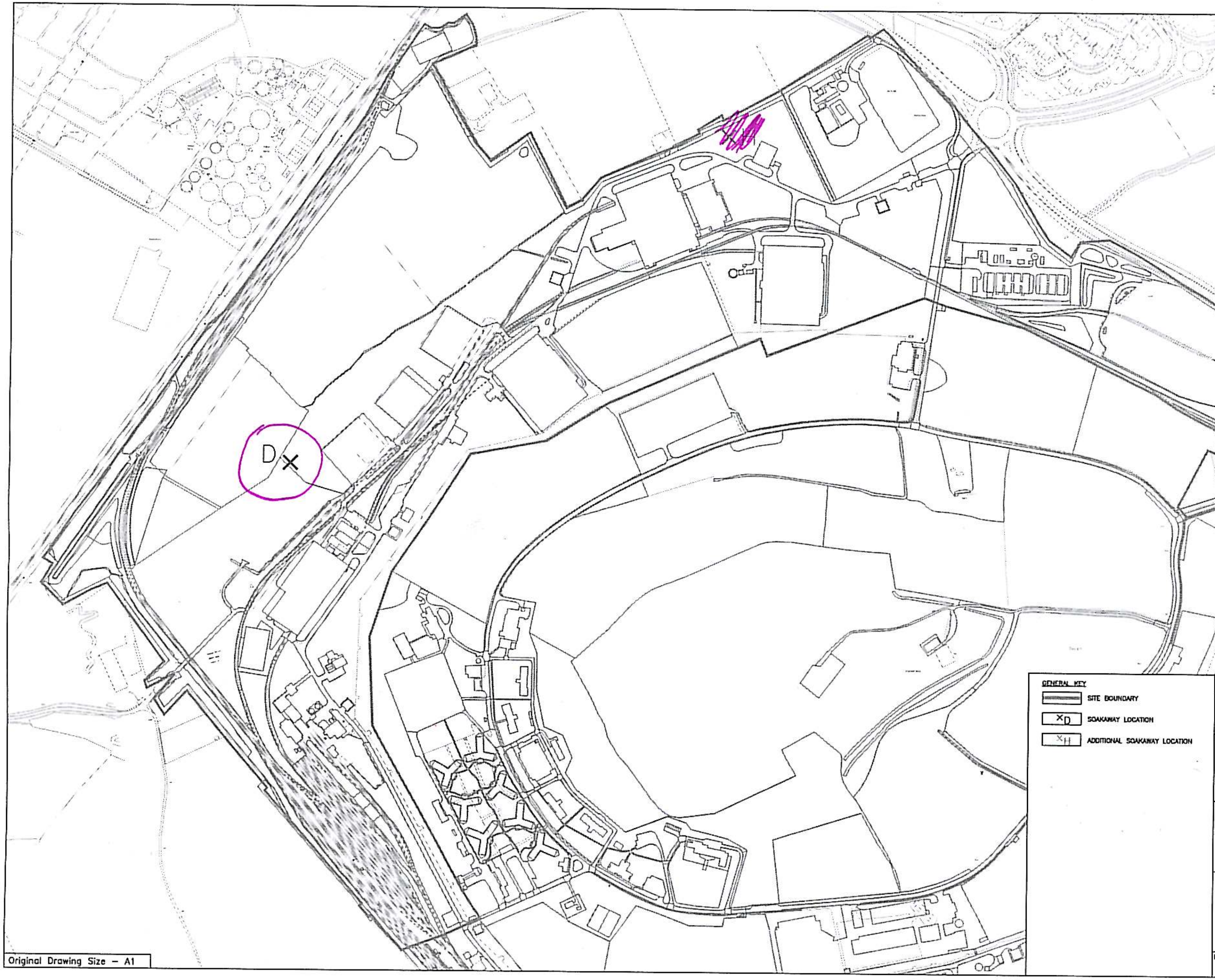
Date	Water Strike (m)	Standing Time (Mins)	Standing Level (m)
	No Groundwater Encountered		

Groundwater Remarks: No groundwater encountered

Remarks: Trial pit backfilled with arisings

Hole Stability: Trial pit stable during excavation and on completion.

Print Date: 27/08/2010



DESCRIPTION

REV	DATE		DRN	CHK	APP
A	JUL 2010	FIRST ISSUE	MS	MH	MW

REVISIONS

REV	DATE		DRN	CHK	APP
B	JULY 2010	TRIAL HOLE LOCATIONS AMENDED	MS	MW	MW

NOTES

1. SOAKAWAY LOCATIONS SHOWN ARE APPROXIMATE AND MAY ALTER DEPENDING ON GROUND CONDITIONS AND LOCATION OF SERVICES.

SCALES: 1:2500 @ A1

PROJECT TITLE:
BICESTER PLANNING SUPPORT

DRAWING TITLE:
SITE E
PROPOSED SOAKAWAY LOCATIONS

CLIENT:

DEFENCE ESTATES

DABLES HOUSE, KENILWORTH ROAD
LEAMINGTON SPA, WARWICKSHIRE, CV32 6JX
TEL: (01926) 438000 FAX: (01926) 438010

DRAWING No.
27808-CVD-008/B

Geotechnical - Site Investigation
Ayton Road, Wymondham, Norfolk, NR18 0RH Tel: 01953 609844 Fax: 01953 609819

Trial Pit Soakaway Test to BRE Digest 365

Site:	Bicester - Trial Trenches and Soakaways Tests	Job No:	SI1638	
Operator:	John Tomalin	Trial Pit No.:	ST - E	
Test Depth (m):	3.00	Date:	24.08.2010	
Test Width (m):	0.60	Groundwater level before test (m):		Dry
Test Length (m):	2.60	Water level start (m):		1.000
Test No:	1 of 1	Water level finish (m):		1.000

Time (Minutes)	Water Depth (m)	Level Drop (m)
0	1.00	0.000
5	1.00	0.000
30	1.00	0.000
60	1.00	0.000
90	1.00	0.000
120	1.00	0.000
180	1.00	0.000
270	1.00	0.000

Insufficent infiltration over 270 minutes to calulate infilrtation rate

May Gurney Limited
Geotechnical - Site Investigation
Ayton Road, Wymondham
NR18 0RH
Tel: 01953 609856 Fax: 01953 609819
Web: www.maygurney.co.uk

Trial Pit Record

ST - E

Sheet 1 of 1

Project: Bicester-Trial Trenches and Soakaways

Project ID: SI1638

Client: Entec UK Limited

Engineer: N/A

Ground Level:

Coordinates: -

Orientation of Trial Pit:

Length: 0.60 Width: 2.60 Depth: 3.00

Description	Legend	Depth (m)	O.D. Level	Water	Sample / Test Type	Sample / Test Depth (m)	Remarks and Test Results PID (ppm)
MADE GROUND: Brownish grey slightly sandy slighty gravelly CLAY. Gravel is angular to subrounded fine to coarse limestone and flint.		0.20					
MADE GROUND: Pale grey and brown clayey subangular to subrounded fine and medium limestone GRAVEL.		0.30					
Very stiff dessicated brown slightly sandy CLAY. ...From 0.50mbgl mottled brown and brownish grey. ...Becoming stiff to very stiff.		1.20					
Stiff mottled brown and grey CLAY. Rare coarse sand size calcareous nodules and occasioanl gypsum crystals.		2.10					
Stiff pale grey and grey, with rare yellowish grey CLAY. Occasional decayed root channels.		2.80					
Very stiff closely fissured CLAY with occasional gypsum crystals.		3.00					

End of Trial Pit at 3.00 m

Client: Entec UK Limited
Engineer: N/A
Contractor: May Gurney Geotechnical
Date: 24/08/2010
Plant: JCB 3CX

Logged By: J. Tomalin
Checked By: P. Lewin

Water Level Observations

Date	Water Strike (m)	Standing Time (Mins)	Standing Level (m)
	No Groundwater Encountered		

Groundwater Remarks: No groundwater encountered

Remarks: Trial pit backfilled with arisings

Hole Stability: Trial pit stable during excavation and on completion.

Print Date: 27/08/2010

Appendix D
Correspondence

Minutes of Meeting

Client	Defence Estates	**Client Reference**	
Our Reference	27808-	**Issued By**	Phill Clay
Issue Number		**Issue Date**	25-06-10
Meeting Date	24-06-10	**Location**	Bicester Garrison - Site E
Present at Meeting (Distribution Copies)	Phill Clay (Entec) Katherine Snell (Entec) Ian McLaughlin (DSDA Head of Establishment) Harvey Connor (DE Estates Management)		
Apologies for Absence (Distribution Copies)			
Additional Distribution (Distribution Copies)			
Project Name	Bicester Garrison Planning Support		
Subject	**INFRASTRUCTURE DATA COLLECTION**		

		Actions
1.0	**GENERAL**	
1.1	All utility costs for whole garrison paid by DSDA Bicester. Oil is dealt with directly by Bicester, but all other utilities through Army.	
1.2	Meter readings for oil, gas, and electric read by Katie Falconer (DE). Penny Martin is Energy Manager. She can provide information on meter positions.	
1.3	FFO and Electricity consumption records provided for 2006-2010	
1.4	Pride is the Regional Prime Contractor for Bicester. All communications to go through Harvey Connor.	
2.0	**AQUATRINE (POTABLE AND DRAINAGE)**	
2.1	Caroline Thomas was the Aquatrine Liaison Representative (ALR) but Harvey Connor has recently taken on this role. Viv Owen works with Harvey and focuses on water issues. Brey are the Aquatrine Service Provider for Bicester and Kelda Water are the contractor/partner.	
2.2	All drainage issues / plans to be directed to Kelda. KS to make initial contact but PC to chase also	**KS/PC**
2.3	Water is pumped up Graven Hill (24hrs) to feed high level tanks. Sometimes experience low pressure across site. Some pipework recently replaced.	

Actions

2.4 Water pumping main taken from prison. KS to find out condition **KS**

2.5 Flooding experienced in many warehouses. Ditches are present around the majority of buildings to catch runoff from the roads. Thought to be constructed when the site was built. Storm ditches generally fill up quickly.

2.6 D Site drainage was cleaned out to alleviate a blockage. System now working better. Whole of E site prone to flooding as ditches fill quickly and overflow.

2.7 At E1 warehouse blocked drains have been cleared and flooding alleviated. New drain agreed between E1 and E2 – KS to check with Kelda. **KS**

2.8 At D8 building heavy rainfall runs directly into building off road. No storm ditches present.

2.9 No known problems with foul drainage.

3.0 GAS

3.1 Gas has been maintained with no major problems over last 4 years. Penny Martin can provide details of meter locations. **KS**

4.0 DISTRICT HEATING

4.1 Largely redundant as oil fired modular boilers have been fitted to warehouses. However, where these could not be located close enough, the existing DH pipework has been used. All pipework remains in place.

Plans should be available as DE is currently assessing the Health & Safety issues associated with lorries clashing with pipes that cross the roads. Pride provides the maintenance to the system and is in the process of fitting Environmental Management Systems to some buildings – list of buildings to be supplied by Harvey. KS to chase. **KS**

5.0 ELECTRICITY

5.1 Electricity supply has no spare capacity. Site often suffers from power outages. KS to contact Approved Person (AP) when returns from leave – HC to provide details, KS to find out if there are any plans to reinforce the system **KS**

6.0 TELECOMS

6.1 Everard Hypolite: 01869 259711 (everard.hypolite986@mod.uk) deals with voice data. 4 Exchanges on site in C Site, D/St David's, St George's and E Site – BT own and maintain these. Ducting routes should be available either hard copy or electronic – Harvey to find out. KS to chase **KS**

Actions

DII(F) being introduced across all sites. Atlas maintain this system. Fire system also on fibre optics from Fire Station, looped around all sites and back again. Al Parry (x3831) may be able to provide further info. KS to follow up. **KS**

7.0 OTHER

7.1 Weigh bridge on site at building E15.

7.2 MoD Fire Station at Ploughly Road

7.3 Server room in C16, but has back-up generators.

7.4 All security issues (i.e. contractors on site) must go through Bob Cubitt: 01869 259354. Passport or driving license and proof of address required for all contractors. Where sewer CCTV or photographs are being taken, camera pass is required from Bob. BC will require method statements, incl. risk assessments and copies of insurance certificates. Permit required for any laptops taken onto site. Pride will need to provide written approval before start.

Minutes of Meeting

Client	Defence Estates	**Client Reference**	
Our Reference	27808/GL043	**Issued By**	Phill Clay
Issue Number		**Issue Date**	08-07-10
Meeting Date	07-07-10	**Location**	Entec FF Meeting Room
Present at Meeting (Distribution Copies)	Phill Clay (Entec) Katherine Snell (Entec) Karen Derry (Kelda)		
Apologies for Absence (Distribution Copies)			
Additional Distribution (Distribution Copies)			
Project Name	Bicester Garrison Planning Support		
Subject	**KELDA WATER SERVICES INFORMATION GATHERING**		

Actions

1.0 SURFACE WATER

1.1 KD confirmed that any surface water outfall below 6" diameter is not classed as an outfall, as agreed under the Kelda contract?

1.2 EA discharge consent data provided (current and revoked). Full copies to be sent – KS to follow up. PC recorded reference, grid position and outfall name — **KS**

1.3 The entire site has a high water table and is prone to flooding under most storm events.

1.4 Many of the ditches on site are not connected to an overall surface water system. Therefore once the ditches are full, the water overflows. The ditches are also positioned in poor locations, so are not being utilised as efficiently as possible. Ditches are only in Kelda scope if receive run-off from road or other impermeable surface.

1.5 Major flooding issues associated with buildings E1 and E2. KD believes that the land drain from Graven Hill is a major factor to this as there is a large diameter drain entering a small ditch. Also the flows from this drain are restricted by the rail track, where the track acts as a dam.

1.6 KD considers that soakaways will not work on the sites due to the high water table. They have never even attempted testing as they do not see the point.

Actions

1.7 There is no scheduled maintenance on surface water systems unless areas are known to flood. Generally deal with problems reactively.

2.0 POTABLE WATER

2.1 Sprinkler system main is in poor condition as it leaks all over – this is not in the Kelda scope.

2.2 Fire main system is present across the sites. This is in Kelda scope and is considered to be in good condition. If required, water is pumped from the EWS tanks by dropping a hose directly into the water – issue with pumping newts out of water.

2.3 Where two assets are shown on the drawing together, this means that one would be for the fire system and the other would be for the sprinkler system.

