Defence Infrastructure Organisation

Future Defence Storage and Redistribution Programme,

Redevelopment of MOD Bicester

C Site: Drainage Strategy

BIC/OPA/DOC/17

September 2011

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Report for

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(BIC/OPA/DOC/17)

September 2011

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Contents

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 C 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;
- 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).

[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 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 Site have been identified as being potentially viable for redevelopment for storage intensification, mixed use development, employment and civilian housing. Graven Hill site has been identified for disposal but C Site would still remain under MOD control/ownership and be solely used as part of the LCS operations.

2.2 The MOD Bicester Sites

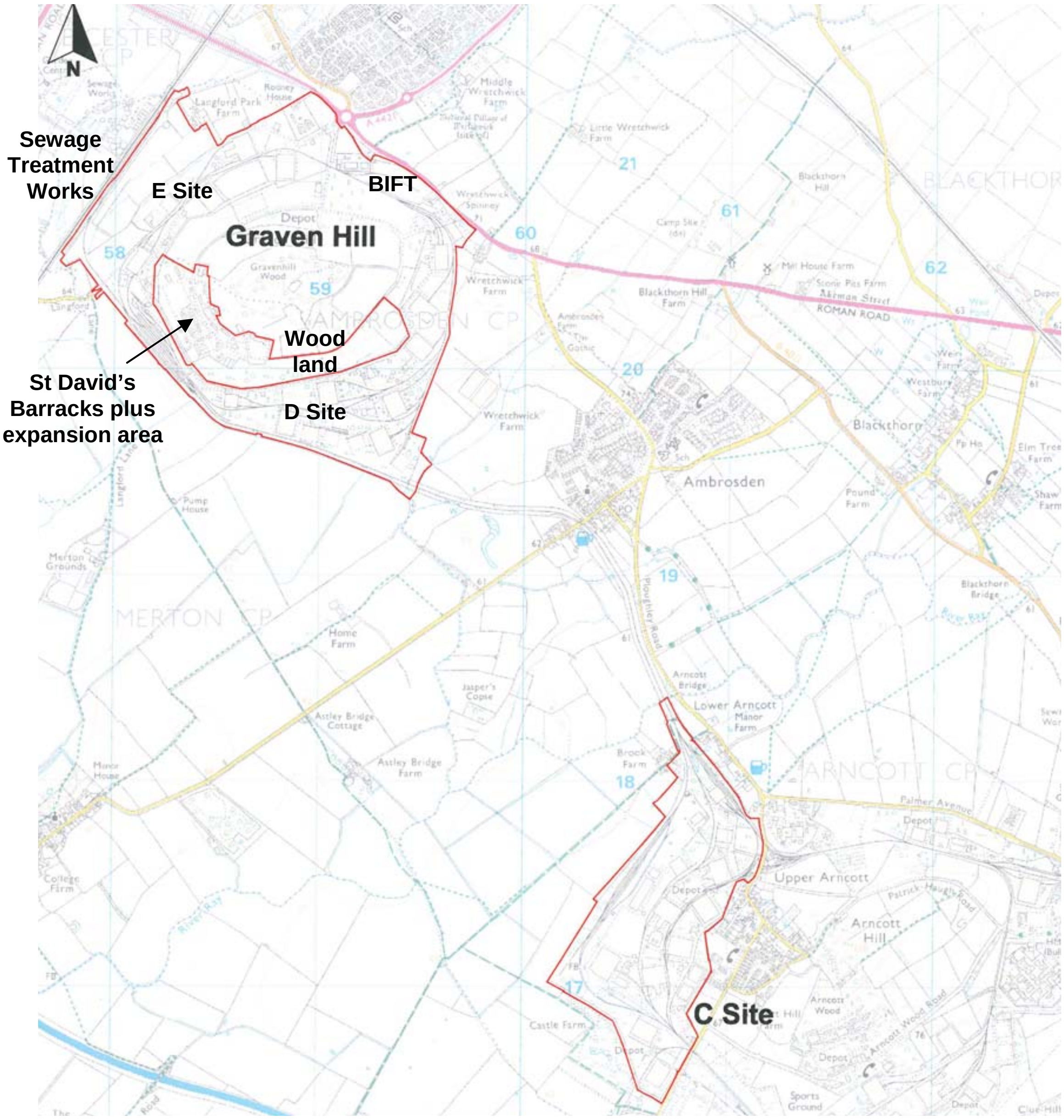
2.2.1 The two sites under consideration as part of this development study consist of two distinct and separate areas of the larger MOD Bicester area. Details are given in Table 2.1, below.

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 of the site 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. 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,

Site Name	Details
	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 C Site

2.3.1 C Site is located to the west of Arncott Hill. It is bounded by civilian properties off Ploughley Road to the north and Norris Road to the east. There are railway lines and open fields to the west and open fields to the south.

2.3.2 C Site contains numerous large storage warehouses, most with road and rail access.

2.3.3 Vehicular access to the site is in the north-east corner off Ploughley Road. A further access point (currently closed) is located to the south off Murcott Road.

2.3.4 The main rail access into the site is from the north-west with onward connection to other MOD Bicester sites to the east of Arncott Hill, leaving C Site at the north-east and south-east corners.

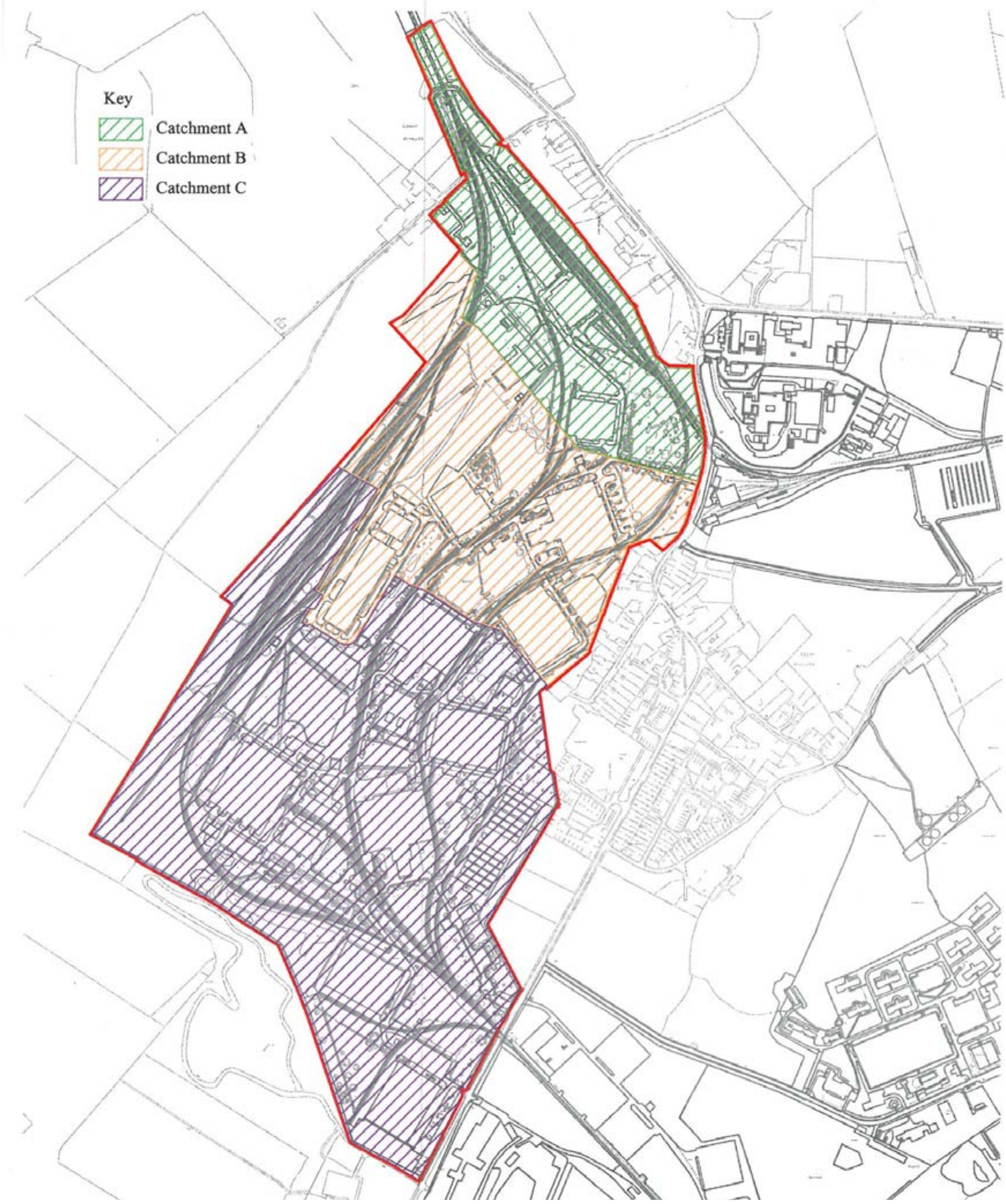
2.3.5 The area under consideration is in the north of the site with Buildings C2 and C8 being retained and all buildings north of this being demolished to make way for the re-development. The area of the site affected by the proposed redevelopment is 35.3ha

