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FORMER EON SITE, 190 LONDON ROAD, RAYLEIGH, ESSEX

PPS25 FLOOD RISK ASSESSMENT

REPORT REF. J661-03
PROJECT NO. J661
NOVEMBER 2011

FORMER EON SITE, 190 LONDON ROAD, RAYLEIGH, ESSEX

PPS25 FLOOD RISK ASSESSMENT

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DOCUMENT CONTROL SHEET

REV	ISSUE PURPOSE	AUTHOR	CHECKED	APPROVED	DATE
-	DRAFT	TS	DJR	DJR	21/10/ 2011
A	Issue for Planning	TS	DJR	DJR	7/11/ 2011

1.0 EXECUTIVE SUMMARY

1.1. Ardent Consulting Engineers has been commissioned to undertake a Flood Risk Assessment for the proposed 103 unit residential redevelopment located on London Road, Rayleigh.

1.2. This Flood Risk Assessment considers the current policy relating to flood risk, including PPS25 and the Rochford District Council Strategic Flood Risk Assessment (SFRA).

1.3. According to the Environment Agency's internet flood zone maps, the Site is located in Flood Zone 1, and is therefore considered to be at low probability of flooding.

1.4. Detailed analysis of the Environment Agency flood levels and the topographic survey indicates that when taking account of the predicted impacts of climate change over the life of the development a portion of the northern western extent of the site would be at risk of flooding.

1.5. As the development proposals will encroach on the 1% flood extent, the development has included a means of providing floodplain compensation within an enhanced widened river edge proposal and within areas of low risk.

1.6. Although the Site is partly located within the 1% AEP floodplain extent safe access and egress can be provided for the Site, including the 300mm freeboard required.

1.7. The desk based assessment of groundwater and pluvial risk undertaken indicates that the Site is not at risk of flooding from these sources.

1.8. In order to achieve the PPS25 SuDS requirements only a nominal amount of surface water attenuation would be required, and this is likely to be accommodated by provision of underground attenuation.

Site constraints and soil conditions preclude the use of infiltration drainage or landscape based SuDS.

1.9. Therefore in conclusion, this FRA demonstrates that the residential proposals are consistent with the aims of PPS25 and the Site will not be at significant risk of flooding, or increase the flood risk to others.

2.0 INTRODUCTION

2.1. Ardent Consulting Engineers has been commissioned to undertake a Flood Risk Assessment (FRA), for the proposed residential redevelopment at London Road in Rayleigh. This FRA is in support of a Planning Application for the 103 residential properties, it has been written with specific reference to the requirements of Planning Policy 25: Development and Flood Risk (PPS25, **Ref 01**)

2.2. A glossary of common Flood Risk Engineering terms is provided in **Appendix A**, to assist non-technical readers.

Site Location

2.3. The former Eon Site in Rayleigh, (hereafter referred to as the "Site") comprises of a redevelopment of the existing EON building, nursery building (at the north east corner of the site), car parking and associated hard standing. The Site is located approximately 1.5km north west of Rayleigh town centre at Ordnance Survey grid TQ793918, as shown in the aerial view as provided in **Figure 2–1** below.

Figure 2-1 : Aerial view of the site

2.4. The site bounded by London Road at the south, residential properties to the north, woodlands and arable farmland to the west and north east; and recreation grounds with a dry pond at the eastern boundary of the site. From an review of the current drainage survey investigations and Anglian Water's Sewer plans it is apparent that this dry pond receives flows from the existing EON site (via an existing 600mm overflow pipe) and two incoming 225mm dia. Anglian Water sewers from Boston Avenue (see figure 2-2).

Figure 2-2: Extract from Anglian Water asset plan

Development Proposals

2.5. The current proposals include for development comprising of 103 residential properties, access roads, off-road parking spaces and a communal landscaped area.

2.6. Copies of the Development Proposals are provided in **Appendix B**.

3.0 POLICY

Planning Policy Statement 25: Development and Flood Risk

3.1. PPS25 (**Ref 01**) originally published in December 2006, and updated in March 2010, sets out Government policy on development and flood risk. Its aims are to ensure that flood risk is taken into account at all stages of the planning process, to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas of highest risk.

3.2. PPS25 advocates the use of the risk-based "Sequential Test", in which new development is directed towards the areas at lowest probability of flooding which are identified by Flood Zones.