2.4 Water consumption data (taken from readings) available from Scott Dexter (07790 616642). Meter readings and DMA zone drawings to be requested. Alternative contacts (Mark Chalkley – Water Supply Manager (07790 616158) or Paul Bramhall – Meter and Measurement (07790 616723) **KS**

2.5 There is a live database that is monitored – this shows any sudden changes in water usage which may indicate a problem.

2.6 WTW01 and WPS01 are located at Ambrosden. Connection from Thames Water. Undergoes secondary chlorination as water has been pumped a long distance and free chlorine is low. WPS used to pump to Graven Hill and Arncott Hill service reservoirs, but the supply to Arncott Hill has been cut as pipe in very poor condition.

2.7 WPS01 now pumps to SVR06 (concrete reservoir at Graven Hill) for 1.5hrs either in late evening or early morning, once every 24hrs. Sometimes this is varied by Thames Water due to circumstances. It is always agreed beforehand.SVR06 supplies D&E sites and St Davids Barracks and married quarters in Ambrosden.

2.8 Arncott Hill is now supplied from a new WPS02 and WTW02 with a new connection from Thames Water. TW installed new WPS but this was not adequate for pumping water up hill so Kelda also constructed new WPS. Secondary chlorination treatment here also. Water is pumped up to SVR 01, 02, 03, & 04 on demand (when level drops to 70%). There are 4 service reservoirs, balanced in pairs, but only 2 in use at any one time – the other 2 being mothballed as not required. However these are sometimes used during maintenance / cleaning. There is spare capacity here.

2.9 There have been 2 TW bursts on supply into Ambrosden in last 2 months so condition of TW network is uncertain.

Actions

3.0 FOUL WATER

3.1 GT = Grease Trap. Not all shown on drawing but should be 6No. in total across all sites.

3.2 OWI discharge to surface water system under guidance from PPG3

3.3 DE looking to resize OWI near to fuel depot, as the fuel tank is far larger than the OWI. If ever a breach of the bund took place, the OWI couldn't handle the volume.

3.4 SLAM building maintained by DE. They should be able to provide information on the OWI and other assets around this building

3.5 Foul outfalls assumed to be to Thames Water treatment works. KD suggested there may be some cess pit outfalls but this disregarded as they would be in their contract

3.6 Foul pumping stations on regular maintenance programme. Checked 1-2 times per week during general look around. All parties appreciate that the foul system is critical and should not be neglected in any way. Larger pump stations have back-up pumps. The locations of these are to be forwarded – KS to follow up. These pumps are ATEX compliant and have been signed off. **KS**

3.7 There is no trade effluent on the sites and no significant problems with particular buildings with regard to foul.

4.0 ASSETS

4.1 KS to contact John Tew – Asset Manager (07790 616661) for information on assets and condition. Info is limited although a condition survey at Bicester has recently been commenced. **KS**

Sewerage Modelling Group

Bicester Garrison, Ambrosden

SMG

Study ID **894** *Estimate Requested*
25/10/2010

Modelling Estimate

Project Ref: Type **Impact**

Background:

The proposed new development is located in the Bicester Garrison, Bicester and is to be constructed on greenfield and brownfield sites in four phases. The development will consist of four phases of offices, workshop, storage, Emergency Services, classroom, canteen and club. The proposed foul sewer connection point and increased peak foul flow has been indicated as follows:
Phase A has a proposed connection point of MH SP62177808, an existing flow of 10.29 l/s, proposed flow of 20.56 l/s, giving an additional flow of 10.27 l/s.
Phase C has a proposed connection point of MH SP60179802, an existing flow of 4.33 l/s, proposed flow of 10.61 l/s, giving an additional flow of 6.28 l/s.
Phase D has a proposed connection point of MH SP58199702, an existing flow of 17.82 l/s, proposed flow of 50.80 l/s, giving an additional flow of 32.98 l/s.
Phase E has two proposed connection point of New SPS or MH SP58216103, an existing flow of 15.51 l/s, a proposed Flow of 32.98 l/s and an additional flow of 53.54 l/s

Key background information is as follows:
1) The proposed development is on a greenfield/brownfield site.
2) The additional peak flow to the foul system has been calculated as 10.27 l/s for Phase A, 6.28 l/s for Phase C , 32.98 l/s for Phase D and 53.54 l/s for Phase E
3) The OS coordinates for this site are: 459300 219900.
4) The developers plan highlights the proposed connection points as MH7808 for Phase A which has been assumed to be SP62177808, MH 8902 for Phase C which has been assumed to be SP60179802, MH 9702 for Phase D which has been assumed to be SP58199702, MH 6130 for Phase E which has been assumed to be SP58216103 and New SPS for Phase E will discharge into the 500 dia sewer draining to SP58212302.

Scope:

The proposed development is located within the existing Bicester foul model. The Bicester model was built and verified in 2008. As the model and flow survey data is available from this period, the existing flow survey data can be used to confirm the flows around the proposed development. A number of manhole surveys will be required to confirm pipe sizes, gradients and ground levels around the proposed connection point. Pumping station asset survey and drop tests at the four local pumping stations are required to confirm the pump rates and available storage.

The developer has given five proposed connection points for the four sites of the proposed development. At Site A, the model indicates that the foul sewer is a 200mm dia laid at an interpolated gradient of 1/58. This gives an approximate capacity of 39l/s. The foul flow from the development is 10.27l/s hence 26% of total capacity.

There are no SFHD registered properties on the gravity sewers downstream of the Site A proposed connection point.

At Site C, the model indicates that the foul sewer is a 525mm dia laid at an interpolated gradient of 1/526. This gives an approximate capacity of 170l/s. The foul flow from the development is 6.28l/s hence 4% of total capacity.

Although there are no SFHD registered properties on the gravity sewers downstream of the Site C proposed

connection point, there are a number on other branches that drain into the same pumping station.

At Site D, the model indicates that the foul sewer is a 375mm dia laid at an interpolated gradient of 1/311. This gives an approximate capacity of 90l/s. The foul flow from the development is 32.98l/s hence 37% of total capacity.

There are no SFHD registered properties on the gravity sewers downstream of the Site D proposed connection point.

At Site E, the model indicates that the foul sewer is a 225mm dia laid at an interpolated gradient of 1/223. This gives an approximate capacity of 27l/s. The foul flow from the development is 53.54l/s hence 198% of total capacity.

There are no SFHD registered properties on the gravity sewers downstream of the Site E proposed connection point.
The key tasks are as follows:
1) Confirm the current model includes any recent changes to the network.
2) Carry out a manhole survey to confirm levels and pipe sizes.
3) Carry out four pumping station surveys
4) Update foul model with asset details and survey results.
5) Confirm verification of the model is still valid with new survey data.
6) Check current performance of the network - 20 year design standard.
7) Review and assign the inflow point and assess the impact of the development on the system against the 20 year design standard.
8) Use the model to develop solutions, if required, to allow the development inflows into the system while maintaining a 'no detriment' situation to the network. This will include assessing what flows can be accepted by the existing system without causing a 'detriment' situation to the network
9) Report.

Notes:
1) A site visit is not envisaged as being necessary at this stage.
2) Allowance has been made for a discussion by telephone with Thames Water Operations to understand the existing catchment issues.
3) The solutions are subject to change following discussions with Thames Water's Operations and Catchment Planning departments.
4) Thames Water Process team may wish to ensure the impact of any solution will be acceptable at the STW. Any implications on the STW will be assessed by Thames Water and a separate additional study may
be appropriate, depending on the outcome of these investigations and assessments.

It is assumed that the surface water flows do not affect the foul system.

£Internal Modelling
£External Modelling
£Management
£Other TW Engineering
£Operations Support
£Flow Survey
£Manhole Survey
£Impermeable Area Survey
£CCTV Survey
Total £10 792
Costs
Estimated by MWH
05/11/2010
Estimate does not include VAT

Risks:
It is assumed that the 2008 updated model can be utilised for this project.

Budget Comments:
A local manhole survey, confirming pipe sizes, inverts and ground levels of the foul system is included. Four pumping station surveys at Blackthorn Road SPS, Ploughley Road SPS, Graven Hill P.S and Rodney Road SPS. (included in the manhole survey costs)
Estimated project completion is within 10 weeks of project commencement, to allow sufficient time for data retrieval.

Geoff.Nokes@thameswater.co.uk
19/11/2010 15:49

To: nick.wood@entecuk.co.uk
cc:
Subject: Fw: Bicester Garrison DIA Scope

Nick

My understanding is - Graven Hill P/S to take Phase D&E has Incoming 375mm sewer and pumps at 60l/s

Ploughley Road P/S takes Arncott Garrison to take site C has Incoming 600mm sewer and pumps at 160l/s

Arncott Garrison P/S takes Blackthorn Rd P/S may take site C has Incoming 150mm sewer and pumps at 7l/s

Blackthorn Road P/S to take Site A has Incoming 200mm sewer and pumps at 31l/s

Regards
Geoff

Geoff.Nokes@thameswater.co.uk

02/02/2011 10:30

To: nick.wood@entecuk.co.uk
cc:
Subject: Re: Bicester - foul drainage issues

Nick

This is our position as outlined below.

Regards
Geoff

|------------>
| From: |
|------------>

>---
---|
  |nick.wood@entecuk.co.uk
|

>---
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|------------>
| To: |
|------------>

>---
---|
  |geoff.nokes@thameswater.co.uk
|

>---
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|------------>
| Cc: |
|------------>

>---
---|
  |Rachel.Dimmick@ENTECUK.CO.UK
|

>---
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|------------>
| Date: |
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---|
  |01/02/2011 18:08
|

>---
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|------------>
| Subject: |
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>---
---|
  |Bicester - foul drainage issues
|

>--|

Hi Geoff

Many thanks for the chat today. Would you be so kind as to confirm the following points from our conversation with respect to the Bicester Garrison site as this will be essential as part of our outline planning submission:

1) Thames Water's immediate concerns with accommodating the proposed development relate to the potential capacity issues at the pumping stations and sewage treatment works. As such further work on the existing model will be required including on site survey work as well understanding phasing opportunities See email from Thames Water to Nick Wood of Entec Uk dated 18/11/10. However, Thames Water will allow these issues to be addressed at detailed design stage as part of an impact study and are not required for outline planning stage. Thames Water has already provided a quote for this work.

2) If the development requires modification/reinforcement works to be carried out at any public sewage treatment works then the cost for this is likely to be met by Thames Water as part of their ongoing AMP commitments and may not require any contribution from the developer

3) Thames Water will allow the proposed development to be phased in accordingly so that the need for any local reinforcement works to pumping stations or the existing adopted network can be programmed and planned accordingly hence controlling any capital expenditure.

Kind regards

Nick

Entec
Entec UK Ltd,
Gables House,
Kenilworth Road,
Leamington Spa,
Warwickshire, CV32 6JX
(Direct: 01926 439 058
(Office: 01926 439 000
6Fax: 01926 439 010

Minutes of Meeting

Client	DIO	**Client Reference**	
Our Reference	27808-gl219	**Issued By**	Phill Clay
Issue Number		**Issue Date**	28th June 2011
Meeting Date	27th June 2011	**Location**	EA Office, Red Kite House, Wallingford
Present at Meeting (Distribution Copies)	Nick Wood - AMEC Phill Clay - AMEC Catherine Harrison - EA Ian Norris - EA Wayne Barker - OCC Gordon Hunt - OCC		
Apologies for Absence (Distribution Copies)			
Additional Distribution (Distribution Copies)	Richard Breakspear		
Project Name	Redevelopment of MOD Bicester		
Subject	**SURFACE WATER ISSUES AT C SITE AND GRAVEN HILL**		

		Actions
1.0	**Aim & Introduction**	
1.1	Aim of meeting was to make the EA and Oxfordshire County Council (OCC) aware of the proposed development aspirations to the Bicester development (C Site and Graven Hill), to discuss the approach of the proposed surface water strategy for each site and to identify any issues which may prevent us from gaining approval	
1.2	Amec reported that the outline planning application was due to be submitted in late summer/early Autumn. **Post note:** application will be for outline planning with all matters reserved. All to note	**All**
1.2	The existing situation and proposed strategy for each site was discussed. The key points are summarised as follows	
2.0	**C Site**	
2.1	The existing drainage regime for C site was discussed and it was stated that there are two key outfalls for the site (west & north). Contour/flow plans were tabled to highlight the existing catchment areas. Existing QBar flow rates of 5 l/s/ha were agreed by EA and OCC. 30yr and 100yr flow rates were also agreed.	
2.2	The proposed strategy for C Site was discussed. All agreed that the proposed flows leaving site would be based around a betterment of	

		Actions
	20%.	
2.3	One metre deep ditches were put forward but careful design of these would be needed if these were indeed to be included in the final scheme due to H&S reasons. The use of swales (300-400mm deep) with the possible use of a stone trench to create additional storage was welcomed and encouraged.	
2.4	OCC are keen on the use of permeable block paving in areas such as car parks.	
2.5	OCC suggested that the swales adjacent to the hardstanding area should outflow into the permeable paving sub base. AMEC to review but considered that the two systems should be kept separate for maintenance reasons EA agreed that designer should be responsible for preferred techniques.	**AMEC**
2.6	EA requested that off-line pond should be removed from the design due to the environmental/operational issues. They would not want the pond to dry out and not be utilised effectively. Although, an off-line pond could be used without objection if deemed absolutely necessary.	
2.7	Green roofs were discussed and the EA suggested the use of light-weight sedum matting to avoid the need to overload the structure. AMEC to discuss opportunity with urban designers	**AMEC**
2.8	AMEC to identify if 10m buffer zone on ponds is achievable. All confirmed that this would be difficult to achieve elsewhere	**AMEC**
3.0	**Graven Hill Site**	
3.1	Graven Hill existing catchments and outfalls were discussed. QBar flow rates of 5 l/s/ha were agreed by EA and OCC. 30yr and 100yr flow rates were also agreed. The downstream watercourse associated the outfalls for catchment C and D were unclear and as such the EA would use a software program to establish where the surface water will go – AMEC to contact EA to find out results	**AMEC**
3.2	The proposed strategy was discussed which included the use of permeable paving in car parks and driveways. Although rainwater harvesting is preferred by OCC it was agreed that the storage attributes should not be included in the design of the drainage system.	
3.3	The use of swales and the creation of 'green corridors' was favoured by all. OCC noted that the flood flow routes should be designed away from the school and that any pond located within the school boundary should only be used by the school and not be used for a wider site control. OCC stated that schools like to see open playing fields but the EA agreed with AMEC that an educational pond area would be beneficial to the children – to be discussed further at detailed design	