2.3.6 There are some established trees on this part of the site, mainly following the main road loops with large tree blocks to the north-west and south-east of Building C9. The northern boundary of the site is well planted and acts as a screen to adjoining civilian development. The west of the site is mainly enclosed with tree planting on the adjoining agricultural land.

2.3.7 The catchment area affected by the development has been identified as Catchment A and Catchment B. The remaining area, Catchment C is not being assessed as part of this strategy as it is considered that this will remain unaffected by the development proposals.

2.3.8 Figure 2.2 (over page) shows the drainage catchments.

Figure 2.2 Existing Catchment Areas

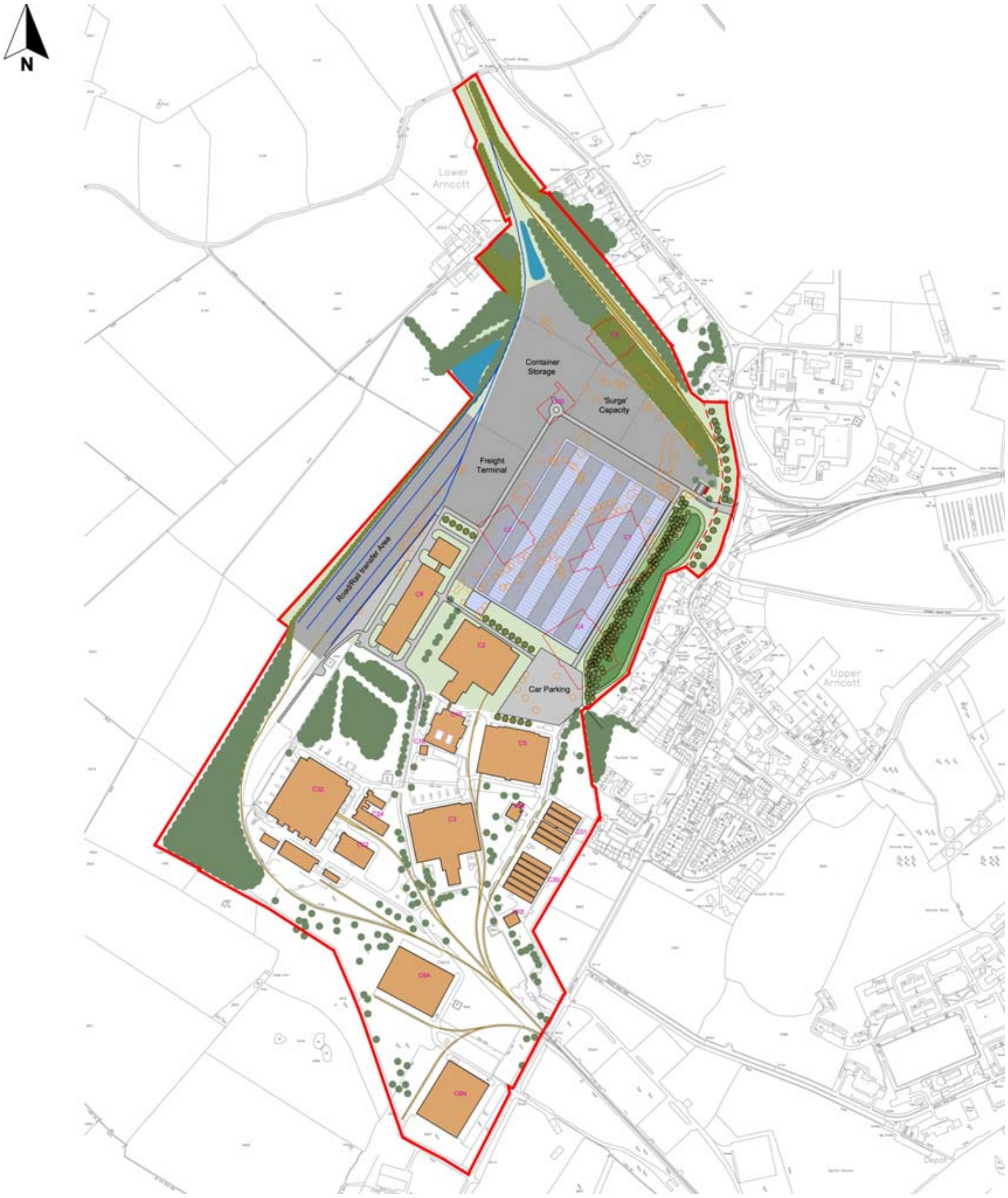


2.4 Proposed Development on C Site

2.4.1 The proposed development on C Site consists of a large storage building with associated car parking and landscaping. There is a proposed open vehicle storage area to the north of the building and a new Road Rail Transfer Area to the west.

2.4.2 Figure 2.3 shows the proposed development.

Figure 2.3 Proposed Development Plan



3. Understanding the Existing Drainage Infrastructure

3.1 Surface Water - General

3.1.1 The existing surface water system on C 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. 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 either naturally infiltrates through the subsoil to some extent or evaporates.

3.1.2 For those systems which do act as conveyance systems, these are understood to collect into the western boundary ditch which flows from south to north before turning to the west near Building C7 and discharging into the River Ray. The condition of this ditch appears to be reasonable as recent work has just been undertaken to clear this ditch of debris and any overgrowth.

3.1.3 The existing flows across the site have been calculated using the Interim Code of Practice (ICP) of SUDS Mean Annual Flood method as the total catchment area is below 50ha. This methodology requires the need to measure the catchment area which was done using the topographical survey as a basis before applying key parameters on average annual rainfall (SAAR), typical soil index and the flood studies report region number.