3.3. Based on the information and Flood Zone Map obtained from the Environment Agency and as shown on in the extract below on figure 3-1, the Site is located within Flood Zone 1 (low probability, less than 0.1% AEP).

Figure 3-1: Extract from Environment Agency Flood Zone Map

3.4 As part of the consultation process, flood levels were obtained from the Environment Agency. This flood level information permitted a review of the Site specific risk based on the detailed topographic survey which we commissioned for this area. **Table 3-1 and Figure 3-2** below summarise the flood levels and node references respectively as provided by the Environment Agency.

Node	10% (1:10)	5% (1:20)	2% (1:50)	1.3% (1:75)	1% (1:100)	1% + CC	0.1% (1:1000)
BENF2_3457	14.39	14.46	14.56	14.61	14.66	14.75	15.09
BENF2_3418	14.34	14.39	14.48	14.53	14.57	14.66	14.98
BENF2_3362wu	13.87	13.95	14.08	14.14	14.19	14.30	14.68
BENF2_3333u	13.16	13.32	13.58	13.71	13.77	13.83	13.93

Table 3-1: Environment Agency Flood Levels

Figure 3-2: Environment Agency Model Nodes.

3.5 A review of the Environment Agency flood levels and the detailed topographic survey of the existing site has indicated that levels at the north end of the site fall below the 1 in 1000 year and 1 in 100 year flood. This would imply that a small extent of the north end of the site falls within Flood Zones 2&3. A detailed 3D ground model (see figure 3-3) has been developed to review the area of the existing site which falls within Flood Zone 3. For clarity and for the purpose of this report; henceforth, the area of the site within Flood Zone 1 will be referred to as **Area A** and the area in of the site at the northern extent which is within Flood Zone 2&3 will be referred to as **Area B** (see figure 3.4).