		Actions
	stage.	
3.4	The idea of introducing a new outfall in 'Catchment A' could not be ruled out but the EA would like to understand the issues associated with the River if this went forward. **Post Note:** After reviewing the contours and catchment again, it is favoured that this area is redesigned so that the existing outfall in 'Catchment G' is used instead. Amec to check with urban design/landscape team	**AMEC**
3.5	EA welcomed the use of several open wet ponds as opposed to underground tanks or a single large pond.	
3.6	OCC raised the issue of springs located on the hill side. AMEC to review if there is any initial evidence at this point in time.	**AMEC**
3.7	Existing flow rates for the sub-catchments and proposed 20% flow betterment was agreed by all	
3.8	Issue regarding flooding to south of D Site was discussed and the EA confirmed that there are no control devices at Islip (as thought by the land owner). EA agreed that a 20% betterment to flows will help alleviate this but we should not be attempting to completely solve the problem	
3.9	AMEC to consider implication of submerged outfall conditions if fluvial flow is deemed to impact on the discharge	**AMEC**
3.10	AMEC to identify allowable discharge constraints from individual development parcels	**AMEC**
4.0	**General**	
4.1	The EA and OCC agreed with our strategy to date and were keen to see the final outline design. Also to date OCC/EA identified no 'show stoppers' which would prevent us from obtaining approval if the issues in these minutes were satisfactorily addressed	
4.2	AMEC to keep the EA informed of progress	

Appendix E
Modelling Results

Existing Network Details for Catchment A - SW Model.txt

* - Indicates pipe has been modified outside of System 1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)
* 1.000	24.959	0.062	402.6	1.040	5.00	0.600	o	600
* 1.001	203.848	0.510	399.7	0.000	0.00	0.600	o	600
* 2.000	23.288	0.500	46.6	1.560	5.00	0.600	o	300
* 2.001	41.235	0.442	93.3	0.000	0.00	0.600	o	300
* 1.002	126.417	3.079	41.1	0.000	0.00	0.600	o	600
* 3.000	12.278	0.300	40.9	5.730	5.00	0.600	o	300
* 3.001	24.642	0.221	111.5	0.000	0.00	0.600	o	300
* 1.003	142.316	3.609	39.4	0.500	0.00	0.600	o	600
* 4.000	18.121	0.200	90.6	3.600	5.00	0.600	o	300
* 4.001	48.201	0.230	209.6	0.000	0.00	0.600	o	300
* 5.000	13.515	0.200	67.6	4.400	5.00	0.600	o	300
* 5.001	16.521	0.230	71.8	0.000	0.00	0.600	o	300
* 1.004	44.280	0.120	369.0	0.342	0.00	0.600	o	600
* 1.005	83.760	0.600	139.6	0.000	0.00	0.600	o	600
* 1.006	27.442	0.050	548.8	0.000	0.00	0.600	o	600

PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
* 1.000	1	76.730	74.330	1.800	76.880	74.268	2.012		1200
* 1.001	2	76.880	74.268	2.012	77.020	73.758	2.662	Hydro-Brake®	1200
* 2.000	3	77.440	75.000	2.140	77.490	74.500	2.690		1200
* 2.001	4	77.490	74.500	2.690	77.020	74.058	2.662	Hydro-Brake®	1200
* 1.002	5	77.020	73.758	2.662	73.080	70.679	1.801		1200
* 3.000	6	73.420	71.500	1.620	73.420	71.200	1.920		1200
* 3.001	7	73.420	71.200	1.920	73.080	70.979	1.801	Hydro-Brake®	1200
* 1.003	8	73.080	70.679	1.801	69.470	67.070	1.800		1200
* 4.000	9	71.890	67.800	3.790	71.890	67.600	3.990		1200
* 4.001	10	71.890	67.600	3.990	69.470	67.370	1.800	Hydro-Brake®	1200
* 5.000	11	70.300	67.800	2.200	70.300	67.600	2.400		1200
* 5.001	12	70.300	67.600	2.400	69.470	67.370	1.800	Hydro-Brake®	1200
* 1.004	13	69.470	67.070	1.800	69.000	66.950	1.450		1200
* 1.005	14	69.000	66.950	1.450	67.650	66.350	0.700		1200
* 1.006	15	67.650	66.350	0.700	67.370	66.300	0.470		1200

Existing Network Details for Catchment A - SW Model.txt

	PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)
*	1.007	110.895	0.200	554.5	0.000	0.00	0.600	o	600
*	1.008	354.690	0.600	591.2	0.000	0.00	0.600	o	600
*	1.009	500.000	0.000	0.0	0.000	0.00	0.600	[]	20
*	1.010	500.000	0.000	0.0	0.000	0.00	0.600	[]	20
*	1.011	78.564	0.150	523.8	0.000	0.00	0.600	o	450
*	6.000	12.399	0.030	413.3	1.830	5.00	0.600	o	300
*	6.001	11.422	0.154	74.2	0.000	0.00	0.600	o	300
*	1.012	83.918	0.168	499.5	0.000	0.00	0.600	o	600
*	7.000	10.069	0.100	100.7	0.800	5.00	0.600	o	300
*	7.001	19.923	0.152	131.1	0.000	0.00	0.600	o	300
*	1.013	146.088	0.292	500.3	0.000	0.00	0.600	o	600
*	8.000	11.519	0.034	338.8	2.460	5.00	0.600	o	300
*	8.001	17.625	0.210	83.9	0.000	0.00	0.600	o	300
*	1.014	72.983	0.148	493.1	0.000	0.00	0.600	o	600
*	9.000	19.995	0.150	133.3	3.680	5.00	0.600	o	300
*	9.001	74.601	0.342	218.1	0.000	0.00	0.600	o	300

	PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
*	1.007	16	67.370	66.300	0.470	67.600	66.100	0.900		1200
*	1.008	17	67.600	66.100	0.900	67.200	65.500	1.100		1200
*	1.009	18	67.200	64.600	1.100	66.300	64.600	0.200		1200
*	1.010	19	66.300	64.600	0.200	66.300	64.600	0.200		1200
*	1.011	20	66.300	64.600	1.250	65.200	64.450	0.300	Hydro-Brake®	1200
*	6.000	21	65.200	64.400	0.500	65.200	64.370	0.530		1200
*	6.001	22	65.200	64.370	0.530	65.200	64.216	0.684	Hydro-Brake®	1200
*	1.012	23	65.200	63.916	0.684	65.290	63.748	0.942		1200
*	7.000	24	65.290	64.300	0.690	65.290	64.200	0.790		1200
*	7.001	25	65.290	64.200	0.790	65.290	64.048	0.942	Hydro-Brake®	1200
*	1.013	26	65.290	63.748	0.942	67.600	63.456	3.544		1200
*	8.000	27	67.800	64.000	3.500	67.800	63.966	3.534		1200
*	8.001	28	67.800	63.966	3.534	67.600	63.756	3.544	Hydro-Brake®	1200
*	1.014	29	67.600	63.456	3.544	68.300	63.308	4.392		1200
*	9.000	30	69.620	64.100	5.220	69.620	63.950	5.370		1200
*	9.001	31	69.620	63.950	5.370	68.300	63.608	4.392	Hydro-Brake®	1200

Existing Network Details for Catchment A - SW Model.txt

	PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)
*	1.015	174.662	0.350	499.0	1.060	0.00	0.600	o	600
*	10.000	19.778	0.200	98.9	1.540	5.00	0.600	o	300
*	10.001	24.341	0.142	171.4	0.000	0.00	0.600	o	300
*	1.016	76.823	0.258	297.8	0.280	0.00	0.600	o	600
*	1.017	200.000	0.100	2000.0	0.000	0.00	0.600	[]	12
*	1.018	164.636	0.200	823.2	0.000	0.00	0.600	o	600

	PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
*	1.015	32	68.300	63.308	4.392	68.300	62.958	4.742		1200
*	10.000	33	68.000	63.600	4.100	68.000	63.400	4.300		1200
*	10.001	34	68.000	63.400	4.300	68.300	63.258	4.742	Hydro-Brake®	1200
*	1.016	35	68.300	62.958	4.742	68.000	62.700	4.700		1200
*	1.017	36	68.000	62.300	4.700	68.000	62.200	4.800		1200
*	1.018	37	68.000	62.200	5.200	66.400	62.000	3.800		1200

Simulation Criteria for Catchment A - SW Model.txt

Volumetric Runoff Coeff	0.649	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	7	Number of Storage Structures	10
Number of Online Controls	11	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.649
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	30
Ratio R	0.400		

Online Controls for Catchment A - SW Model.txt

Hydro-Brake® Manhole: 2, DS/PN: 1.001, Volume (m^3): 9.7

Design Head (m) 2.000 Hydro-Brake® Type Md1 Invert Level (m) 74.268
Design Flow (l/s) 23.0 Diameter (mm) 120

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.9	1.200	17.6	3.000	27.8	7.000	42.4
0.200	9.9	1.400	19.0	3.500	30.0	7.500	43.9
0.300	9.5	1.600	20.3	4.000	32.1	8.000	45.3
0.400	10.2	1.800	21.5	4.500	34.0	8.500	46.7
0.500	11.3	2.000	22.7	5.000	35.8	9.000	48.1
0.600	12.4	2.200	23.8	5.500	37.6	9.500	49.4
0.800	14.3	2.400	24.8	6.000	39.3		
1.000	16.0	2.600	25.8	6.500	40.9		

Hydro-Brake® Manhole: 4, DS/PN: 2.001, Volume (m^3): 4.9

Design Head (m) 2.000 Hydro-Brake® Type Md1 Invert Level (m) 74.500
Design Flow (l/s) 34.0 Diameter (mm) 146

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.9	1.200	26.0	3.000	41.1	7.000	62.8
0.200	14.5	1.400	28.1	3.500	44.4	7.500	65.0
0.300	16.4	1.600	30.0	4.000	47.5	8.000	67.1
0.400	15.6	1.800	31.8	4.500	50.3	8.500	69.2
0.500	16.8	2.000	33.6	5.000	53.1	9.000	71.2
0.600	18.4	2.200	35.2	5.500	55.7	9.500	73.1
0.800	21.2	2.400	36.8	6.000	58.1		
1.000	23.7	2.600	38.3	6.500	60.5		

Hydro-Brake® Manhole: 7, DS/PN: 3.001, Volume (m^3): 3.3

Design Head (m) 2.000 Hydro-Brake® Type Md1 Invert Level (m) 71.200
Design Flow (l/s) 126.0 Diameter (mm) 282

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	9.3	1.200	97.0	3.000	153.3	7.000	234.2
0.200	32.3	1.400	104.8	3.500	165.6	7.500	242.4
0.300	58.2	1.600	112.0	4.000	177.1	8.000	250.4
0.400	76.9	1.800	118.8	4.500	187.8	8.500	258.1
0.500	85.5	2.000	125.2	5.000	198.0	9.000	265.6
0.600	84.1	2.200	131.3	5.500	207.6	9.500	272.9
0.800	81.3	2.400	137.1	6.000	216.9		
1.000	88.7	2.600	142.7	6.500	225.7		

Hydro-Brake® Manhole: 10, DS/PN: 4.001, Volume (m³): 6.0

Design Head (m) 2.000 Hydro-Brake® Type Md1 Invert Level (m) 67.600
Design Flow (l/s) 79.0 Diameter (mm) 224

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	8.1	1.200	61.2	3.000	96.7	7.000	147.8
0.200	25.9	1.400	66.1	3.500	104.5	7.500	153.0
0.300	41.5	1.600	70.7	4.000	111.7	8.000	158.0
0.400	48.2	1.800	74.9	4.500	118.5	8.500	162.9
0.500	46.5	2.000	79.0	5.000	124.9	9.000	167.6
0.600	45.3	2.200	82.9	5.500	131.0	9.500	172.2
0.800	50.0	2.400	86.5	6.000	136.8		
1.000	55.9	2.600	90.1	6.500	142.4		

Hydro-Brake® Manhole: 12, DS/PN: 5.001, Volume (m³): 3.9

Design Head (m) 2.000 Hydro-Brake® Type Md1 Invert Level (m) 67.600
Design Flow (l/s) 97.0 Diameter (mm) 248

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	8.6	1.200	75.0	3.000	118.6	7.000	181.2
0.200	28.7	1.400	81.0	3.500	128.1	7.500	187.5
0.300	48.8	1.600	86.6	4.000	136.9	8.000	193.7
0.400	59.8	1.800	91.9	4.500	145.2	8.500	199.6
0.500	61.9	2.000	96.8	5.000	153.1	9.000	205.4
0.600	58.7	2.200	101.6	5.500	160.6	9.500	211.0
0.800	61.6	2.400	106.1	6.000	167.7		
1.000	68.5	2.600	110.4	6.500	174.6		

Hydro-Brake® Manhole: 20, DS/PN: 1.011, Volume (m³): 1971.7

Design Head (m) 2.000 Hydro-Brake® Type Md1 Invert Level (m) 64.600
Design Flow (l/s) 230.0 Diameter (mm) 382

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	10.9	1.200	179.5	3.000	281.4	7.000	429.8
0.200	40.9	1.400	192.4	3.500	303.9	7.500	444.9
0.300	81.1	1.600	205.5	4.000	324.9	8.000	459.5
0.400	121.9	1.800	218.0	4.500	344.6	8.500	473.6
0.500	154.6	2.000	229.7	5.000	363.2	9.000	487.3
0.600	173.7	2.200	241.0	5.500	381.0	9.500	500.7
0.800	180.5	2.400	251.7	6.000	397.9		
1.000	171.6	2.600	261.9	6.500	414.2		

Hydro-Brake® Manhole: 22, DS/PN: 6.001, Volume (m³): 1.7

Design Head (m) 2.000 Hydro-Brake® Type Md1 Invert Level (m) 64.370
Design Flow (l/s) 104.0 Diameter (mm) 257

Hydro-Brake® Manhole: 22, DS/PN: 6.001, Volume (m³): 1.7

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	8.8	1.200	80.5	3.000	127.4	7.000	194.5
0.200	29.7	1.400	87.0	3.500	137.6	7.500	201.4
0.300	51.4	1.600	93.0	4.000	147.1	8.000	208.0
0.400	64.2	1.800	98.6	4.500	156.0	8.500	214.4
0.500	68.2	2.000	104.0	5.000	164.4	9.000	220.6
0.600	64.7	2.200	109.1	5.500	172.4	9.500	226.6
0.800	66.4	2.400	113.9	6.000	180.1		
1.000	73.6	2.600	118.6	6.500	187.5		