3.1.4 The key parameters are summarised Table 3.1, below, along with the input data and calculated flow results.

Table 3.1 Greenfield Run-off Rates

Parameter	Catchment A (outfall to the north)	Catchment B (outfall to the west)
Total site area	13.5ha	21.8ha
Impermeable area	2.3ha (17%)	9.3ha (43%)
SAAR (mm)	622	622
Soil Index (from Wallingford WRAP Map)	0.45	0.45
FSR Region	6	6
Flow Results		
QBAR	69 l/s or approx 5 l/s/ha	162 l/s or approx 7 l/s/ha
1:1yr Flow	59 l/s or approx 4 l/s/ha	138 l/s or approx 6 l/s/ha
1:30yr Flow	146 l/s or approx 11 l/s/ha	312 l/s or approx 14 l/s/ha
1:100yr Flow	192 l/s or approx 14 l/s/ha	385 l/s or approx 18 l/s/ha

3.1.5 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 operated and maintained by Kelda. There is also a public sewer network which crosses the northern part of the site. This sewer system is owned and operated by Thames Water.

3.2.2 A 300mm diameter vitrified clay gravity fed system enters the site at the north-east corner of the site and connects into a larger 525mm diameter pipe located to the south of Building C9. Foul flows generated from the southern section of the site are connected into the system at this point via a 450mm diameter pipe.

3.2.3 Although the records supplied by Kelda are inconclusive and appear inaccurate, no major problems have been reported and it is reasonable to conclude that foul water is being conveyed through the system and that the existing buildings on site are connected into the Thames Water system at appropriate locations. Kelda confirm that the condition of this on-site pipe work is considered to be in a good condition.

3.2.4 As the public system is maintained by Thames Water, if problems occur Thames Water will aim to investigate the issue within 24hrs. Therefore, it is reasonable to conclude that that the public system is in a good condition and currently performs well.

3.2.5 The foul flows from C Site gravitate to a pumping station just north-west of the Site via the 525mm diameter sewer. These flows are then pumped to Bicester Sewage Treatment Works located to the northwest near Graven Hill.

3.2.6 Existing foul water drainage flows have been calculated using guidance provided in Sewers for Adoption 6th Edition. Table 3.2, below, summarises the existing flow rates generated from the buildings generating foul flows that are currently present on site.

Table 3.2 Existing Foul Water Drainage Flow Rates

Building No Affected	Building Footprint Area affected	Average DWF	Peak Flow (6 x DWF)
C1,C4,C7,C9, C13, C11, C21, C49, C60, C61,C63	36,092m^2	1.2 l/s	7.4 l/s

Notes

1) The basis of these calculations is included in Annex A

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, amenity value and reducing the 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 a key location identified within the site. The 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 - C	South of Building C9	Stiff clay	From 100mm to 3m below ground level.	Insufficient infiltration over 225 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 do not have suitable properties to accommodate infiltration. Therefore, the use of soakaways to accommodate the surface water run-off is not considered feasible at this time.

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 with underground storage (i.e. sub-base with 30% voids or manufactured storage cells) To include high level overflow into pond or swale	HGV parking and small car parks	

Stage	Technique	Possible Location	Example
	Bio-retention	Along edge of private accesses	
Site Control	Swale	Along road edge in verge area.	
	Filter trench	Along road edge in verge area and at the edge of car parks	
Wider site control	Wet Pond	Downstream of larger development	

4.3.2 In order to add amenity and environmental value to the SUDS solutions on site it is considered that wet ponds should be incorporated. Suggested locations include the area just north of the container vehicle storage parking area and an area close to the freight terminal.

4.4 Surface Water - Modelling

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 illustrate how the different SUDS solutions work together as well as to identify what volume of attenuation is needed to ensure that a target reduction of 20% in betterment of the flows is achieved.

4.4.2 Due to the layout of the new development and the size of the proposed storage facility, it was found that some of the area from Catchment A had to be redirected into Catchment B. However, the outfall location from Catchment A and Catchment B into the River Ray remains unchanged.

4.4.3 The proposed total catchment area and calculated impermeable area is summarised in Table 4.3, below.

Table 4.3 Proposed Catchment Areas

Catchment	Total Area	Impermeable Area
Catchment A	26.7ha	17.6ha (66%)
Catchment B	8.6ha	5.7ha (66%)

4.4.4 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. The key parameters used have been summarised in Table 4.4, below.

Table 4.4 Network Global Variables and Simulation Parameters Used in the Modelling

Model Parameters	Value
Return Period (yrs)	1 in 1, 1 in 30 and 1 in 100 + 20% 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)

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.

4.4.5 The results of the modelling are summarised at Table 4.5.

Table 4.5 Surface Water Run-off Flows

Storm Return period	Catchment A (System 1) critical flow (Northern Outfall)	Catchment B (System 2) critical flow (Western Outfall)
1 in 1 year	146 l/s	43 l/s
1 in 30 year	253 l/s	95 l/s
1 in 100 year+30%	275 l/s	120 l/s

4.4.6 The modelling identified the need for attenuation to accommodate all storm events up to a 1:100yr + 20% climate change event. Table 4.6, below, summarises these volumes when flows are restricted to 80% of the existing green field run-off rate.

Table 4.6 Estimated Pond/Tank Volumes

System	Pond Type	Attenuation Volume Required
System 01	On-line wet pond	2,500m^3
System 02	On-line wet pond	500m^3

Notes

1) The design of the pond assumes that a permanent pool will be provided, which will not contribute to the attenuation volume required.

2) The pond for system 2 shown represents the attenuation volume only. It is considered that during detailed design, the size of the pond will be maximised to the available area in order to provide the maximum quality and amenity value within the land that is available.

3) System 01 will also be design with an overspill facility into the landscaping area.

4.4.7 Results of the modelling calculations can be found in Appendix E.

4.4.8 The indicative layout of each pond is shown on drawing 27808-CVD-171 found in Appendix B.

4.4.9 The pond layout has been set out against topographical survey data and illustrates a possible layout that could be achieved. 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.

4.4.10 Close attention has been paid to accommodating landscape features in with the SUDS solution. This has resulted in a landscape zone being identified near the northern pond which will be contoured specifically to act as an overspill area from the main pond when the higher 1 in 100 year storm events occur.

4.5 Surface Water- Comparison of Flows from The Site

4.5.1 Table 4.7, below, provides a high level summary of the comparison of flows from the site.

Table 4.7 Comparison of Surface Water flows

Storm event	Existing flows to northern outfall (Catchment A=13.5ha)	Existing flows to western outfall (Catchment B=21.8ha)	Total Existing Flow	Proposed flows to northern outfall (Catchment A=26.7ha)	Proposed flows to western outfall (Catchment B=8.6ha)	Total Proposed Flow
1 in 1	59 l/s (~4 l/s/ha)	138 l/s (~6 l/s/ha)	197 l/s	146 l/s (~4 l/s/ha)	43 l/s (~5 l/s/ha)	157 l/s
1 in 30	146 l/s (~11 l/s/ha)	312 l/s (~14 l/s/ha)	458 l/s	253 l/s (~7 l/s/ha)	95 l/s (~11 l/s/ha)	295 l/s
1 in 100	192 l/s (~14 l/s/ha)	385 l/s (~18 l/s/ha)	577 l/s	275 l/s* (~10 l/s/ha)	120* l/s (~14 l/s/ha)	391 l/s

Notes

1) * Flow rate also includes 20% climate change.

2) When the total existing flows are compared with the total proposed flows a minimum 20% reduction can be seen.

4.5.2 Although the results show that there is a net increase in flow to the northern outfall, this is due to the fact that the area of Catchment A increases in size to accommodate the proposed development. The area of Catchment B and associated flow will reduce correspondingly.