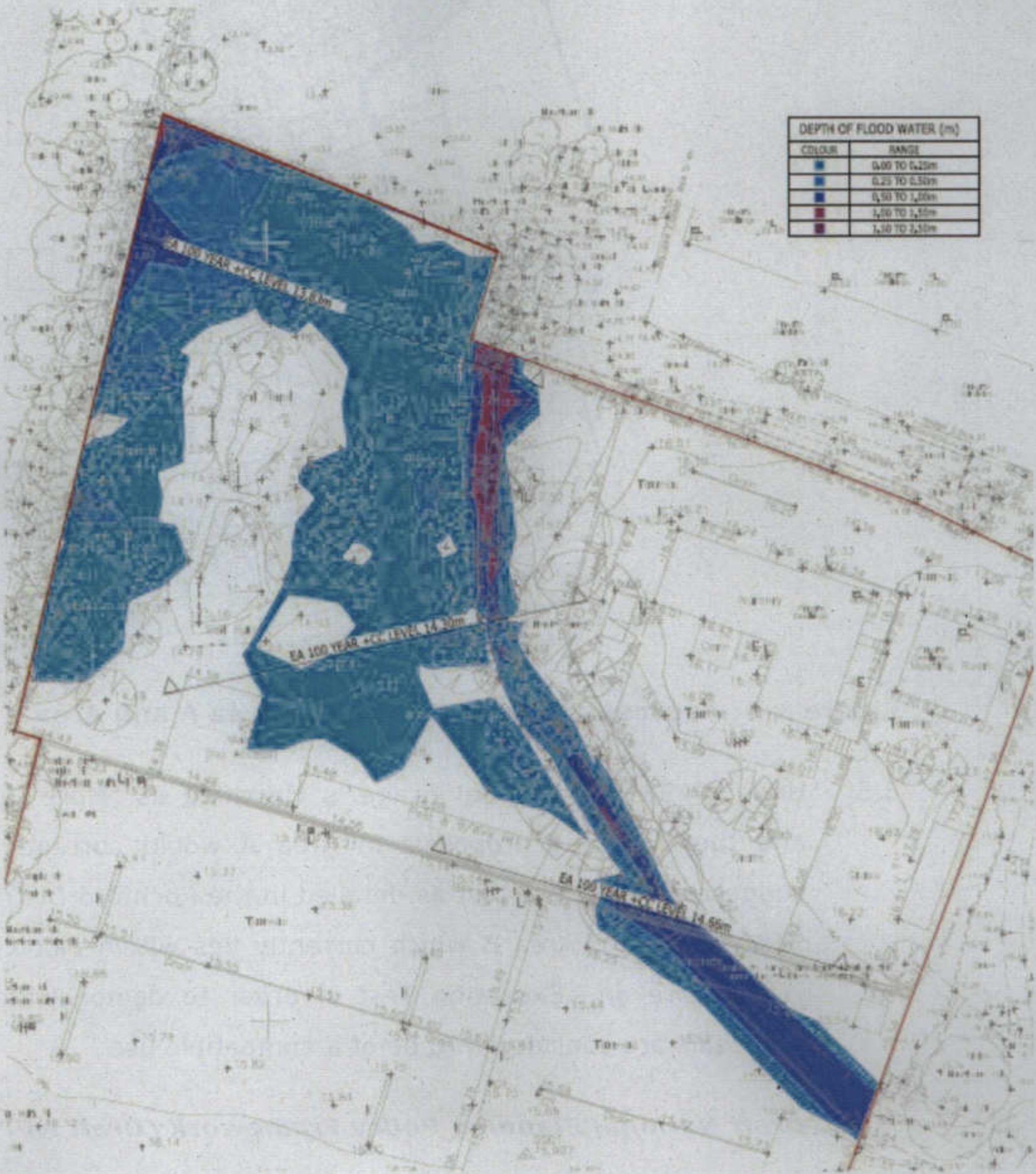

Figure 3-3: Excerpt from drawing J661-009 of 3D ground terrain model with flood extents for 1 in 100 year +CC

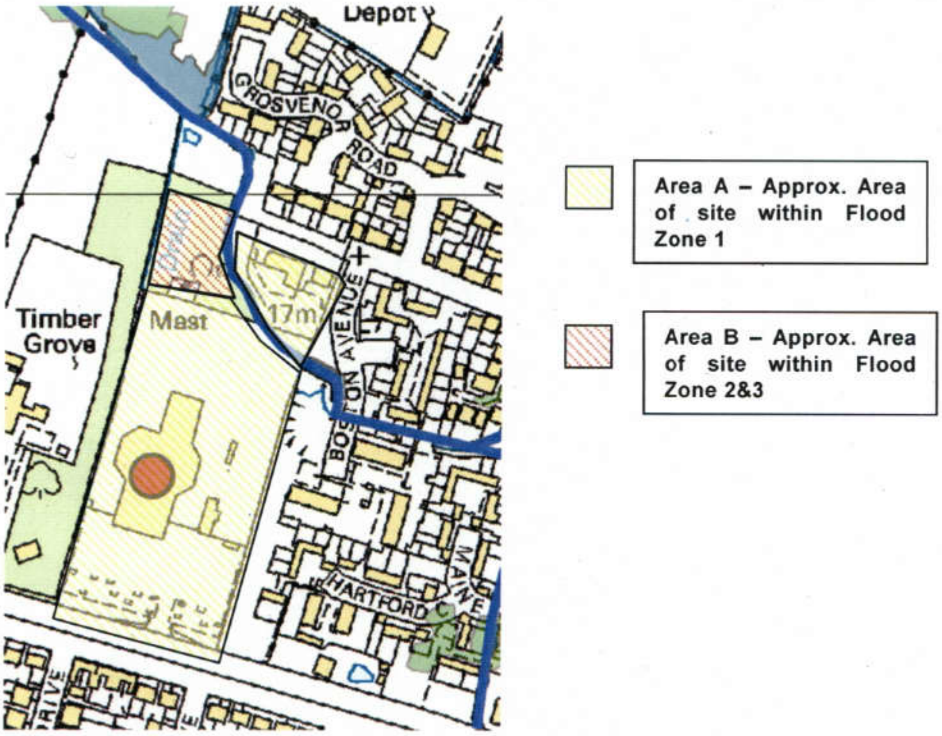

Figure 3-4: Approximate demarcation of Area A and Area B

3.5 Under PPS25, residential usage is classified as "More Vulnerable", and therefore the proposals in Area A would currently pass the suggested sequential test as detailed in the Rochford District Council SFRA (**ref 03**). Area B which currently lies within Flood Zone 2&3 will require an Exception Test in order to demonstrate that the proposals are considered to be of a compatible use.

Draft National Planning Policy Framework (Draft NPPF)

3.6 In July 2011, the Department of Communities and Local Government (DCLG) published the Draft NPPF (Ref 02). Once enacted, the NPPF would replace all of the existing Planning Policy Statements and Guidance's.

3.7 The Draft NPPF removes the PPS25 Vulnerability Classifications and requires each development to be Sequentially tested on its own merits.