Hydro-Brake® Manhole: 25, DS/PN: 7.001, Volume (m³): 1.9

Design Head (m) 2.000 Hydro-Brake® Type Md1 Invert Level (m) 64.200
Design Flow (l/s) 46.0 Diameter (mm) 170

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.6	1.200	35.2	3.000	55.7	7.000	85.1
0.200	18.4	1.400	38.1	3.500	60.2	7.500	88.1
0.300	24.1	1.600	40.7	4.000	64.3	8.000	91.0
0.400	23.0	1.800	43.2	4.500	68.2	8.500	93.8
0.500	23.2	2.000	45.5	5.000	71.9	9.000	96.5
0.600	25.0	2.200	47.7	5.500	75.5	9.500	99.2
0.800	28.8	2.400	49.8	6.000	78.8		
1.000	32.2	2.600	51.9	6.500	82.0		

Hydro-Brake® Manhole: 28, DS/PN: 8.001, Volume (m³): 5.1

Design Head (m) 2.000 Hydro-Brake® Type Md1 Invert Level (m) 63.966
Design Flow (l/s) 140.0 Diameter (mm) 298

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	9.6	1.200	108.3	3.000	171.2	7.000	261.6
0.200	33.8	1.400	117.0	3.500	185.0	7.500	270.7
0.300	62.3	1.600	125.0	4.000	197.7	8.000	279.6
0.400	84.8	1.800	132.6	4.500	209.7	8.500	288.2
0.500	96.4	2.000	139.8	5.000	221.1	9.000	296.6
0.600	98.1	2.200	146.6	5.500	231.8	9.500	304.7
0.800	92.4	2.400	153.2	6.000	242.2		
1.000	99.2	2.600	159.4	6.500	252.0		

Hydro-Brake® Manhole: 31, DS/PN: 9.001, Volume (m³): 7.7

Design Head (m) 4.500 Hydro-Brake® Type Md1 Invert Level (m) 63.950
Design Flow (l/s) 210.0 Diameter (mm) 298

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	9.6	0.400	84.8	0.800	92.4	1.400	117.0
0.200	33.8	0.500	96.4	1.000	99.2	1.600	125.0
0.300	62.3	0.600	98.1	1.200	108.3	1.800	132.6

Hydro-Brake® Manhole: 31, DS/PN: 9.001, Volume (m³): 7.7

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
2.000	139.8	3.500	185.0	6.000	242.2	8.500	288.2
2.200	146.6	4.000	197.7	6.500	252.0	9.000	296.6
2.400	153.2	4.500	209.7	7.000	261.6	9.500	304.7
2.600	159.4	5.000	221.1	7.500	270.7		
3.000	171.2	5.500	231.8	8.000	279.6		

Hydro-Brake® Manhole: 34, DS/PN: 10.001, Volume (m³): 6.5

Design Head (m) 2.000 Hydro-Brake® Type Md1 Invert Level (m) 63.400
Design Flow (l/s) 88.0 Diameter (mm) 236

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	8.3	1.200	67.9	3.000	107.4	7.000	164.0
0.200	27.3	1.400	73.4	3.500	116.0	7.500	169.8
0.300	45.2	1.600	78.4	4.000	124.0	8.000	175.4
0.400	54.0	1.800	83.2	4.500	131.5	8.500	180.8
0.500	53.9	2.000	87.7	5.000	138.6	9.000	186.0
0.600	51.5	2.200	92.0	5.500	145.4	9.500	191.1
0.800	55.6	2.400	96.1	6.000	151.9		
1.000	62.0	2.600	100.0	6.500	158.1		

Storage Structures for Catchment A - SW Model.txt

Tank or Pond Manhole: 1, DS/PN: 1.000

Invert Level (m) 74.330

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	10000.0	1.000	10000.0

Tank or Pond Manhole: 3, DS/PN: 2.000

Invert Level (m) 75.000

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	10000.0	1.000	10000.0

Tank or Pond Manhole: 6, DS/PN: 3.000

Invert Level (m) 71.500

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	10000.0	1.000	10000.0

Tank or Pond Manhole: 9, DS/PN: 4.000

Invert Level (m) 67.800

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	10000.0	1.000	10000.0

Tank or Pond Manhole: 11, DS/PN: 5.000

Invert Level (m) 67.800

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	10000.0	1.000	10000.0

Tank or Pond Manhole: 21, DS/PN: 6.000

Invert Level (m) 64.400

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	5000.0	0.800	5000.0

Tank or Pond Manhole: 24, DS/PN: 7.000

Invert Level (m) 64.300

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	5000.0	1.000	5000.0

Tank or Pond Manhole: 27, DS/PN: 8.000

Invert Level (m) 66.800

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	5000.0	1.000	5000.0

Tank or Pond Manhole: 30, DS/PN: 9.000

Invert Level (m) 68.620

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	5000.0	1.000	5000.0

Tank or Pond Manhole: 33, DS/PN: 10.000

Invert Level (m) 67.000

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	5000.0	1.000	5000.0

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment A - SW Model.txt

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	1440 Winter	1	0%					
1.001	1440 Winter	1	0%					
2.000	1440 Winter	1	0%					
2.001	1440 Winter	1	0%	100/120 Summer				
1.002	1440 Winter	1	0%					
3.000	960 Winter	1	0%					
3.001	960 Winter	1	0%	30/60 Winter				
1.003	15 Winter	1	0%					
4.000	1440 Winter	1	0%					
4.001	1440 Winter	1	0%	100/60 Winter				
5.000	960 Winter	1	0%					
5.001	960 Winter	1	0%	100/30 Winter				
1.004	15 Winter	1	0%	100/15 Summer				
1.005	15 Winter	1	0%	100/15 Winter				
1.006	15 Winter	1	0%	30/15 Winter				
1.007	15 Winter	1	0%	100/15 Summer				
1.008	15 Winter	1	0%	100/15 Summer				
1.009	960 Winter	1	0%					
1.010	1440 Winter	1	0%					
1.011	1440 Winter	1	0%	30/360 Winter				
6.000	1440 Winter	1	0%					
6.001	1440 Winter	1	0%	100/15 Summer				
1.012	1440 Winter	1	0%	30/30 Summer	100/15 Summer			1
7.000	1440 Winter	1	0%					
7.001	1440 Winter	1	0%	30/30 Winter				
1.013	30 Winter	1	0%	30/15 Summer	100/15 Winter			3
8.000	15 Winter	1	0%					
8.001	30 Winter	1	0%		30/360 Summer			3
1.014	30 Winter	1	0%	30/15 Summer				
9.000	15 Winter	1	0%					
9.001	15 Summer	1	0%		30/480 Summer			1
1.015	30 Winter	1	0%					
10.000	15 Winter	1	0%					
10.001	15 Winter	1	0%		100/360 Summer			2
1.016	30 Winter	1	0%	1/15 Winter				
1.017	60 Winter	1	0%	30/60 Winter				
1.018	60 Winter	1	0%	1/15 Winter				

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment A - SW Model.txt

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m^3)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	74.352	-0.578	0.000	0.00	0.0	1.3	OK
1.001	2	74.326	-0.542	0.000	0.01	0.0	2.0	OK
2.000	3	75.029	-0.271	0.000	0.02	0.0	3.0	OK
2.001	4	74.568	-0.232	0.000	0.03	0.0	3.0	OK
1.002	5	73.773	-0.585	0.000	0.01	0.0	5.4	OK
3.000	6	71.586	-0.214	0.000	0.18	0.0	24.9	OK
3.001	7	71.371	-0.129	0.000	0.27	0.0	24.9	OK
1.003	8	70.774	-0.505	0.000	0.06	0.0	61.4	OK
4.000	9	67.864	-0.236	0.000	0.10	0.0	10.2	OK
4.001	10	67.714	-0.186	0.000	0.14	0.0	10.2	OK
5.000	11	67.873	-0.227	0.000	0.13	0.0	15.0	OK
5.001	12	67.735	-0.165	0.000	0.13	0.0	15.0	OK
1.004	13	67.308	-0.362	0.000	0.33	0.0	100.8	OK
1.005	14	67.125	-0.425	0.000	0.18	0.0	99.1	OK
1.006	15	66.628	-0.322	0.000	0.41	0.0	96.9	OK
1.007	16	66.546	-0.354	0.000	0.33	0.0	89.1	OK
1.008	17	66.329	-0.371	0.000	0.31	0.0	85.9	OK
1.009	18	64.849	-1.251	0.000	0.01	0.0	59.2	OK
1.010	19	64.844	-1.256	0.000	0.01	0.0	56.4	OK
1.011	20	64.840	-0.210	0.000	0.43	0.0	56.2	OK
6.000	21	64.470	-0.230	0.000	0.11	0.0	4.1	OK
6.001	22	64.437	-0.233	0.000	0.04	0.0	4.1	OK
1.012	23	64.103	-0.413	0.000	0.21	0.0	60.2	OK
7.000	24	64.329	-0.271	0.000	0.02	0.0	1.6	OK
7.001	25	64.247	-0.253	0.000	0.02	0.0	1.6	OK
1.013	26	64.051	-0.297	0.000	0.07	0.0	19.4	OK
8.000	27	66.804	2.504	0.000	3.32	0.0	150.4	SURCHARGED
8.001	28	66.470	2.204	0.000	1.42	0.0	147.6	SURCHARGED
1.014	29	64.053	-0.003	0.000	0.48	0.0	133.8	OK
9.000	30	68.630	4.230	0.000	2.03	0.0	170.2	SURCHARGED
9.001	31	68.115	3.865	0.000	2.22	0.0	159.7	SURCHARGED
1.015	32	64.013	0.105	0.000	1.08	0.0	317.8	SURCHARGED
10.000	33	67.000	3.100	0.000	1.17	0.0	113.3	SURCHARGED
10.001	34	66.767	3.067	0.000	1.45	0.0	109.1	SURCHARGED
1.016	35	63.602	0.044	0.000	1.14	0.0	412.5	SURCHARGED
1.017	36	62.954	-0.346	0.000	0.14	0.0	387.3	OK
1.018	37	62.945	0.145	0.000	1.35	0.0	307.6	SURCHARGED

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment A - SW Model.txt

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	1440 Winter	30	0%					
1.001	1440 Summer	30	0%					
2.000	960 Winter	30	0%					
2.001	960 Winter	30	0%	100/120 Summer				
1.002	1440 Winter	30	0%					
3.000	360 Winter	30	0%					
3.001	360 Winter	30	0%	30/60 Winter				
1.003	15 Winter	30	0%					
4.000	480 Winter	30	0%					
4.001	480 Winter	30	0%	100/60 Winter				
5.000	480 Winter	30	0%					
5.001	480 Winter	30	0%	100/30 Winter				
1.004	15 Winter	30	0%	100/15 Summer				
1.005	15 Winter	30	0%	100/15 Winter				
1.006	15 Winter	30	0%	30/15 Winter				
1.007	15 Winter	30	0%	100/15 Summer				
1.008	15 Winter	30	0%	100/15 Summer				
1.009	960 Winter	30	0%					
1.010	960 Winter	30	0%					
1.011	960 Winter	30	0%	30/360 Winter				
6.000	960 Winter	30	0%					
6.001	30 Winter	30	0%	100/15 Summer				
1.012	30 Winter	30	0%	30/30 Summer	100/15 Summer			1
7.000	960 Winter	30	0%					
7.001	30 Winter	30	0%	30/30 Winter				
1.013	30 Winter	30	0%	30/15 Summer	100/15 Winter			3
8.000	30 Winter	30	0%					
8.001	480 Summer	30	0%		30/360 Summer			3
1.014	30 Winter	30	0%	30/15 Summer				
9.000	30 Winter	30	0%					
9.001	480 Summer	30	0%		30/480 Summer			1
1.015	30 Winter	30	0%					
10.000	30 Winter	30	0%					
10.001	30 Summer	30	0%		100/360 Summer			2
1.016	30 Winter	30	0%	1/15 Winter				
1.017	120 Winter	30	0%	30/60 Winter				
1.018	120 Winter	30	0%	1/15 Winter				

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment A - SW Model.txt

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	74.379	-0.551	0.000	0.01	0.0	2.8	OK
1.001	2	74.369	-0.499	0.000	0.01	0.0	5.0	OK
2.000	3	75.054	-0.246	0.000	0.08	0.0	10.9	OK
2.001	4	74.651	-0.149	0.000	0.10	0.0	10.9	OK
1.002	5	73.806	-0.552	0.000	0.02	0.0	17.3	OK
3.000	6	71.665	-0.135	0.000	0.54	0.0	73.8	OK
3.001	7	71.578	0.078	0.000	0.79	0.0	73.8	SURCHARGED
1.003	8	70.852	-0.427	0.000	0.18	0.0	183.9	OK
4.000	9	67.917	-0.183	0.000	0.32	0.0	32.5	OK
4.001	10	67.837	-0.063	0.000	0.45	0.0	32.5	OK
5.000	11	67.936	-0.164	0.000	0.42	0.0	47.3	OK
5.001	12	67.891	-0.009	0.000	0.42	0.0	47.3	OK
1.004	13	67.557	-0.113	0.000	0.98	0.0	301.1	OK
1.005	14	67.272	-0.278	0.000	0.55	0.0	293.0	OK
1.006	15	66.951	0.001	0.000	1.17	0.0	273.6	SURCHARGED
1.007	16	66.782	-0.118	0.000	0.88	0.0	238.5	OK
1.008	17	66.520	-0.180	0.000	0.83	0.0	229.9	OK
1.009	18	65.118	-0.982	0.000	0.03	0.0	176.3	OK
1.010	19	65.113	-0.987	0.000	0.03	0.0	158.3	OK
1.011	20	65.108	0.058	0.000	1.14	0.0	150.0	SURCHARGED
6.000	21	64.527	-0.173	0.000	0.34	0.0	12.9	OK
6.001	22	64.557	-0.113	0.000	0.05	0.0	4.7	OK
1.012	23	64.630	0.114	0.000	0.19	0.0	53.1	SURCHARGED
7.000	24	64.354	-0.246	0.000	0.08	0.0	6.0	OK
7.001	25	64.511	0.011	0.000	0.03	0.0	2.9	SURCHARGED
1.013	26	64.656	0.308	0.000	0.18	0.0	53.4	SURCHARGED
8.000	27	66.851	2.551	0.000	3.36	0.0	152.1	SURCHARGED
8.001	28	67.320	3.054	0.000	1.10	0.0	114.5	SURCHARGED
1.014	29	64.691	0.635	0.000	0.69	0.0	193.5	SURCHARGED
9.000	30	68.707	4.307	0.000	2.00	0.0	167.3	SURCHARGED
9.001	31	69.432	5.182	1.823	2.11	0.0	152.0	FLOOD
1.015	32	64.671	0.763	0.000	1.42	0.0	416.0	SURCHARGED
10.000	33	67.027	3.127	0.000	1.18	0.0	114.8	SURCHARGED
10.001	34	66.819	3.119	0.000	1.43	0.0	107.9	SURCHARGED
1.016	35	63.898	0.340	0.000	1.55	0.0	562.5	SURCHARGED
1.017	36	63.409	0.109	0.000	0.18	0.0	501.1	SURCHARGED
1.018	37	63.393	0.593	0.000	2.02	0.0	460.1	SURCHARGED