4.5.3 When the total calculated surface water flows for the existing development are compared with the total calculated flows for the proposed development, there is a 20% reduction in flow rates per ha.

4.5.4 The principles of the surface water drainage strategy were discussed with the Environment Agency (EA) in early July 2011. The minutes of this meeting are contained in Appendix D. The outcome of the meeting was that the EA had no adverse comments to make.

4.6 Foul Flows - Assessment

4.6.1 The foul water flows have been calculated for the proposed development. These flows have been calculated by multiplying the overall floor area as indicated in the masterplan by typical usage rates per metre square for this type of development.

4.6.2 The calculations also assume that the majority of water entering the building is used in applications where the dirty water is discharged to the foul system. As such, the foul water flows will be the same as the water usage values.

4.6.3 Table 4.8, below, summarises the calculated flow rates. A full copy can be found in Appendix A.

Table 4.8 Proposed Theoretical Flows

Development Type	Foul Water Drainage Flows	
	Average DWF (l/s)	**Peak Flow (l/s)**
B8 - Storage/Warehouse	2.4	14.4
Offices	0.2	1.5
Total	**2.6**	**15.9**

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

4.6.4 Drawing 27808-CVD-171 contained in Appendix B indicates the location of the proposed foul water sewer connection point to serve each catchment.

4.7 Foul Flows - Comparison of Flows

4.7.1 Table 4.9 provides a comparison of the foul flows of the affected area of the site.

Table 4.9 Comparison of Foul Water Drainage Flow Rates

Development Affected	Building Area Affected	Average DWF	Peak Flow (i.e. 6xDWF)
C1,C4,C7,C9, C13, C11, C21, C49, C60,C61,C63	36,092m^2	1.2 l/s	7.4 l/s
Proposed storage development	71,600m^2	2.6 l/s	15.9 l/s
Difference		+1.4 l/s	+8.5 l/s

4.7.2 The foul flow calculations indicate that there is likely to be a small 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.

4.7.3 Thames Water have identified that the foul flows from C Site are likely to require a connection into the pumping station located in Ploughley Lane. This pumping station currently accommodates the majority of Arncott Garrison and has an incoming 525/600mm dia sewer and pumps the flows at 60 l/s. As a secondary option, there may be some limited capacity in the Arncott Garrison/Blackthorn Road pumping station which currently has an incoming 150mm dia sewer and pumps at 7 l/s but this would require further investigation. (Ref: email 19-11-10 N Wood with G Nokes of Thames Water.)

4.7.4 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 near MH 8902 (SP60179802). This connection assumes that only the Ploughley Lane pumping station will be used to accommodate the flows. If there is spare capacity in the Arncott/ Blackthorn Road pumping station then an additional connection will need to be made.

4.7.5 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 be undertaken to ascertain the true extent of any reinforcement works and phasing implications of any identified solution.

4.7.6 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.

4.7.7 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.

4.7.8 However, Thames Water has confirmed that the Drainage Impact Assessment can be done at the Reserved Matters stage to enable a detailed design process. Thames Water has confirmed via email that they will not put in any objection to the outline planning application as long assurances are given that these issues are addressed at the next stage. Reference should be made to the key correspondence in Appendix D for further details.

4.7.9 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.

4.7.10 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 proposed development at MOD Bicester, Oxfordshire. The area of study covers two distinct sites; C Site and Graven Hill Site. This assessment is for C Site only.

5.1.2 This report sets out the constraints/opportunities of the existing surface water drainage and foul water drainage infrastructure across the site, so that a proposed strategy for accommodating the proposed development can be identified.

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 surface water 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 (PPS 25) and does not have the capacity to accommodate the proposed increase in impermeable area across the whole site, particularly in Catchment A.

5.2.2 The total area in Catchment A has increased from 13.5ha to 26.7ha to accommodate the proposed building roof area. As such, there is an increase in impermeable area. of 13.2ha

5.2.3 The total area in Catchment B has decreased from 21.8ha to 8.6ha now that the building has been included in Catchment A. As such, there is a decrease in impermeable area of 3.6ha, resulting a net increase across the whole site of 9.7ha (i.e. 13.3ha - 3.6ha).

5.2.4 To cater for this increase, SUDS systems have been incorporated into the proposed scheme to reduce the peak run-off flows and volumes. Suitable SUDS solutions involve the introduction of permeable paving, ditches/swales and attenuation ponds.

5.2.5 Generally, a minimum of 20% betterment in the flows has been achieved. This figure was agreed with the EA at a meeting on the 28 June. A copy of the minutes is contained in Appendix D.

5.2.6 Although there has been an increase in impermeable area the overall flow from the site has been reduced. That is to say, the 1 in 1 year flows have reduced from 5 l/s/ha to 4 l/s/ha, the 1 in 30 year flows reduced from 12 l/s/ha to 9 l/s/ha and the 1 in 100 year flows reduced from 16 l/s/ha to 12 l/s/ha.

5.3 Foul Water Findings

5.3.1 The loading calculations show there is a 1.4 l/s increase in dry weather flow expected as a result of the new development.

5.3.2 This new development is intended to be accommodated into the existing public foul sewer network which is located to the north of the site. Drawing 27808-CVD-171 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 as long as assurances are given that the Drainage Impact Assessment will be carried out at the Reserved Matters Stage.

Appendix A
Loading Calculations

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.450
Area (ha)	13.500	Urban	0.170
SAAR (mm)	622	Region Number	Region 6

Results	**l/s**
QBAR Rural	51.7
QBAR Urban	68.9
Q100 years	192.4
Q1 year	58.5
Q30 years	145.8
Q100 years	192.4

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.450
Area (ha)	21.800	Urban	0.430
SAAR (mm)	622	Region Number	Region 6

Results	**l/s**
QBAR Rural	83.4
QBAR Urban	161.8
Q100 years	385.4
Q1 year	137.6
Q30 years	312.1
Q100 years	385.4