Strategic Flood Risk Assessment: Level 1&2

3.8 Scott Wilson on behalf of Rochford District Council, has undertaken a Level 1&2 Strategic Flood Risk Assessment (**Ref 03**), which includes flood zone mapping to assist in the development of local development strategies and to inform the Sequential Test.

Sequential Test

3.9 The local authority will need to confirm if the Site is Sequentially acceptable, and should convey this in writing to the Environment Agency.

3.10 As the proposed use is classified as "More Vulnerable" the Exception Test is not applicable for Area A within Flood Zone 1 but will be required for Area B which lies within Flood Zone 2&3. This report will demonstrate that the proposed development is "*Safe from Flood risk*" as required by Part C of the Exception Test as noted in the **SFRA (Ref 02)**, in summary:

- Floodplain compensation measures are discussed in Chapter 5 of this report and aims to demonstrate that the development will not increase flood to neighbouring sites downstream of the site
- Although the Site is partly located within the 1% AEP floodplain extent safe access and egress can be provided for the Site, including the 300mm freeboard required.

4.0 SITE DESCRIPTION

4.1. The area being redeveloped within the Site is currently vacant and formed of: the existing former Eon building; car park; hard standings; an existing nursery at the north eastern corner of the site and an existing woodland area which comprises earth mounds of made ground.

Hydrology

4.2. The Rawreth Brook runs through the north eastern corner of the site. The river flows are conveyed through a culvert, where it enters the site on the eastern boundary, and continues within the culvert beneath the existing car park and exits to an open channel beyond the existing former Eon car park boundary. There are three weirs present along this channel which are assumed to have been installed to control the upstream channel flow The Rawreth Brook is classified by the Environment Agency as a main river, and is a tributary to the River Crouch. The level 1 SFRA (**ref 02**) has indicated that this these tributaries' pose a source of fluvial flooding and are known to react rapidly to intense rainfall.

4.3. According to the Environment Agency Flood Zone Map, the Site is located within Flood Zone 1, as shown on **Figure 3-1** previously. A review of the existing site levels has determined that part of the site lies within Flood Zones 2&3. The Site is not shown as benefitting from flood defences; however, the SFRA does state that the Rawreth Brook has maintained channels providing protection against the 50 year flood event.

Ground conditions

4.4. According to the RSK Consult Geotechnical Report Letter (**ref 05**) the Site is underlain by superficial Head and Alluvial Deposits, which is further underlain by London Clay formation. The single round of ground watering monitoring carried out during the ground investigations, have indicated variable water levels across the site ranging from 1.02mbgl to 8.17mbgl, with the highest recorded level at the northern part of the site adjacent to the stream.

Existing Sewer Infrastructure

4.5. According to the Anglian Water sewer records (**Appendix D**) there are two foul sewers running through the northern side of the site. A 300mm foul sewer from Boston Avenue runs through the north eastern corner of the site and a 225mm dia. foul sewer runs across the north western corner of the site and crosses the stream near the northern boundary.

4.6. An existing 300mm dia. Anglian water surface water sewer runs through the north eastern corner of the site and beneath the existing nursery building. This surface water sewer discharges directly to the existing Brook via a bag work headwall.

5.0 SOURCES OF FLOODING

5.1. PPS25 requires flood risk from the following sources to be assessed:

- Fluvial Sources (river flooding);
- Tidal Sources (flooding from the sea);
- Groundwater Sources;
- Pluvial Sources (flooding resulting from overland flows); and,
- It also requires the risk from increases in surface water discharge to be assessed (surface water management).

5.2. Each of these sources are assessed separately below.

Tidal / Fluvial Flooding

5.3. It is understood that the Rawreth Brook is not influenced by tidal flooding. It is noted in the SFRA **(ref 02)** that the Rawreth Brook does pose a source of fluvial risk and known to react rapidly to intense rainfall.

5.4. The Environment Agency has confirmed that their model of the Rawreth Brook within the Site has been modelled as a fluvial watercourse. Consequently the risk to the Site will be based on a fluvial assessment of risk.

5.5. According to the Environment Agency Flood Zone Maps, the Site is located within Flood Zone 1, as shown on **Figure 3-1**, previously. However following further review of the existing site levels and EA fluvial flood levels, part of the site appears to lie within Flood Zones 2&3.