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment A - SW Model.txt

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	1440 Winter	100	+30%					
1.001	480 Summer	100	+30%					
2.000	480 Winter	100	+30%					
2.001	480 Winter	100	+30%	100/120 Summer				
1.002	480 Summer	100	+30%					
3.000	240 Winter	100	+30%					
3.001	1440 Winter	100	+30%	30/60 Winter				
1.003	15 Winter	100	+30%					
4.000	480 Winter	100	+30%					
4.001	960 Winter	100	+30%	100/60 Winter				
5.000	480 Winter	100	+30%					
5.001	480 Winter	100	+30%	100/30 Winter				
1.004	15 Winter	100	+30%	100/15 Summer				
1.005	15 Winter	100	+30%	100/15 Winter				
1.006	15 Winter	100	+30%	30/15 Winter				
1.007	15 Winter	100	+30%	100/15 Summer				
1.008	15 Winter	100	+30%	100/15 Summer				
1.009	960 Winter	100	+30%					
1.010	960 Winter	100	+30%					
1.011	960 Winter	100	+30%	30/360 Winter				
6.000	360 Winter	100	+30%					
6.001	30 Winter	100	+30%	100/15 Summer				
1.012	30 Summer	100	+30%	30/30 Summer	100/15 Summer			1
7.000	360 Winter	100	+30%					
7.001	30 Summer	100	+30%	30/30 Winter				
1.013	15 Winter	100	+30%	30/15 Summer	100/15 Winter			3
8.000	60 Winter	100	+30%					
8.001	480 Summer	100	+30%		30/360 Summer			3
1.014	15 Winter	100	+30%	30/15 Summer				
9.000	60 Winter	100	+30%					
9.001	1440 Summer	100	+30%		30/480 Summer			1
1.015	15 Winter	100	+30%					
10.000	60 Winter	100	+30%					
10.001	480 Summer	100	+30%		100/360 Summer			2
1.016	120 Winter	100	+30%	1/15 Winter				
1.017	120 Winter	100	+30%	30/60 Winter				
1.018	120 Winter	100	+30%	1/15 Winter				

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment A - SW Model.txt

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	74.437	-0.493	0.000	0.03	0.0	7.7	OK
1.001	2	74.517	-0.351	0.000	0.03	0.0	10.2	OK
2.000	3	75.087	-0.213	0.000	0.12	0.0	18.1	OK
2.001	4	75.060	0.260	0.000	0.17	0.0	17.8	SURCHARGED
1.002	5	73.842	-0.516	0.000	0.05	0.0	48.9	OK
3.000	6	71.789	-0.011	0.000	0.61	0.0	84.2	OK
3.001	7	71.736	0.236	0.000	0.85	0.0	79.6	SURCHARGED
1.003	8	70.909	-0.370	0.000	0.30	0.0	313.4	OK
4.000	9	67.996	-0.104	0.000	0.43	0.0	43.5	OK
4.001	10	67.995	0.095	0.000	0.60	0.0	43.4	SURCHARGED
5.000	11	68.042	-0.058	0.000	0.48	0.0	53.8	OK
5.001	12	68.385	0.485	0.000	0.46	0.0	51.0	SURCHARGED
1.004	13	67.865	0.195	0.000	1.63	0.0	501.2	SURCHARGED
1.005	14	67.616	0.066	0.000	0.84	0.0	447.4	SURCHARGED
1.006	15	67.355	0.405	0.000	1.73	0.0	405.2	FLOOD RISK
1.007	16	67.267	0.367	0.000	1.35	0.0	368.9	FLOOD RISK
1.008	17	67.074	0.374	0.000	1.24	0.0	340.5	SURCHARGED
1.009	18	65.943	-0.157	0.000	0.04	0.0	260.1	OK
1.010	19	65.918	-0.182	0.000	0.04	0.0	215.4	OK
1.011	20	65.895	0.845	0.000	1.40	0.0	184.6	SURCHARGED
6.000	21	64.647	-0.053	0.000	0.98	0.0	37.0	OK
6.001	22	64.807	0.137	0.000	0.14	0.0	13.6	SURCHARGED
1.012	23	65.201	0.685	0.515	0.30	0.0	84.8	FLOOD
7.000	24	64.424	-0.176	0.000	0.23	0.0	18.6	OK
7.001	25	64.634	0.134	0.000	0.07	0.0	5.8	SURCHARGED
1.013	26	65.297	0.949	8.767	0.25	0.0	74.3	FLOOD
8.000	27	66.924	2.624	0.000	3.22	0.0	145.9	SURCHARGED
8.001	28	67.800	3.534	1.056	1.23	0.0	128.1	FLOOD
1.014	29	65.629	1.573	0.000	0.75	0.0	209.7	SURCHARGED
9.000	30	68.829	4.429	0.000	1.93	0.0	161.7	SURCHARGED
9.001	31	69.621	5.371	7.183	1.57	0.0	113.3	FLOOD
1.015	32	65.688	1.780	0.000	1.72	0.0	506.4	SURCHARGED
10.000	33	67.068	3.168	0.000	1.13	0.0	110.1	SURCHARGED
10.001	34	68.000	4.300	1.309	1.24	0.0	93.8	FLOOD
1.016	35	64.360	0.802	0.000	1.63	0.0	590.6	SURCHARGED
1.017	36	63.781	0.481	0.000	0.20	0.0	568.8	SURCHARGED
1.018	37	63.761	0.961	0.000	2.31	0.0	526.7	SURCHARGED

Existing Network Details for Catchment B - SW Model.txt

* - Indicates pipe has been modified outside of System 1

	PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)
*	1.000	57.722	0.144	400.8	0.473	5.00	0.600	o	450
*	1.001	117.399	1.016	115.6	0.000	5.00	0.600	o	450
*	2.000	10.576	0.026	406.8	0.470	5.00	0.600	o	450
*	2.001	79.972	0.747	107.1	0.000	0.00	0.600	o	225
*	3.000	8.144	0.020	407.2	0.940	5.00	0.600	o	450
*	3.001	51.525	0.533	96.7	0.000	0.00	0.600	o	225
*	4.000	8.430	0.050	168.6	0.520	5.00	0.600	o	450
*	4.001	30.884	0.233	132.5	0.000	0.00	0.600	o	225
*	1.002	58.967	0.362	162.9	0.237	5.00	0.600	o	450
*	1.003	116.993	0.234	500.0	0.236	5.00	0.600	o	450
*	5.000	14.196	0.035	405.6	0.420	5.00	0.600	o	450
*	5.001	17.970	0.744	24.2	0.000	0.00	0.600	o	225
*	1.004	122.452	0.396	309.2	0.473	5.00	0.600	o	450
*	1.005	800.000	0.000	0.0	0.000	0.00	0.600	[]	8
*	1.006	20.472	0.181	113.1	0.000	0.00	0.600	o	450

	PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
*	1.000	1	71.000	69.200	1.350	70.430	69.056	0.924		1500
*	1.001	2	70.430	69.056	0.924	68.800	68.040	0.310		1500
*	2.000	3	69.840	68.040	1.350	69.840	68.014	1.376		1500
*	2.001	4	69.840	68.014	1.601	68.800	67.267	1.308		1500
*	3.000	5	69.620	67.820	1.350	69.620	67.800	1.370		1500
*	3.001	6	69.620	67.800	1.595	68.800	67.267	1.308		1500
*	4.000	7	68.940	67.550	0.940	68.940	67.500	0.990		1500
*	4.001	8	68.940	67.500	1.215	68.800	67.267	1.308		1500
*	1.002	9	68.800	67.042	1.308	68.800	66.680	1.670		1500
*	1.003	10	68.800	66.680	1.670	69.310	66.446	2.414		1500
*	5.000	11	69.250	67.450	1.350	69.250	67.415	1.385		1500
*	5.001	12	69.250	67.415	1.610	69.310	66.671	2.414		1500
*	1.004	13	69.310	66.446	2.414	67.850	66.050	1.350		1500
*	1.005	14	67.850	65.500	1.350	67.170	65.500	0.670		1500
*	1.006	15	67.170	65.500	1.220	66.400	65.319	0.631	Hydro-Brake®	1500

Simulation Criteria for Catchment B - SW Model.txt

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

Number of Input Hydrographs	2	Number of Storage Structures	5
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	30
Ratio R	0.400		

Online Controls for Catchment B - SW Model.txt

Hydro-Brake® Manhole: 15, DS/PN: 1.006, Volume (m^3): 936.4

Design Head (m) 1.200 Hydro-Brake® Type Md1 Invert Level (m) 65.500
Design Flow (l/s) 130.0 Diameter (mm) 326

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	10.1	1.200	129.8	3.000	204.9	7.000	313.0
0.200	36.4	1.400	140.0	3.500	221.3	7.500	324.0
0.300	69.0	1.600	149.7	4.000	236.6	8.000	334.6
0.400	98.0	1.800	158.7	4.500	251.0	8.500	344.9
0.500	115.4	2.000	167.3	5.000	264.6	9.000	354.9
0.600	123.7	2.200	175.5	5.500	277.5	9.500	364.7
0.800	115.9	2.400	183.3	6.000	289.8		
1.000	119.7	2.600	190.8	6.500	301.6		

Storage Structures for Catchment B - SW Model.txt

Tank or Pond Manhole: 1, DS/PN: 1.000

Invert Level (m) 69.200

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	1500.0	1.000	1500.0

Tank or Pond Manhole: 3, DS/PN: 2.000

Invert Level (m) 68.040

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	1500.0	1.000	1500.0

Tank or Pond Manhole: 5, DS/PN: 3.000

Invert Level (m) 67.820

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	1500.0	1.000	1500.0

Tank or Pond Manhole: 7, DS/PN: 4.000

Invert Level (m) 67.550

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	1500.0	1.000	1500.0

Tank or Pond Manhole: 11, DS/PN: 5.000

Invert Level (m) 67.450

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	1500.0	1.000	1500.0

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment B - SW Model.txt

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	480 Winter	1	0%					
1.001	480 Winter	1	0%					
2.000	480 Winter	1	0%					
2.001	480 Winter	1	0%					
3.000	360 Winter	1	0%					
3.001	360 Winter	1	0%	100/15 Summer				
4.000	360 Winter	1	0%					
4.001	360 Winter	1	0%	100/15 Summer				
1.002	15 Winter	1	0%	100/15 Summer				
1.003	15 Winter	1	0%	30/15 Summer				
5.000	480 Winter	1	0%					
5.001	480 Winter	1	0%	100/15 Summer				
1.004	15 Winter	1	0%	30/15 Summer				
1.005	15 Winter	1	0%					
1.006	120 Winter	1	0%	100/60 Winter				

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m^3)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	69.241	-0.409	0.000	0.02	0.0	2.8	OK
1.001	2	69.077	-0.429	0.000	0.01	0.0	2.8	OK
2.000	3	68.084	-0.406	0.000	0.02	0.0	2.0	OK
2.001	4	68.043	-0.196	0.000	0.04	0.0	2.0	OK
3.000	5	67.898	-0.372	0.000	0.07	0.0	6.4	OK
3.001	6	67.853	-0.172	0.000	0.13	0.0	6.4	OK
4.000	7	67.592	-0.408	0.000	0.02	0.0	3.2	OK
4.001	8	67.541	-0.184	0.000	0.08	0.0	3.2	OK
1.002	9	67.158	-0.334	0.000	0.15	0.0	34.0	OK
1.003	10	66.898	-0.232	0.000	0.41	0.0	55.8	OK
5.000	11	67.488	-0.412	0.000	0.02	0.0	1.9	OK
5.001	12	67.436	-0.204	0.000	0.02	0.0	1.9	OK
1.004	13	66.700	-0.196	0.000	0.61	0.0	106.7	OK
1.005	14	65.722	-0.778	0.000	0.07	0.0	93.6	OK
1.006	15	65.672	-0.278	0.000	0.12	0.0	28.0	OK

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment B - SW Model.txt

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	240 Winter	30	0%					
1.001	240 Winter	30	0%					
2.000	240 Winter	30	0%					
2.001	240 Winter	30	0%					
3.000	240 Winter	30	0%					
3.001	240 Winter	30	0%	100/15 Summer				
4.000	240 Winter	30	0%					
4.001	240 Winter	30	0%	100/15 Summer				
1.002	15 Winter	30	0%	100/15 Summer				
1.003	15 Winter	30	0%	30/15 Summer				
5.000	240 Winter	30	0%					
5.001	240 Winter	30	0%	100/15 Summer				
1.004	15 Winter	30	0%	30/15 Summer				
1.005	240 Winter	30	0%					
1.006	240 Winter	30	0%	100/60 Winter				

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	69.279	-0.371	0.000	0.07	0.0	10.6	OK
1.001	2	69.111	-0.395	0.000	0.04	0.0	10.6	OK
2.000	3	68.124	-0.366	0.000	0.08	0.0	7.7	OK
2.001	4	68.074	-0.165	0.000	0.16	0.0	7.7	OK
3.000	5	67.972	-0.298	0.000	0.25	0.0	22.4	OK
3.001	6	67.904	-0.121	0.000	0.44	0.0	22.4	OK
4.000	7	67.632	-0.368	0.000	0.08	0.0	12.7	OK
4.001	8	67.584	-0.141	0.000	0.30	0.0	12.7	OK
1.002	9	67.341	-0.151	0.000	0.35	0.0	82.5	OK
1.003	10	67.304	0.174	0.000	0.85	0.0	117.4	SURCHARGED
5.000	11	67.526	-0.374	0.000	0.07	0.0	6.9	OK
5.001	12	67.455	-0.185	0.000	0.07	0.0	6.9	OK
1.004	13	67.150	0.254	0.000	1.27	0.0	223.8	SURCHARGED
1.005	14	65.843	-0.657	0.000	0.07	0.0	92.2	OK
1.006	15	65.816	-0.134	0.000	0.31	0.0	74.3	OK