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

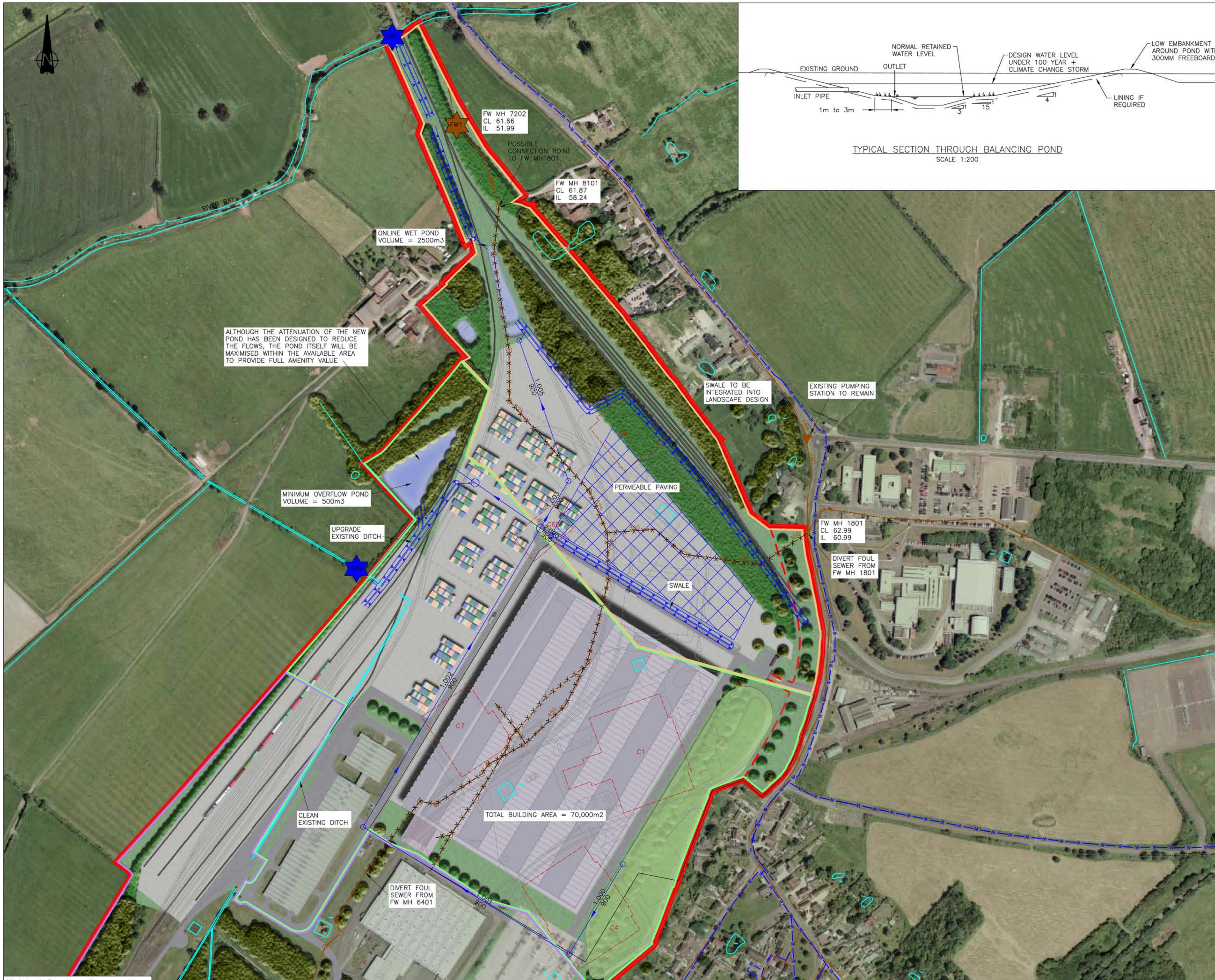
05/08/2011

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 C SITE DRAINAGE STRATEGY (27808/RR016)
4. SUMMARY OF OUTFALLS

CATCHMENT	DISCHARGES TO SW OUTFALL	CONNECTS INTO FW PIPE
A	SW1	FW1
B	SW2	FW1

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
- SURFACE WATER CATCHMENT BOUNDARY A
- SURFACE WATER CATCHMENT BOUNDARY B
- EXISTING FOUL DRAINAGE (GRAVITY) – THAMES WATER
- EXISTING FOUL DRAINAGE (PRESSURISED) – THAMES WATER
- EXISTING SURFACE WATER WATERCOURSE
- EXISTING FOUL PUMPING STATION – THAMES WATER
- EXISTING FOUL PIPE TO BE REMOVED
- PROPOSED SURFACE WATER DRAINAGE ROUTE WITH MODEL PIPE REFERENCE / DIAMETER
- PROPOSED SURFACE WATER DRAINAGE SWALE
- PROPOSED SURFACE WATER ATTENUATION POND
- PROPOSED SURFACE WATER DRAINAGE OUTFALL
- PROPOSED FOUL WATER DRAINAGE OUTFALL
- EXISTING BUILDING (WITH REFERENCE) TO BE REMOVED

SCALES: 1:2000 @ A1

PROJECT TITLE:
REDEVELOPMENT OF MoD BICESTER

DRAWING TITLE:
C SITE
DRAINAGE STRATEGY

CLIENT:
Defence Infrastructure Organisation

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DRAWING No.
27808-CVD-171

Appendix C
SUDS Assessment and Supporting Data

Defence Infrastructure Organisation

Future Defence Storage and Distribution Programme - Redevelopment of MOD Bicester

C Site: SUDS Assessment

August 2011

AMEC Environment & Infrastructure
UK Limited

Report for

Ms Ellen O'Grady
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Defence Infrastructure Organisation

Future Defence Storage and Distribution Programme - Redevelopment of MOD Bicester

C Site: SUDS Assessment

August 2011

AMEC Environment & Infrastructure UK Limited

Document Revisions

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

Contents

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 C Site 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 (document reference BIC/OPA/DOC/17 - C Site: Drainage Strategy) for the development.

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

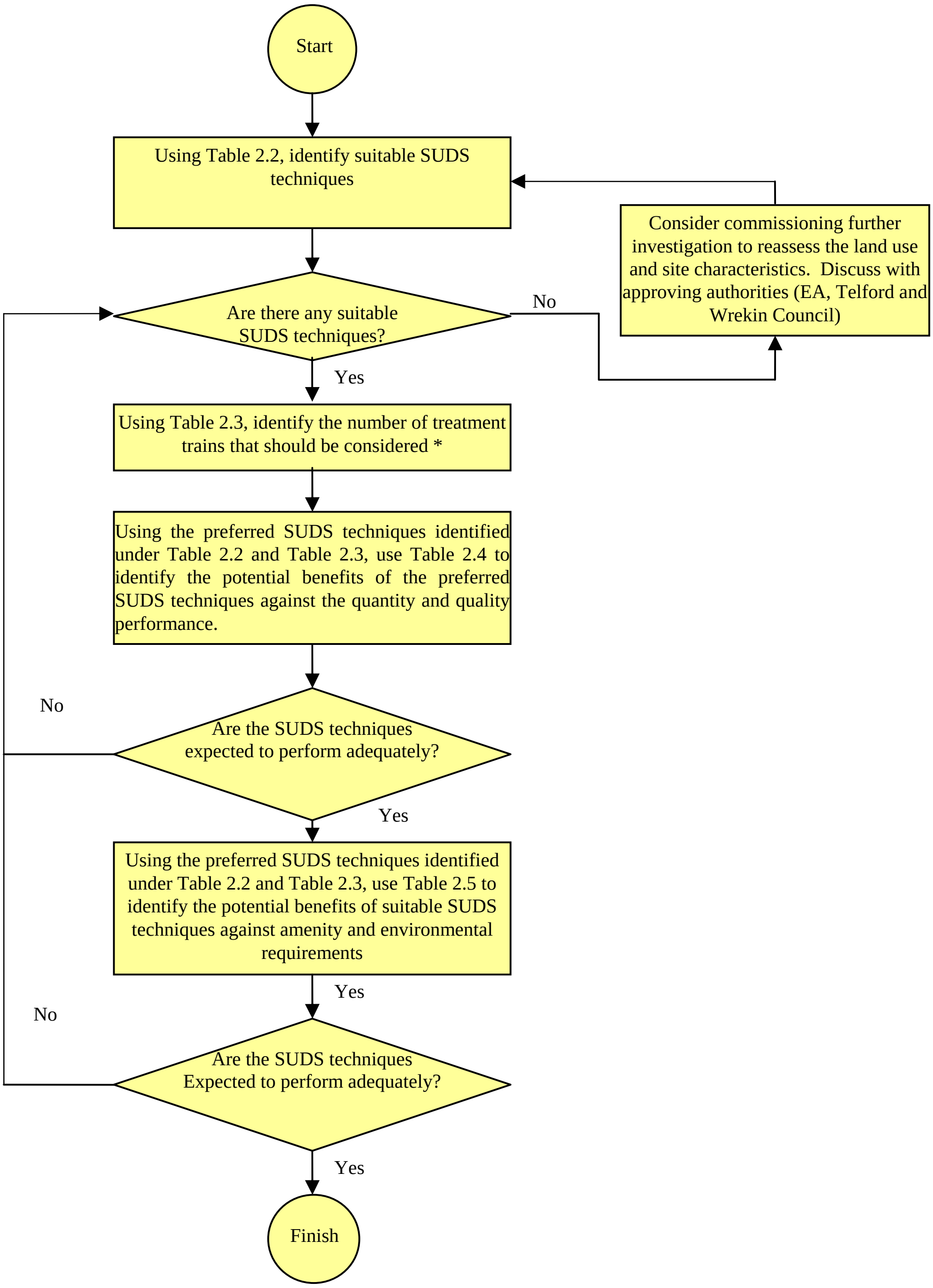
1.2.3 The Manual identifies five key areas in which to assess the suitability of these SUDS techniques.