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment B - SW Model.txt

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	120 Winter	100	+30%					
1.001	120 Winter	100	+30%					
2.000	240 Winter	100	+30%					
2.001	15 Winter	100	+30%					
3.000	120 Winter	100	+30%					
3.001	15 Winter	100	+30%	100/15 Summer				
4.000	60 Winter	100	+30%					
4.001	15 Winter	100	+30%	100/15 Summer				
1.002	15 Winter	100	+30%	100/15 Summer				
1.003	15 Winter	100	+30%	30/15 Summer				
5.000	240 Winter	100	+30%					
5.001	15 Winter	100	+30%	100/15 Summer				
1.004	15 Winter	100	+30%	30/15 Summer				
1.005	240 Winter	100	+30%					
1.006	240 Winter	100	+30%	100/60 Winter				

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	69.323	-0.327	0.000	0.17	0.0	24.7	OK
1.001	2	69.144	-0.362	0.000	0.09	0.0	24.6	OK
2.000	3	68.171	-0.319	0.000	0.19	0.0	18.2	OK
2.001	4	68.210	-0.029	0.000	0.15	0.0	7.5	OK
3.000	5	68.058	-0.212	0.000	0.55	0.0	49.4	OK
3.001	6	68.107	0.082	0.000	0.51	0.0	25.9	SURCHARGED
4.000	7	67.680	-0.320	0.000	0.18	0.0	30.6	OK
4.001	8	67.956	0.231	0.000	0.41	0.0	17.5	SURCHARGED
1.002	9	68.310	0.818	0.000	0.48	0.0	110.8	SURCHARGED
1.003	10	68.293	1.163	0.000	1.08	0.0	148.6	SURCHARGED
5.000	11	67.568	-0.332	0.000	0.16	0.0	16.1	OK
5.001	12	67.825	0.185	0.000	0.08	0.0	7.3	SURCHARGED
1.004	13	67.978	1.082	0.000	1.92	0.0	337.7	SURCHARGED
1.005	14	66.151	-0.349	0.000	0.14	0.0	186.7	OK
1.006	15	66.134	0.184	0.000	0.51	0.0	123.0	SURCHARGED

Existing Network Details for Catchment C - SW Model.txt

* - Indicates pipe has been modified outside of System 1

	PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)
*	1.000	20.551	0.103	199.5	1.570	5.00	0.600	o	300
*	1.001	124.524	0.950	131.1	0.627	0.00	0.600	o	600
*	2.000	22.836	0.100	228.4	2.000	5.00	0.600	o	300
*	2.001	12.967	0.373	34.8	0.000	0.00	0.600	o	300
*	1.002	82.387	0.820	100.5	0.160	0.00	0.600	o	600
*	3.000	13.217	0.040	330.4	1.550	5.00	0.600	o	300
*	3.001	14.964	0.050	299.3	0.000	0.00	0.600	o	300
*	1.003	117.186	1.170	100.2	0.524	0.00	0.600	o	600
*	4.000	12.736	0.064	199.0	2.860	5.00	0.600	o	300
*	4.001	11.469	0.899	12.8	0.000	0.00	0.600	o	300
*	1.004	71.428	0.700	102.0	0.160	0.00	0.600	o	600
*	5.000	6.063	0.063	96.2	1.260	5.00	0.600	o	300
*	5.001	11.712	0.100	117.1	0.000	0.00	0.600	o	300
*	1.005	350.000	0.000	0.0	0.160	0.00	0.600	[]	3

	PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
*	1.000	1	73.580	71.780	1.500	72.500	71.677	0.523		1500
*	1.001	2	72.500	71.377	0.523	72.000	70.427	0.973		1500
*	2.000	3	72.000	71.200	0.500	72.000	71.100	0.600		1050
*	2.001	4	72.000	71.100	0.600	72.000	70.727	0.973	Hydro-Brake®	1200
*	1.002	5	72.000	70.427	0.973	70.340	69.607	0.133		1500
*	3.000	6	71.000	69.997	0.703	71.000	69.957	0.743		1050
*	3.001	7	71.000	69.957	0.743	70.340	69.907	0.133	Hydro-Brake®	1050
*	1.003	8	70.340	69.607	0.133	71.200	68.437	2.163		1500
*	4.000	9	71.200	69.700	1.200	71.200	69.636	1.264		1050
*	4.001	10	71.200	69.636	1.264	71.200	68.737	2.163	Hydro-Brake®	1050
*	1.004	11	71.200	68.437	2.163	69.500	67.737	1.163		1500
*	5.000	12	70.000	68.200	1.500	69.500	68.137	1.063		1200
*	5.001	13	69.500	68.137	1.063	69.500	68.037	1.163	Hydro-Brake®	1200
*	1.005	12	69.500	67.737	1.163	69.500	67.737	1.163		1500

Existing Network Details for Catchment C - SW Model.txt

	PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)
*	1.006	10.030	0.126	79.6	0.000	0.00	0.600	o	375
*	1.007	12.864	0.600	21.4	0.000	0.00	0.600	o	375

	PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
*	1.006	13	69.500	67.726	1.399	69.000	67.600	1.025		1500
*	1.007	14	69.000	67.600	1.025	69.000	67.000	1.625		1500

Simulation Criteria for Catchment C - SW Model.txt

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

Number of Input Hydrographs	4	Number of Storage Structures	5
Number of Online Controls	4	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	30
Ratio R	0.400		

Online Controls for Catchment C - SW Model.txt

Hydro-Brake® Manhole: 4, DS/PN: 2.001, Volume (m³): 2.6

Design Head (m) 1.000 Hydro-Brake® Type Md1 Invert Level (m) 71.100
Design Flow (l/s) 24.0 Diameter (mm) 146

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.9	1.200	26.0	3.000	41.1	7.000	62.8
0.200	14.5	1.400	28.1	3.500	44.4	7.500	65.0
0.300	16.4	1.600	30.0	4.000	47.5	8.000	67.1
0.400	15.6	1.800	31.8	4.500	50.3	8.500	69.2
0.500	16.8	2.000	33.6	5.000	53.1	9.000	71.2
0.600	18.4	2.200	35.2	5.500	55.7	9.500	73.1
0.800	21.2	2.400	36.8	6.000	58.1		
1.000	23.7	2.600	38.3	6.500	60.5		

Hydro-Brake® Manhole: 7, DS/PN: 3.001, Volume (m³): 1.8

Design Head (m) 1.000 Hydro-Brake® Type Md1 Invert Level (m) 69.957
Design Flow (l/s) 19.0 Diameter (mm) 130

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	20.6	3.000	32.6	7.000	49.8
0.200	11.6	1.400	22.3	3.500	35.2	7.500	51.5
0.300	11.8	1.600	23.8	4.000	37.6	8.000	53.2
0.400	12.0	1.800	25.2	4.500	39.9	8.500	54.9
0.500	13.3	2.000	26.6	5.000	42.1	9.000	56.4
0.600	14.6	2.200	27.9	5.500	44.1	9.500	58.0
0.800	16.8	2.400	29.1	6.000	46.1		
1.000	18.8	2.600	30.3	6.500	48.0		

Hydro-Brake® Manhole: 10, DS/PN: 4.001, Volume (m³): 2.2

Design Head (m) 1.000 Hydro-Brake® Type Md1 Invert Level (m) 69.636
Design Flow (l/s) 34.0 Diameter (mm) 174

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.8	1.200	36.9	3.000	58.4	7.000	89.2
0.200	19.0	1.400	39.9	3.500	63.1	7.500	92.3
0.300	25.4	1.600	42.6	4.000	67.4	8.000	95.3
0.400	24.5	1.800	45.2	4.500	71.5	8.500	98.3
0.500	24.4	2.000	47.7	5.000	75.4	9.000	101.1
0.600	26.2	2.200	50.0	5.500	79.0	9.500	103.9
0.800	30.1	2.400	52.2	6.000	82.6		
1.000	33.7	2.600	54.3	6.500	85.9		

Hydro-Brake® Manhole: 13, DS/PN: 5.001, Volume (m³): 1.9

Design Head (m) 1.000 Hydro-Brake® Type Md1 Invert Level (m) 68.137
Design Flow (l/s) 15.0 Diameter (mm) 116

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.7	1.200	16.4	3.000	25.9	7.000	39.6
0.200	9.2	1.400	17.7	3.500	28.0	7.500	41.0
0.300	8.7	1.600	18.9	4.000	30.0	8.000	42.4
0.400	9.5	1.800	20.1	4.500	31.8	8.500	43.7
0.500	10.6	2.000	21.2	5.000	33.5	9.000	44.9
0.600	11.6	2.200	22.2	5.500	35.1	9.500	46.2
0.800	13.4	2.400	23.2	6.000	36.7		
1.000	15.0	2.600	24.2	6.500	38.2		

Storage Structures for Catchment C - SW Model.txt

Tank or Pond Manhole: 1, DS/PN: 1.000

Invert Level (m) 71.780

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	10000.0	1.000	10000.0

Tank or Pond Manhole: 3, DS/PN: 2.000

Invert Level (m) 71.200

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	10000.0	1.000	10000.0

Tank or Pond Manhole: 6, DS/PN: 3.000

Invert Level (m) 69.997

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	10000.0	1.000	10000.0

Tank or Pond Manhole: 9, DS/PN: 4.000

Invert Level (m) 69.700

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	10000.0	1.000	10000.0

Tank or Pond Manhole: 12, DS/PN: 5.000

Invert Level (m) 68.200

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	10000.0	1.000	10000.0

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment C - SW Model.txt

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	1440 Winter	1	0%					
1.001	15 Winter	1	0%					
2.000	1440 Winter	1	0%					
2.001	1440 Winter	1	0%					
1.002	15 Winter	1	0%					
3.000	1440 Winter	1	0%					
3.001	1440 Winter	1	0%					
1.003	15 Winter	1	0%					
4.000	1440 Winter	1	0%					
4.001	1440 Winter	1	0%					
1.004	15 Winter	1	0%	100/15 Winter				
5.000	1440 Winter	1	0%					
5.001	1440 Winter	1	0%					
1.005	30 Winter	1	0%	100/60 Winter				
1.006	30 Winter	1	0%	100/15 Summer				
1.007	30 Winter	1	0%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	71.815	-0.265	0.000	0.03	0.0	2.1	OK
1.001	2	71.516	-0.461	0.000	0.12	0.0	67.9	OK
2.000	3	71.241	-0.259	0.000	0.05	0.0	3.0	OK
2.001	4	71.171	-0.229	0.000	0.02	0.0	3.2	OK
1.002	5	70.572	-0.455	0.000	0.13	0.0	83.6	OK
3.000	6	70.033	-0.264	0.000	0.03	0.0	1.3	OK
3.001	7	70.006	-0.251	0.000	0.03	0.0	1.5	OK
1.003	8	69.796	-0.411	0.000	0.21	0.0	137.2	OK
4.000	9	69.757	-0.243	0.000	0.08	0.0	4.9	OK
4.001	10	69.720	-0.216	0.000	0.02	0.0	4.9	OK
1.004	11	68.638	-0.399	0.000	0.24	0.0	151.4	OK
5.000	12	68.228	-0.272	0.000	0.02	0.0	1.2	OK
5.001	13	68.183	-0.254	0.000	0.02	0.0	1.2	OK
1.005	12	67.947	-0.390	0.000	0.13	0.0	125.7	OK
1.006	13	67.915	-0.186	0.000	0.50	0.0	70.1	OK
1.007	14	67.722	-0.253	0.000	0.23	0.0	70.2	OK

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment C - SW Model.txt

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	1440 Winter	30	0%					
1.001	15 Winter	30	0%					
2.000	1440 Winter	30	0%					
2.001	1440 Winter	30	0%					
1.002	15 Winter	30	0%					
3.000	1440 Winter	30	0%					
3.001	1440 Winter	30	0%					
1.003	15 Winter	30	0%					
4.000	1440 Winter	30	0%					
4.001	960 Winter	30	0%					
1.004	15 Winter	30	0%	100/15 Winter				
5.000	1440 Winter	30	0%					
5.001	1440 Winter	30	0%					
1.005	60 Winter	30	0%	100/60 Winter				
1.006	30 Winter	30	0%	100/15 Summer				
1.007	15 Winter	30	0%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	71.845	-0.235	0.000	0.11	0.0	7.2	OK
1.001	2	71.612	-0.365	0.000	0.31	0.0	174.9	OK
2.000	3	71.279	-0.221	0.000	0.13	0.0	8.6	OK
2.001	4	71.235	-0.165	0.000	0.06	0.0	9.3	OK
1.002	5	70.675	-0.352	0.000	0.35	0.0	220.3	OK
3.000	6	70.067	-0.230	0.000	0.09	0.0	4.1	OK
3.001	7	70.046	-0.211	0.000	0.08	0.0	4.4	OK
1.003	8	69.932	-0.275	0.000	0.55	0.0	356.4	OK
4.000	9	69.811	-0.189	0.000	0.21	0.0	13.4	OK
4.001	10	69.798	-0.138	0.000	0.06	0.0	13.2	OK
1.004	11	68.787	-0.250	0.000	0.63	0.0	388.4	OK
5.000	12	68.253	-0.247	0.000	0.07	0.0	4.5	OK
5.001	13	68.233	-0.204	0.000	0.06	0.0	4.5	OK
1.005	12	68.092	-0.245	0.000	0.24	0.0	240.2	OK
1.006	13	68.082	-0.019	0.000	1.00	0.0	138.9	OK
1.007	14	67.778	-0.197	0.000	0.46	0.0	138.9	OK

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment C - SW Model.txt

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	1440 Winter	100	+30%					
1.001	15 Winter	100	+30%					
2.000	960 Winter	100	+30%					
2.001	1440 Winter	100	+30%					
1.002	15 Winter	100	+30%					
3.000	1440 Winter	100	+30%					
3.001	1440 Winter	100	+30%					
1.003	15 Winter	100	+30%					
4.000	960 Winter	100	+30%					
4.001	1440 Winter	100	+30%					
1.004	15 Winter	100	+30%	100/15 Winter				
5.000	1440 Winter	100	+30%					
5.001	60 Winter	100	+30%					
1.005	60 Winter	100	+30%	100/60 Winter				
1.006	60 Winter	100	+30%	100/15 Summer				
1.007	60 Winter	100	+30%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	71.882	-0.198	0.000	0.25	0.0	17.4	OK
1.001	2	71.694	-0.283	0.000	0.52	0.0	295.4	OK
2.000	3	71.334	-0.166	0.000	0.21	0.0	13.8	OK
2.001	4	71.332	-0.068	0.000	0.10	0.0	15.3	OK
1.002	5	70.764	-0.263	0.000	0.59	0.0	372.5	OK
3.000	6	70.113	-0.184	0.000	0.16	0.0	7.8	OK
3.001	7	70.103	-0.154	0.000	0.17	0.0	8.9	OK
1.003	8	70.072	-0.135	0.000	0.92	0.0	597.5	FLOOD RISK
4.000	9	69.880	-0.120	0.000	0.34	0.0	21.2	OK
4.001	10	69.928	-0.008	0.000	0.09	0.0	20.3	OK
1.004	11	69.052	0.015	0.000	1.02	0.0	633.0	SURCHARGED
5.000	12	68.286	-0.214	0.000	0.11	0.0	6.8	OK
5.001	13	68.301	-0.136	0.000	0.06	0.0	4.7	OK
1.005	12	68.347	0.010	0.000	0.42	0.0	411.8	SURCHARGED
1.006	13	68.315	0.214	0.000	1.69	0.0	234.3	SURCHARGED
1.007	14	67.849	-0.126	0.000	0.77	0.0	234.3	OK

Existing Network Details for Catchment D - SW Model.txt

* - Indicates pipe has been modified outside of System 1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	n	HYD SECT	DIA (mm)
* 1.000	82.949	0.100	829.5	0.112	5.00		0.010	o	450
* 1.001	9.958	0.050	199.2	0.000	0.00	0.600		o	450
* 1.002	64.325	0.130	494.8	0.000	0.00	0.600		o	450
* 2.000	7.181	0.230	31.2	2.270	5.00	0.600		o	150
* 2.001	24.403	0.159	153.5	0.080	0.00	0.600		o	150
* 2.002	37.514	0.065	577.1	0.000	0.00	0.600		o	150
* 1.003	100.000	0.000	0.0	0.280	0.00	0.600		[]	3
* 1.004	44.913	0.120	374.3	0.000	0.00	0.600		o	300

PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
* 1.000	14	71.200	70.200	0.550	71.200	70.100	0.650		1200
* 1.001	17	71.200	70.100	0.650	70.940	70.050	0.440		1200
* 1.002	18	70.940	70.050	0.440	70.700	69.920	0.330		1200
* 2.000	18	71.840	70.674	1.016	71.400	70.444	0.806		1200
* 2.001	19	71.400	70.444	0.806	71.400	70.285	0.965		1200
* 2.002	20	71.400	70.285	0.965	70.700	70.220	0.330		1200
* 1.003	19	70.700	69.770	0.330	70.990	69.770	0.620		1200
* 1.004	20	70.990	69.770	0.920	70.800	69.650	0.850	Hydro-Brake®	1200

Simulation Criteria for Catchment D - SW Model.txt

Volumetric Runoff Coeff	0.840	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	240
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	4

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	120
Ratio R	0.400		

Online Controls for Catchment D - SW Model.txt

Hydro-Brake® Manhole: 20, DS/PN: 1.004, Volume (m³): 102.1

Design Head (m) 0.947 Hydro-Brake® Type Md1 Invert Level (m) 69.770
Design Flow (l/s) 69.0 Diameter (mm) 252

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	8.7	1.200	77.4	3.000	122.4	7.000	187.0
0.200	29.1	1.400	83.6	3.500	132.3	7.500	193.6
0.300	49.9	1.600	89.4	4.000	141.4	8.000	200.0
0.400	61.7	1.800	94.8	4.500	150.0	8.500	206.1
0.500	64.7	2.000	100.0	5.000	158.1	9.000	212.1
0.600	61.3	2.200	104.9	5.500	165.8	9.500	217.9
0.800	63.7	2.400	109.5	6.000	173.2		
1.000	70.7	2.600	114.0	6.500	180.2		

Storage Structures for Catchment D - SW Model.txt

Tank or Pond Manhole: 18, DS/PN: 2.000

Invert Level (m) 70.674

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	10000.0	1.000	10000.0

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment D - SW Model.txt

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	1	0%					
1.001	15 Winter	1	0%					
1.002	15 Winter	1	0%					
2.000	1440 Winter	1	0%					
2.001	15 Winter	1	0%	30/15 Summer				
2.002	15 Winter	1	0%					
1.003	30 Winter	1	0%					
1.004	30 Winter	1	0%	30/30 Winter				

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	14	70.308	-0.342	0.000	0.12	0.0	13.9	OK
1.001	17	70.189	-0.361	0.000	0.09	0.0	13.7	OK
1.002	18	70.146	-0.354	0.000	0.10	0.0	13.8	OK
2.000	18	70.717	-0.107	0.000	0.18	0.0	5.0	OK
2.001	19	70.539	-0.055	0.000	0.71	0.0	9.6	OK
2.002	20	70.469	0.034	0.000	1.28	0.0	9.0	SURCHARGED
1.003	19	69.949	-0.421	0.000	0.05	0.0	41.6	OK
1.004	20	69.947	-0.123	0.000	0.45	0.0	23.9	OK

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment D - SW Model.txt

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	30	0%					
1.001	15 Winter	30	0%					
1.002	15 Winter	30	0%					
2.000	960 Winter	30	0%					
2.001	15 Winter	30	0%	30/15 Summer				
2.002	15 Summer	30	0%					
1.003	30 Winter	30	0%					
1.004	30 Winter	30	0%	30/30 Winter				

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	14	70.376	-0.274	0.000	0.28	0.0	33.7	OK
1.001	17	70.237	-0.313	0.000	0.20	0.0	32.3	OK
1.002	18	70.199	-0.301	0.000	0.23	0.0	30.8	OK
2.000	18	70.756	-0.068	0.000	0.46	0.0	12.5	OK
2.001	19	70.902	0.308	0.000	1.21	0.0	16.5	SURCHARGED
2.002	20	70.697	0.262	0.000	2.24	0.0	15.8	SURCHARGED
1.003	19	70.093	-0.277	0.000	0.11	0.0	97.7	OK
1.004	20	70.089	0.019	0.000	0.97	0.0	51.6	SURCHARGED

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment D - SW Model.txt

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+30%					
1.001	30 Winter	100	+30%					
1.002	30 Winter	100	+30%					
2.000	960 Winter	100	+30%					
2.001	15 Summer	100	+30%	30/15 Summer				
2.002	15 Summer	100	+30%					
1.003	30 Winter	100	+30%					
1.004	30 Winter	100	+30%	30/30 Winter				

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	14	70.438	-0.212	0.000	0.48	0.0	56.8	OK
1.001	17	70.285	-0.265	0.000	0.28	0.0	44.8	OK
1.002	18	70.282	-0.218	0.000	0.32	0.0	42.6	OK
2.000	18	70.821	-0.003	0.000	0.50	0.0	13.6	OK
2.001	19	71.097	0.503	0.000	1.37	0.0	18.6	SURCHARGED
2.002	20	70.803	0.368	0.000	2.58	0.0	18.2	SURCHARGED
1.003	19	70.274	-0.096	0.000	0.17	0.0	153.3	OK
1.004	20	70.265	0.195	0.000	1.17	0.0	62.6	SURCHARGED

Existing Network Details for D Site SW Model 02.txt

* - Indicates pipe has been modified outside of System 1

	PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)
*	1.000	12.709	0.930	13.7	4.950	5.00	0.600	o	300
*	1.001	16.407	0.050	328.1	0.185	0.00	0.600	o	600
*	2.000	10.754	0.270	39.8	5.150	5.00	0.600	o	300
*	2.001	21.550	0.101	213.4	0.202	0.00	0.600	o	300
*	2.002	47.978	0.200	239.9	0.000	0.00	0.600	o	300
*	3.000	11.738	0.080	146.7	3.200	5.00	0.600	o	300
*	3.001	29.387	0.095	309.3	0.235	0.00	0.600	o	300
*	2.003	185.090	0.370	500.2	0.000	0.00	0.600	o	600
*	2.004	155.979	1.505	103.6	0.000	0.00	0.600	o	600
*	4.000	2.000	0.100	20.0	3.790	5.00	0.600	o	300
*	4.001	25.607	0.000	0.0	0.297	5.00	0.600	o	300
*	2.005	25.514	0.200	127.6	0.000	0.00	0.600	o	600
*	2.006	430.000	0.330	1303.0	0.000	0.00	0.600	[]	12
*	1.002	123.075	0.330	373.0	0.000	0.00	0.600	o	600
*	1.003	122.945	3.190	38.5	0.000	0.00	0.600	o	600

	PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
*	1.000	1	70.000	68.000	1.700	70.000	67.070	2.630		1200
*	1.001	2	70.000	66.770	2.630	68.500	66.720	1.180		1200
*	2.000	3	71.200	70.000	0.900	71.200	69.730	1.170		1200
*	2.001	4	71.200	69.730	1.170	71.200	69.629	1.271		1200
*	2.002	5	71.200	69.625	1.275	71.200	69.425	1.475		1200
*	3.000	6	71.200	69.600	1.300	71.200	69.520	1.380		1200
*	3.001	7	71.200	69.520	1.380	71.200	69.425	1.475		1200
*	2.003	8	71.200	69.125	1.475	70.780	68.755	1.425		1200
*	2.004	9	70.780	68.755	1.425	69.000	67.250	1.150		1200
*	4.000	10a	69.000	67.650	1.050	69.000	67.550	1.150		1325
*	4.001	10	69.000	67.550	1.150	69.000	67.550	1.150		1200
*	2.005	11	69.000	67.250	1.150	69.000	67.050	1.350		1200
*	2.006	12	69.000	67.050	0.950	68.500	66.720	0.780		1200
*	1.002	13	68.500	66.720	1.180	68.000	66.390	1.010		1200
*	1.003	14	68.000	66.390	1.010	65.000	63.200	1.200		1200

Existing Network Details for D Site SW Model 02.txt

	PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)
*	5.000	15.525	0.050	310.5	4.780	5.00	0.600	o	300
*	5.001	14.305	0.050	286.1	0.179	0.00	0.600	o	300
*	6.000	13.654	0.050	273.1	3.980	5.00	0.600	o	300
*	6.001	13.947	0.050	278.9	0.140	0.00	0.600	o	300
*	5.002	105.752	0.262	403.6	0.000	0.00	0.600	o	300
*	7.000	14.517	0.100	145.2	3.740	5.00	0.600	o	300
*	7.001	11.067	0.562	19.7	0.190	0.00	0.600	o	300
*	5.003	127.178	0.538	236.4	0.000	0.00	0.600	o	600
*	8.000	12.614	0.100	126.1	5.604	5.00	0.600	o	300
*	8.001	12.531	0.050	250.6	0.258	0.00	0.600	o	150
*	1.004	149.580	0.400	373.9	0.000	0.00	0.600	o	600
*	1.005	71.942	0.300	239.8	0.000	0.00	0.600	o	600
*	1.006	700.000	0.000	0.0	0.000	0.00	0.600	[]	12
*	9.000	113.601	0.395	287.6	3.910	5.00	0.600	o	600
*	9.001	26.150	0.200	130.8	0.280	0.00	0.600	o	600
*	9.002	314.824	1.100	286.2	0.000	0.00	0.600	o	600

	PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
*	5.000	15	67.000	64.400	2.300	67.000	64.350	2.350		1200
*	5.001	16	67.000	64.350	2.350	66.300	64.300	1.700		1200
*	6.000	17	66.900	64.400	2.200	66.300	64.350	1.650		1200
*	6.001	18	66.300	64.350	1.650	66.300	64.300	1.700		1200
*	5.002	19	66.300	64.300	1.700	65.250	64.038	0.912		1200
*	7.000	20	65.950	64.700	0.950	65.950	64.600	1.050		1200
*	7.001	21	65.950	64.600	1.050	65.250	64.038	0.912		1200
*	5.003	22	65.250	63.738	0.912	65.000	63.200	1.200		1200
*	8.000	23	66.623	63.800	2.523	66.623	63.700	2.623		1200
*	8.001	24	66.623	63.700	2.773	65.000	63.650	1.200		1200
*	1.004	25	65.000	63.200	1.200	65.000	62.800	1.600		1200
*	1.005	26	65.000	62.800	1.600	64.500	62.500	1.400		1200
*	1.006	27	64.500	62.100	1.400	64.000	62.100	0.900	Hydro-Brake®	1200
*	9.000	28	65.000	63.795	0.605	65.000	63.400	1.000		1200
*	9.001	29	65.000	63.400	1.000	65.000	63.200	1.200		1200
*	9.002	30	65.000	63.200	1.200	64.000	62.100	1.300		1200

Existing Network Details for D Site SW Model 02.txt

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)
* 1.007	56.265	0.510	110.3	0.000	0.00	0.600	o	600

PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
* 1.007	31	64.000	62.100	1.300	63.290	61.590	1.100		1200

Simulation Criteria for D Site SW Model 02.txt

Volumetric Runoff Coeff	0.840	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	3	Number of Storage Structures	9
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	15
Ratio R	0.400		

Online Controls for D Site SW Model 02.txt

Hydro-Brake® Manhole: 27, DS/PN: 1.006, Volume (m³): 22.7

Design Head (m) 3.200 Hydro-Brake® Type Md1 Invert Level (m) 62.100
Design Flow (l/s) 700.0 Diameter (mm) 592

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	13.5	1.200	544.7	3.000	675.8	7.000	1032.2
0.200	54.0	1.400	519.0	3.500	729.9	7.500	1068.5
0.300	115.4	1.600	514.4	4.000	780.3	8.000	1103.5
0.400	190.4	1.800	530.1	4.500	827.6	8.500	1137.5
0.500	270.9	2.000	553.7	5.000	872.4	9.000	1170.5
0.600	349.5	2.200	579.3	5.500	915.0	9.500	1202.5
0.800	474.4	2.400	604.6	6.000	955.7		
1.000	537.7	2.600	629.1	6.500	994.7		

Storage Structures for D Site SW Model 02.txt

Tank or Pond Manhole: 1, DS/PN: 1.000

Invert Level (m) 68.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	5000.0	1.000	5000.0

Tank or Pond Manhole: 3, DS/PN: 2.000

Invert Level (m) 70.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	5000.0	1.000	5000.0

Tank or Pond Manhole: 6, DS/PN: 3.000

Invert Level (m) 69.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	5000.0	1.000	5000.0