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	Employment. The land will be used for employment and storage use.	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 33.3ha	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 0.88%.	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 7m over a length of 795m. 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	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 industrial areas/loading bays/lorry parks/highways	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

(grey shading) 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 3. 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.

2.2.5

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

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
	Enhanced wet swale	Yes	Yes (4)	Yes (7)	Yes	Yes	Yes	Yes	Suitable
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 now 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)

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)
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

SuDS Group	Technique	Maintenance	Community acceptability	Cost	Habitat creation potential
~~Open channels~~	~~Conveyance swale~~	Low	Medium*	Low	Medium
	~~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.

2.4 Possible SUDS Solutions

2.4.1 Based on the findings from the assessment there are several permutations that may be considered feasible. The following table summarises the most appropriate solutions in terms of their effectiveness and practicality based on a minimum of three management trains.

Table 2.6 Possible SUDS Solutions which contain a minimum of three 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, Open Channels and Retention	Pervious pavement or channel drain with subsurface storage as source control. Swale as site control to convey flows across site as site control Ponds to store flows as regional control	Yes	Good. Pervious paving or channel drain could be used in car parking areas. However maintenance issues need to be taken into account. Swales can be located along highway verges and ponds can be located in available green space, in the vicinity of the final outfall location
Filtration, Open Channels and Retention	Filter strip/trench as source control along highway or back of hardstanding areas. Swale as site control to convey flows across site as site control Ponds to store flows as regional 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, Open Channels and Detention/Wet Land	Rain water harvesting as source control. Swale as site control to convey flows across site as site control Detention basin/wet land to store excessive flows as regional 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

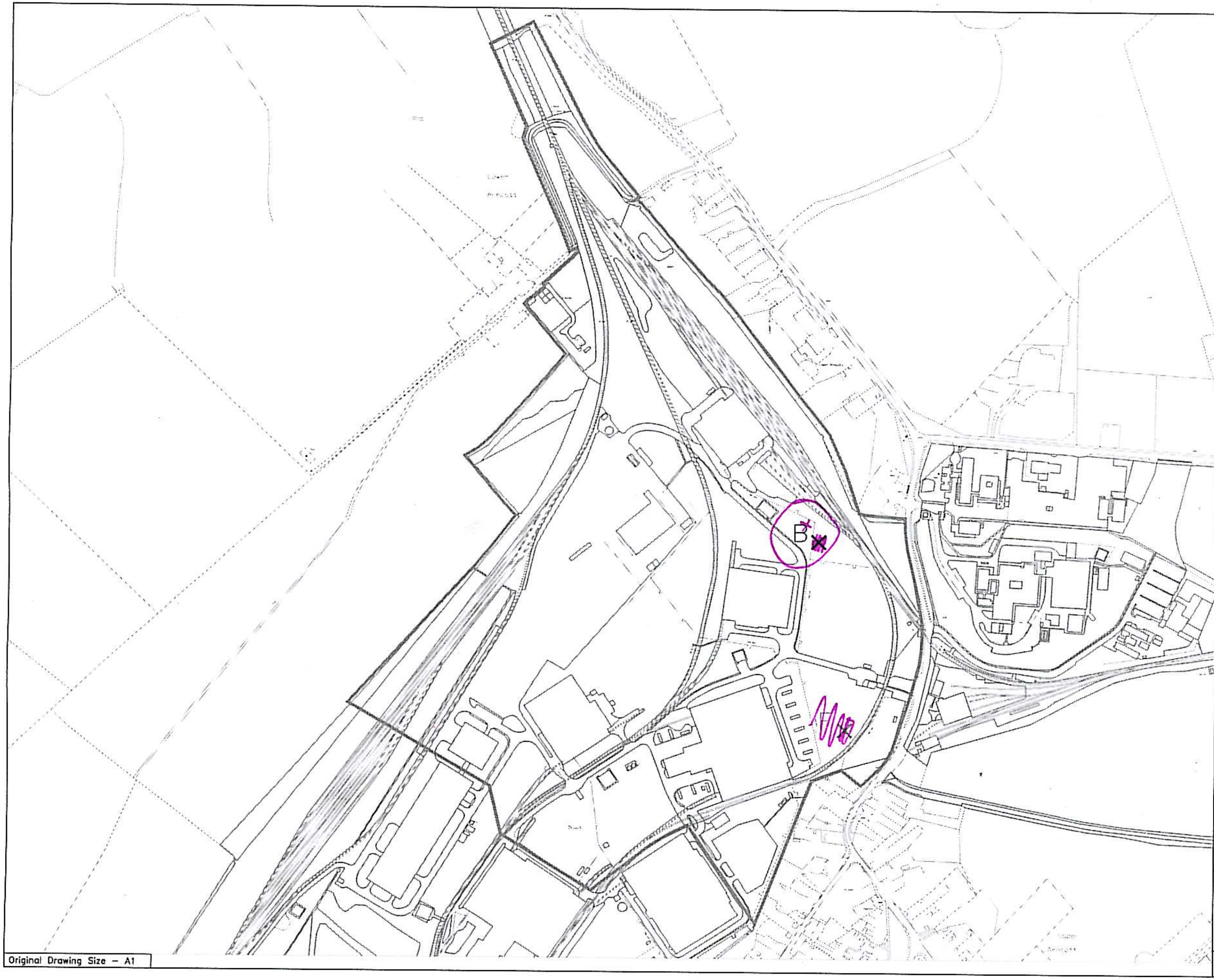
3.1.1 This Sustainable Drainage System (SUDS) assessment covers the complete site development as one entity, results of which inform Entec's Drainage Strategy (report ref: CL016 – C Site Drainage Strategy) for the development.

3.1.2 The assessment has shown that when an effective management train (Table 2.2 suggests a minimum of three management train combinations) is combined with appropriate SUDS techniques (see Table 2.3), an overall effective 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.



Original Drawing Size – A1

REV	DATE	DESCRIPTION	DRN	CHK	APP
A	JUL 2018	FIRST ISSUE	MS	MH	MW

REVISIONS

REV	DATE		DRN	CHK	APP
B	JULY 2018	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
- ×B SOAKAWAY LOCATION
- ×F ADDITIONAL SOAKAWAY LOCATION

SCALES: 1:2000 @ A1

PROJECT TITLE:
BICESTER PLANNING SUPPORT

DRAWING TITLE:
SITE C
PROPOSED SOAKAWAY LOCATIONS

CLIENT:
DE
DEFENCE ESTATES

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

DRAWING No.
27808-CVD-006/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 - C	
Test Depth (m):	3.00	Date:	24.08.2010	
Test Width (m):	0.60	Groundwater level before test (m):		Dry
Test Length (m):	2.40	Water level start (m):		0.960
Test No:	1 of 1	Water level finish (m):		0.960

Time (Minutes)	Water Depth (m)	Level Drop (m)
0	0.96	0.000
5	0.96	0.000
10	0.96	0.000
15	0.96	0.000
95	0.96	0.000
125	0.96	0.000
185	0.96	0.000
225	0.96	0.000

Insufficent infiltration over 225 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 - C

Project: Bicester-Trial Trenches and Soakaways

Project ID: SI1638

Client: Entec UK Limited

Engineer: N/A

Ground Level:

Coordinates: -

Orientation of Trial Pit:

Length: 2.40 Width: 0.60 Depth: 3.00

Description	Legend	Depth (m)	O.D. Level	Water	Sample / Test Type	Sample / Test Depth (m)	Remarks and Test Results PID (ppm)
Brown grey sandy SILT.		0.10					
Very stiff yellow grey slightly sandy silty CLAY. Occasional angular to subangular fine to coarse limestone gravel.		0.30					
Stiff mottled grey and yellow brown CLAY. Rare weak calcareous concretions. ...at 1.40mbgl sub horizontal polished fissure planes. ...From 1.60mbgl fossilised shell debris ...From 1.90mbgl becoming grey with rare yellow.		2.20					
Stiff locally closely fissured slightly brownish grey CLAY. Rare shell fragments and fossils, fragments of wood and fine decayed root traces along fissures. ...From 2.80mbgl becoming brown grey and closely fissured.		3.00					
End of Trial Pit at 3.00 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

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: |
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  |nick.wood@entecuk.co.uk
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| To: |
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  |geoff.nokes@thameswater.co.uk
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| Cc: |
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  |Rachel.Dimmick@ENTECUK.CO.UK
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  |Bicester - foul drainage issues
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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 C Site 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	122.112	0.407	300.0	2.193	5.00	0.600		o	600
* 1.001	281.714	0.943	298.7	2.193	0.00	0.600		o	600
* 1.002	403.991	0.958	421.7	3.940	0.00	0.600		o	600
* 2.000	18.007	0.390	46.2	1.750	5.00	0.600		o	600
* 1.003	63.926	0.128	499.4	1.750	0.00	0.600		o	600
* 1.004	98.309	0.164	599.4	0.000	0.00	0.600		o	900
* 3.000	38.606	0.450	85.8	5.770	5.00	0.600		o	225
* 1.005	200.743	0.532	377.3	0.000	0.00	0.600		o	900
* 1.006	800.000	0.000	0.0	0.000	0.00	0.600		[]	16
* 1.007	134.379	0.248	541.9	0.000	0.00	0.600		o	525
* 1.008	10.000	0.020	500.0	0.000	0.00		0.030	\/	31

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	65.000	63.350	1.050	65.000	62.943	1.457		1200
* 1.001	2	65.000	62.943	1.457	65.000	62.000	2.400		1200
* 1.002	3	65.000	62.000	2.400	63.000	61.042	1.358		1200
* 2.000	4	63.000	61.432	0.968	63.000	61.042	1.358		1200
* 1.003	5	63.000	61.042	1.358	62.200	60.914	0.686		1200
* 1.004	6	62.200	60.614	0.686	62.500	60.450	1.150		1200
* 3.000	7	63.000	61.575	1.200	62.500	61.125	1.150		1200
* 1.005	8	62.500	60.450	1.150	62.000	59.918	1.182		1200
* 1.006	9	62.000	59.618	1.182	61.800	59.618	0.982		1200
* 1.007	10	61.800	59.618	1.657	61.800	59.370	1.905	Hydro-Brake®	1200
* 1.008	11	61.800	59.370	1.830	63.000	59.350	3.050		1932

Simulation Criteria for C Site 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	7
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Simulation Criteria for C Site SW Model.txt

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 C Site SW Model.txt

Hydro-Brake® Manhole: 10, DS/PN: 1.007, Volume (m³): 2509.9

Design Head (m) 2.800 Diameter (mm) 520
Design Flow (l/s) 300.0 Invert Level (m) 59.618
Hydro-Brake® Type Md12 SW Only

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	20.1	1.200	268.4	3.000	309.8	7.000	472.9
0.200	60.0	1.400	255.6	3.500	334.4	7.500	489.5
0.300	108.3	1.600	250.9	4.000	357.5	8.000	505.5
0.400	158.0	1.800	253.2	4.500	379.1	8.500	521.1
0.500	203.8	2.000	259.9	5.000	399.7	9.000	536.2
0.600	241.2	2.200	268.8	5.500	419.2	9.500	550.9
0.800	280.8	2.400	278.8	6.000	437.8		
1.000	283.1	2.600	289.2	6.500	455.7		

Storage Structures for C Site SW Model.txt

Swale Manhole: 1, DS/PN: 1.000

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

Infiltration Coefficient Base (m/hr)	0.00001	Length (m)	100.0
Infiltration Coefficient Side (m/hr)	0.00001	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	500.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	63.350	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5	Include Swale Volume	Yes

Swale Manhole: 2, DS/PN: 1.001

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

Infiltration Coefficient Base (m/hr)	0.00001	Length (m)	100.0
Infiltration Coefficient Side (m/hr)	0.00001	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	500.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	62.943	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5	Include Swale Volume	Yes

Swale Manhole: 3, DS/PN: 1.002

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

Infiltration Coefficient Base (m/hr)	0.00001	Length (m)	100.0
Infiltration Coefficient Side (m/hr)	0.00001	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	500.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	62.000	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5	Include Swale Volume	Yes

Swale Manhole: 4, DS/PN: 2.000

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

Infiltration Coefficient Base (m/hr)	0.00001	Length (m)	250.0
Infiltration Coefficient Side (m/hr)	0.00001	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	500.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	61.800	Cap Infiltration Depth (m)	0.000
Base Width (m)	1.2	Include Swale Volume	Yes

Swale Manhole: 6, DS/PN: 1.004

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

Infiltration Coefficient Base (m/hr)	0.00001	Length (m)	200.0
Infiltration Coefficient Side (m/hr)	0.00001	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	500.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	60.914	Cap Infiltration Depth (m)	0.000
Base Width (m)	2.0	Include Swale Volume	Yes

Porous Car Park Manhole: 7, DS/PN: 3.000

Infiltration Coefficient Base (m/hr)	0.00001	Width (m)	150.0
Membrane Percolation (mm/hr)	1000	Length (m)	200.0
Max Percolation (l/s)	8333.3	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	61.475	Cap Volume Depth (m)	0.000

Infiltration Basin Manhole: 10, DS/PN: 1.007

Invert Level (m)	59.618	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00001	Porosity	0.30
Infiltration Coefficient Side (m/hr)	0.00001		

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	1200.0	0.500	1200.0

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for C Site 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, 20