Tank or Pond Manhole: 10a, DS/PN: 4.000

Invert Level (m) 67.650

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	5000.0	1.000	5000.0

Tank or Pond Manhole: 15, DS/PN: 5.000

Invert Level (m) 64.400

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	5000.0	1.000	5000.0

Tank or Pond Manhole: 17, DS/PN: 6.000

Invert Level (m) 64.400

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	5000.0	1.000	5000.0

Tank or Pond Manhole: 20, DS/PN: 7.000

Invert Level (m) 64.700

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	5000.0	1.000	5000.0

Tank or Pond Manhole: 23, DS/PN: 8.000

Invert Level (m) 64.823

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	5000.0	1.000	5000.0

Tank or Pond Manhole: 28, DS/PN: 9.000

Invert Level (m) 63.795

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	5000.0	1.000	5000.0

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for D Site SW Model 02.txt

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	240 Winter	1	0%	100/60 Winter				
1.001	240 Winter	1	0%	100/60 Summer				
2.000	360 Winter	1	0%	100/30 Summer				
2.001	360 Winter	1	0%	30/15 Summer				
2.002	360 Winter	1	0%	30/15 Summer				
3.000	960 Winter	1	0%	100/120 Winter				
3.001	15 Winter	1	0%	30/15 Summer				
2.003	360 Winter	1	0%					
2.004	360 Winter	1	0%					
4.000	480 Winter	1	0%	100/60 Winter				
4.001	15 Winter	1	0%					
2.005	480 Winter	1	0%					
2.006	360 Winter	1	0%					
1.002	360 Winter	1	0%	100/60 Summer				
1.003	360 Winter	1	0%					
5.000	960 Winter	1	0%	30/240 Winter				
5.001	960 Winter	1	0%	30/15 Summer				
6.000	960 Winter	1	0%	100/60 Summer				
6.001	960 Winter	1	0%	30/15 Summer				
5.002	960 Winter	1	0%	30/15 Summer	100/480 Summer			
7.000	480 Winter	1	0%	100/120 Winter				
7.001	15 Winter	1	0%	100/120 Summer				
5.003	960 Winter	1	0%	30/120 Winter				
8.000	120 Winter	1	0%					
8.001	1440 Summer	1	0%		100/1440 Winter			
1.004	360 Winter	1	0%	30/30 Winter	100/240 Winter			2
1.005	360 Winter	1	0%	30/60 Summer				
1.006	360 Winter	1	0%	30/60 Summer				
9.000	480 Winter	1	0%					
9.001	15 Winter	1	0%					
9.002	15 Winter	1	0%					
1.007	360 Winter	1	0%	100/120 Winter				

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m^3)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	68.101	-0.199	0.000	0.25	0.0	60.4	OK
1.001	2	67.005	-0.365	0.000	0.23	0.0	62.8	OK

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for D Site SW Model 02.txt

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
2.000	3	70.120	-0.180	0.000	0.34	0.0	43.8	OK
2.001	4	69.913	-0.117	0.000	0.69	0.0	45.7	OK
2.002	5	69.807	-0.118	0.000	0.68	0.0	45.6	OK
3.000	6	69.693	-0.207	0.000	0.21	0.0	14.9	OK
3.001	7	69.666	-0.154	0.000	0.47	0.0	26.9	OK
2.003	8	69.310	-0.415	0.000	0.21	0.0	61.2	OK
2.004	9	68.878	-0.477	0.000	0.09	0.0	61.1	OK
4.000	10a	67.761	-0.189	0.000	0.20	0.0	16.2	OK
4.001	10	67.863	0.013	0.000	1.08	0.0	23.9	SURCHARGED
2.005	11	67.418	-0.432	0.000	0.17	0.0	77.3	OK
2.006	12	67.153	-0.897	0.000	0.03	0.0	77.4	OK
1.002	13	66.982	-0.338	0.000	0.40	0.0	133.0	OK
1.003	14	66.531	-0.459	0.000	0.13	0.0	133.0	OK
5.000	15	64.543	-0.157	0.000	0.38	0.0	20.3	OK
5.001	16	64.508	-0.142	0.000	0.39	0.0	21.1	OK
6.000	17	64.525	-0.175	0.000	0.27	0.0	15.2	OK
6.001	18	64.499	-0.151	0.000	0.28	0.0	15.6	OK
5.002	19	64.483	-0.117	0.000	0.69	0.0	36.7	OK
7.000	20	64.803	-0.197	0.000	0.26	0.0	19.9	OK
7.001	21	64.671	-0.229	0.000	0.13	0.0	23.7	OK
5.003	22	63.884	-0.454	0.000	0.13	0.0	56.8	OK
8.000	23	64.912	0.812	0.000	0.57	0.0	45.5	SURCHARGED
8.001	24	65.401	1.551	0.000	4.09	0.0	41.5	SURCHARGED
1.004	25	63.567	-0.233	0.000	0.69	0.0	232.6	OK
1.005	26	63.128	-0.272	0.000	0.58	0.0	232.7	OK
1.006	27	62.825	-0.275	0.000	0.08	0.0	231.1	OK
9.000	28	63.896	-0.499	0.000	0.07	0.0	25.4	OK
9.001	29	63.512	-0.488	0.000	0.08	0.0	35.5	OK
9.002	30	63.321	-0.479	0.000	0.09	0.0	35.5	OK
1.007	31	62.376	-0.324	0.000	0.44	0.0	253.5	OK

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for D Site SW Model 02.txt

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	120 Winter	30	0%	100/60 Winter				
1.001	240 Winter	30	0%	100/60 Summer				
2.000	240 Winter	30	0%	100/30 Summer				
2.001	240 Winter	30	0%	30/15 Summer				
2.002	240 Winter	30	0%	30/15 Summer				
3.000	360 Winter	30	0%	100/120 Winter				
3.001	15 Winter	30	0%	30/15 Summer				
2.003	15 Winter	30	0%					
2.004	240 Winter	30	0%					
4.000	480 Winter	30	0%	100/60 Winter				
4.001	15 Winter	30	0%					
2.005	360 Winter	30	0%					
2.006	240 Winter	30	0%					
1.002	240 Winter	30	0%	100/60 Summer				
1.003	240 Winter	30	0%					
5.000	480 Winter	30	0%	30/240 Winter				
5.001	1440 Winter	30	0%	30/15 Summer				
6.000	480 Winter	30	0%	100/60 Summer				
6.001	1440 Winter	30	0%	30/15 Summer				
5.002	1440 Winter	30	0%	30/15 Summer	100/480 Summer			
7.000	240 Winter	30	0%	100/120 Winter				
7.001	15 Winter	30	0%	100/120 Summer				
5.003	240 Winter	30	0%	30/120 Winter				
8.000	240 Winter	30	0%					
8.001	1440 Winter	30	0%		100/1440 Winter			
1.004	240 Winter	30	0%	30/30 Winter	100/240 Winter			2
1.005	240 Winter	30	0%	30/60 Summer				
1.006	240 Winter	30	0%	30/60 Summer				
9.000	240 Winter	30	0%					
9.001	15 Winter	30	0%					
9.002	15 Winter	30	0%					
1.007	240 Winter	30	0%	100/120 Winter				

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	68.202	-0.098	0.000	0.79	0.0	191.3	OK
1.001	2	67.216	-0.154	0.000	0.67	0.0	182.1	OK

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for D Site SW Model 02.txt

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
2.000	3	70.263	-0.037	0.000	0.62	0.0	80.1	OK
2.001	4	70.165	0.135	0.000	1.23	0.0	82.3	SURCHARGED
2.002	5	70.010	0.085	0.000	1.22	0.0	82.3	SURCHARGED
3.000	6	69.780	-0.120	0.000	0.67	0.0	47.4	OK
3.001	7	69.869	0.049	0.000	1.29	0.0	73.4	SURCHARGED
2.003	8	69.418	-0.307	0.000	0.40	0.0	117.8	OK
2.004	9	68.939	-0.416	0.000	0.21	0.0	133.0	OK
4.000	10a	67.895	-0.055	0.000	0.48	0.0	37.7	OK
4.001	10	67.965	0.115	0.000	3.12	0.0	69.1	SURCHARGED
2.005	11	67.508	-0.342	0.000	0.38	0.0	171.0	OK
2.006	12	67.262	-0.788	0.000	0.06	0.0	171.1	OK
1.002	13	67.187	-0.133	0.000	0.96	0.0	322.6	OK
1.003	14	66.617	-0.373	0.000	0.31	0.0	322.5	OK
5.000	15	64.720	0.020	0.000	0.61	0.0	32.2	SURCHARGED
5.001	16	65.121	0.471	0.000	0.58	0.0	31.7	SURCHARGED
6.000	17	64.683	-0.017	0.000	0.51	0.0	28.3	OK
6.001	18	65.121	0.471	0.000	0.42	0.0	23.2	SURCHARGED
5.002	19	65.191	0.591	0.000	0.96	0.0	51.2	SURCHARGED
7.000	20	64.901	-0.099	0.000	0.78	0.0	60.2	OK
7.001	21	64.732	-0.168	0.000	0.39	0.0	73.1	OK
5.003	22	64.495	0.157	0.000	0.27	0.0	113.8	SURCHARGED
8.000	23	65.125	1.025	0.000	0.65	0.0	51.5	SURCHARGED
8.001	24	65.539	1.689	0.000	4.25	0.0	43.1	SURCHARGED
1.004	25	64.454	0.654	0.000	1.37	0.0	461.5	SURCHARGED
1.005	26	63.714	0.314	0.000	1.14	0.0	460.9	SURCHARGED
1.006	27	63.326	0.226	0.000	0.15	0.0	458.0	SURCHARGED
9.000	28	63.989	-0.406	0.000	0.23	0.0	87.0	OK
9.001	29	63.599	-0.401	0.000	0.24	0.0	107.2	OK
9.002	30	63.412	-0.388	0.000	0.25	0.0	99.3	OK
1.007	31	62.549	-0.151	0.000	0.91	0.0	531.4	OK

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for D Site SW Model 02.txt

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	120 Winter	100	+30%	100/60 Winter				
1.001	240 Winter	100	+30%	100/60 Summer				
2.000	240 Winter	100	+30%	100/30 Summer				
2.001	240 Winter	100	+30%	30/15 Summer				
2.002	240 Winter	100	+30%	30/15 Summer				
3.000	240 Winter	100	+30%	100/120 Winter				
3.001	15 Winter	100	+30%	30/15 Summer				
2.003	15 Winter	100	+30%					
2.004	240 Winter	100	+30%					
4.000	360 Winter	100	+30%	100/60 Winter				
4.001	15 Winter	100	+30%					
2.005	240 Winter	100	+30%					
2.006	240 Winter	100	+30%					
1.002	240 Winter	100	+30%	100/60 Summer				
1.003	240 Winter	100	+30%					
5.000	480 Winter	100	+30%	30/240 Winter				
5.001	1440 Winter	100	+30%	30/15 Summer				
6.000	480 Winter	100	+30%	100/60 Summer				
6.001	1440 Winter	100	+30%	30/15 Summer				
5.002	1440 Winter	100	+30%	30/15 Summer	100/480 Summer			
7.000	360 Winter	100	+30%	100/120 Winter				
7.001	360 Winter	100	+30%	100/120 Summer				
5.003	360 Winter	100	+30%	30/120 Winter				
8.000	480 Winter	100	+30%					
8.001	1440 Winter	100	+30%		100/1440 Winter			
1.004	360 Winter	100	+30%	30/30 Winter	100/240 Winter			2
1.005	360 Winter	100	+30%	30/60 Summer				
1.006	360 Winter	100	+30%	30/60 Summer				
9.000	120 Winter	100	+30%					
9.001	120 Winter	100	+30%					
9.002	120 Winter	100	+30%					
1.007	360 Winter	100	+30%	100/120 Winter				

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	1	68.350	0.050	0.000	1.03	0.0	249.3	SURCHARGED
1.001	2	67.578	0.208	0.000	0.96	0.0	261.2	SURCHARGED

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for D Site SW Model 02.txt

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
2.000	3	70.491	0.191	0.000	0.74	0.0	96.4	SURCHARGED
2.001	4	70.350	0.320	0.000	1.47	0.0	97.6	SURCHARGED
2.002	5	70.133	0.208	0.000	1.45	0.0	97.6	SURCHARGED
3.000	6	69.913	0.013	0.000	0.93	0.0	65.7	SURCHARGED
3.001	7	69.957	0.137	0.000	1.62	0.0	92.2	SURCHARGED
2.003	8	69.472	-0.253	0.000	0.53	0.0	156.4	OK
2.004	9	68.961	-0.394	0.000	0.26	0.0	166.3	OK
4.000	10a	68.045	0.095	0.000	0.85	0.0	67.2	SURCHARGED
4.001	10	68.047	0.197	0.000	3.96	0.0	87.8	SURCHARGED
2.005	11	67.606	-0.244	0.000	0.54	0.0	240.3	OK
2.006	12	67.551	-0.499	0.000	0.08	0.0	238.0	OK
1.002	13	67.540	0.220	0.000	1.33	0.0	443.8	SURCHARGED
1.003	14	66.662	-0.328	0.000	0.42	0.0	443.8	OK
5.000	15	65.047	0.347	0.000	0.63	0.0	33.2	SURCHARGED
5.001	16	66.000	1.350	0.000	0.62	0.0	33.7	SURCHARGED
6.000	17	64.982	0.282	0.000	0.45	0.0	25.1	SURCHARGED
6.001	18	65.982	1.332	0.000	0.52	0.0	28.6	SURCHARGED
5.002	19	66.299	1.699	0.996	1.08	0.0	57.6	FLOOD
7.000	20	65.076	0.076	0.000	1.11	0.0	85.3	SURCHARGED
7.001	21	65.046	0.146	0.000	0.48	0.0	90.9	SURCHARGED
5.003	22	65.021	0.683	0.000	0.35	0.0	148.4	FLOOD RISK
8.000	23	65.467	1.367	0.000	0.72	0.0	57.0	SURCHARGED
8.001	24	66.156	2.306	0.704	5.03	0.0	51.0	FLOOD
1.004	25	65.006	1.206	5.871	1.49	0.0	503.4	FLOOD
1.005	26	64.122	0.722	0.000	1.25	0.0	503.1	SURCHARGED
1.006	27	63.659	0.559	0.000	0.17	0.0	502.4	SURCHARGED
9.000	28	64.097	-0.298	0.000	0.50	0.0	191.7	OK
9.001	29	63.686	-0.314	0.000	0.46	0.0	205.9	OK
9.002	30	63.508	-0.292	0.000	0.52	0.0	204.7	OK
1.007	31	62.769	0.069	0.000	1.09	0.0	635.2	SURCHARGED