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%	30/15 Winter				
1.001	15 Winter	1	0%	30/15 Summer				
1.002	30 Winter	1	0%	1/15 Winter				
2.000	30 Winter	1	0%	30/15 Summer				
1.003	30 Winter	1	0%	1/15 Summer				
1.004	60 Winter	1	0%	100/120 Winter				
3.000	1440 Winter	1	0%	100/60 Winter				
1.005	60 Winter	1	0%	100/120 Winter				
1.006	120 Winter	1	0%	100/120 Summer				
1.007	120 Winter	1	0%	30/60 Summer				
1.008	120 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	63.687	-0.263	0.000	0.56	0.0	210.9	OK
1.001	2	63.371	-0.172	0.000	0.76	0.0	292.2	OK
1.002	3	62.705	0.105	0.000	0.99	0.0	322.6	SURCHARGED
2.000	4	61.849	-0.183	0.000	0.28	0.0	174.6	OK
1.003	5	61.830	0.188	0.000	1.63	0.0	449.1	SURCHARGED
1.004	6	61.118	-0.396	0.000	0.60	0.0	433.5	OK
3.000	7	61.669	-0.131	0.000	0.37	0.0	19.6	OK
1.005	8	60.873	-0.477	0.000	0.45	0.0	435.4	OK
1.006	9	60.133	-0.685	0.000	0.09	0.0	382.8	OK
1.007	10	60.123	-0.020	0.000	0.74	0.0	146.2	OK
1.008	11	59.626	-0.951	0.000	0.10	0.0	146.2	OK

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for C Site 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, 20

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%	30/15 Winter				
1.001	30 Winter	30	0%	30/15 Summer				
1.002	60 Winter	30	0%	1/15 Winter				
2.000	30 Winter	30	0%	30/15 Summer				
1.003	30 Winter	30	0%	1/15 Summer				
1.004	60 Winter	30	0%	100/120 Winter				
3.000	480 Winter	30	0%	100/60 Winter				
1.005	60 Winter	30	0%	100/120 Winter				
1.006	240 Winter	30	0%	100/120 Summer				
1.007	240 Winter	30	0%	30/60 Summer				
1.008	240 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	63.965	0.015	0.000	0.91	0.0	338.1	SURCHARGED
1.001	2	63.833	0.290	0.000	0.82	0.0	316.0	SURCHARGED
1.002	3	63.347	0.747	0.000	1.22	0.0	401.0	SURCHARGED
2.000	4	62.298	0.266	0.000	0.38	0.0	236.3	SURCHARGED
1.003	5	62.270	0.628	0.000	2.47	0.0	678.8	SURCHARGED
1.004	6	61.272	-0.242	0.000	0.88	0.0	639.4	OK
3.000	7	61.761	-0.039	0.000	1.00	0.0	53.2	OK
1.005	8	61.006	-0.344	0.000	0.70	0.0	671.6	OK
1.006	9	60.818	0.000	0.000	0.12	0.0	545.4	OK
1.007	10	60.755	0.612	0.000	1.28	0.0	252.6	SURCHARGED
1.008	11	59.742	-0.835	0.000	0.18	0.0	252.6	OK

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for C Site 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, 20

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	30 Winter	100	+20%	30/15 Winter				
1.001	60 Winter	100	+20%	30/15 Summer				
1.002	60 Winter	100	+20%	1/15 Winter				
2.000	30 Winter	100	+20%	30/15 Summer				
1.003	30 Winter	100	+20%	1/15 Summer				
1.004	360 Winter	100	+20%	100/120 Winter				
3.000	480 Winter	100	+20%	100/60 Winter				
1.005	360 Winter	100	+20%	100/120 Winter				
1.006	360 Winter	100	+20%	100/120 Summer				
1.007	360 Winter	100	+20%	30/60 Summer				
1.008	480 Summer	100	+20%					

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	64.265	0.315	0.000	0.87	0.0	325.8	SURCHARGED
1.001	2	64.185	0.642	0.000	0.80	0.0	309.0	SURCHARGED
1.002	3	63.779	1.179	0.000	1.32	0.0	433.4	SURCHARGED
2.000	4	62.567	0.535	0.000	0.48	0.0	302.7	SURCHARGED
1.003	5	62.543	0.901	0.000	2.86	0.0	786.9	SURCHARGED
1.004	6	61.849	0.335	0.000	0.81	0.0	587.4	SURCHARGED
3.000	7	61.900	0.100	0.000	1.11	0.0	58.9	SURCHARGED
1.005	8	61.819	0.469	0.000	0.67	0.0	641.8	SURCHARGED
1.006	9	61.774	0.956	0.000	0.14	0.0	611.3	FLOOD RISK
1.007	10	61.774	1.631	0.000	1.39	0.0	274.7	FLOOD RISK
1.008	11	59.760	-0.817	0.000	0.20	0.0	274.5	OK

Existing Network Details for C 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	43.633	0.130	335.6	1.000	10.00	0.600	o	450
* 1.001	215.000	0.000	0.0	0.000	0.00	0.600	[]	12
* 1.002	35.568	0.070	508.1	0.000	0.00	0.600	o	450
* 1.003	80.963	0.160	506.0	0.000	0.00	0.600	\/	38

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	62.240	61.200	0.590	62.000	61.070	0.480		1200
* 1.001	2	62.000	60.520	0.480	62.000	60.520	0.480		1200
* 1.002	3	62.000	60.520	1.030	61.900	60.450	1.000	Hydro-Brake®	1200
* 1.003	4	61.900	60.450	0.850	62.400	60.290	1.510		1200

Simulation Criteria for C 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)	240
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	4

Number of Input Hydrographs	0	Number of Storage Structures	0
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 C Site SW Model 02.txt

Hydro-Brake® Manhole: 3, DS/PN: 1.002, Volume (m³): 501.8

Design Head (m) 3.000 Hydro-Brake® Type Md4 Invert Level (m) 60.520
Design Flow (l/s) 140.0 Diameter (mm) 322

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.0	1.200	96.8	3.000	139.9	7.000	213.8
0.200	22.6	1.400	98.8	3.500	151.2	7.500	221.3
0.300	49.3	1.600	103.4	4.000	161.6	8.000	228.5
0.400	78.1	1.800	108.8	4.500	171.4	8.500	235.6
0.500	101.9	2.000	114.4	5.000	180.7	9.000	242.4
0.600	114.7	2.200	119.9	5.500	189.5	9.500	249.0
0.800	112.9	2.400	125.2	6.000	197.9		
1.000	101.0	2.600	130.3	6.500	206.0		

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for C 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, 20

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%	30/15 Summer				
1.001	60 Winter	1	0%					
1.002	60 Winter	1	0%	100/15 Winter				
1.003	60 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	61.453	-0.197	0.000	0.60	0.0	95.2	OK
1.001	2	60.753	-0.767	0.000	0.02	0.0	65.3	OK
1.002	3	60.752	-0.218	0.000	0.22	0.0	27.0	OK
1.003	4	60.535	-0.709	0.000	0.01	0.0	27.0	OK

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for C 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, 20

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%	30/15 Summer				
1.001	60 Winter	30	0%					
1.002	60 Winter	30	0%	100/15 Winter				
1.003	60 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	61.781	0.131	0.000	1.47	0.0	231.9	SURCHARGED
1.001	2	60.931	-0.589	0.000	0.05	0.0	154.7	OK
1.002	3	60.928	-0.042	0.000	0.50	0.0	62.9	OK
1.003	4	60.571	-0.673	0.000	0.03	0.0	62.9	OK

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for C 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, 20

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	+20%	30/15 Summer				
1.001	60 Winter	100	+20%					
1.002	60 Winter	100	+20%	100/15 Winter				
1.003	60 Winter	100	+20%					

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	62.171	0.521	0.000	2.27	0.0	357.9	FLOOD RISK
1.001	2	61.108	-0.412	0.000	0.09	0.0	248.0	OK
1.002	3	61.104	0.134	0.000	0.76	0.0	95.6	SURCHARGED
1.003	4	60.602	-0.642	0.000	0.04	0.0	95.5	OK