5.6. Using a 3D terrain model (**refer to figure 5-1**) of the existing site levels the volume of the lost flood plain, as a result of the new development, has been calculated as approximately 300m^3. This lost volume of flood plain will need to be compensated elsewhere on site to ensure that it does not increase risk of flooding to others downstream of the site.

5.7. As part of the development of the strategy for the Site the Environment Agency has been consulted and the general parameters for floodplain mitigation at the Site have been broadly agreed as follows:

- Opening the culvert and returning it to more natural water course is supported and preferred by the Environment Agency
- A Level for Level floodplain compensation solution to any loss of floodplain is the EA's preferred option. However if this proved to be unfeasible then the stream can be re-profiled to provide compensatory floodplain volume.

OPTION 1: FLOODPLAIN COMPENSATION

5.8. The Environment Agency's preferred solution is for the provision of level for level floodplain compensation, to offset that lost through the provision of safe access and dwellings, unless deemed impractical.

5.9. In order to assess the viability of providing level for level compensation for development in this area, it is first necessary to establish an acceptable minimum finished ground level for the area.

5.10. Using the Environment Agency guidance on deriving Flood Hazard Ratings, for low to medium water velocities up to 300mm flood depth is usually classified as being "Danger for Some". This level of Flood Hazard Rating is usually considered the most severe which is suitable for use as an emergency access and egress route. Furthermore 300mm of water is the threshold at which some cars may begin to float. Consequently it is considered that the maximum flood water level that should be permissible at the Site is 200mm.

5.11. Based on the 1 in 100 (plus climate change) flood levels (refer to Table 2-1) and the need to ensure a maximum flood water depth of 200mm within the roads, the minimum design finished ground levels across the northern portion of the Site are proposed as follows:

- South (near downstream edge of culvert): 14.46m AOD
- Middle (adjacent to existing nursery): 14.10m AOD
- North (northern edge of Site): 13.63m AOD

5.12. Whole-scale land raising across the site is required to achieve these minimum ground levels.

5.13. The development layout is heavily constrained by the presence of an existing telecommunications mobile phone mast. This mast requires that vehicular access is maintained and imposes an exclusion zone within which no residential properties can be constructed. This has dictated the general location of the main access route as well as the orientation of the proposed dwellings.

5.14. Due to the location of the mobile phone mast and the need to maintain safe access and egress from the Site, it would not be possible to provide floodplain compensation on the western bank of the watercourse.

5.15. The eastern bank of the watercourse is approximately 1.7m higher than ground levels on the west bank; however, the area of land available is considerably less than that on the western side of the watercourse. As such, it would not be possible to provide level for level compensation within this smaller area. Furthermore it is proposed to provide residential dwellings within the eastern bank portion and will be necessary to provide the same safe access and egress levels.

Summary

5.16. An initial evaluation of the opportunities for level for level floodplain compensation have been explored. The mobile phone mast and the need to maintain safe access and egress on site are significant constraints on the development layout (spatially) and design ground level. Due to these constraints it is not considered practicable to provide level for level floodplain compensation for a watercourse with significantly varying flood levels.

OPTION 2: IN-CHANNEL COMPENSATION

5.17. If the channel was to be opened up without any additional mitigation measures then overall conveyance would increase, potentially resulting in the increased flow of floodwater from the Site and increasing flood risk downstream. Options for widening the channel have been considered whilst ensuring that the flow capacity of the channel is broadly maintained as existing.

5.18. To achieve an increase in capacity with a reduction in flow rates two broad strategies can be adopted. Firstly the slope of the channel can be decreased, secondly the 'surface roughness' of the channel can be increased. As the channel is currently fairly slack the impact of slacking the channel further is likely to be fairly minimal. Subsequently some initial calculations have been undertaken to identify the required degree of 'surface roughness' to adequately slow flows.

5.19. In order to assess the degree of surface roughness reference has been made to "Open Channel Hydraulics" by Chow, 1959, which provides a comprehensive list of Manning's n values which are used to express the impact of surface roughness on open channel flows.

Table 5 -1, overleaf, summarises the roughness values used in the initial calculations

Value	Description	Sub-group
0.013	Concrete	Trowel Finished
0.017	Concrete	Unfinished
0.022	Earth - straight and uniform	Clean - after weathering
0.025	Earth - winding and sluggish	No vegetation
0.030	Earth - winding and sluggish	Grass, some weeds
0.040	Earth - winding and sluggish	cobble bottom - clean sides
0.060	Channel not maintained, weeds and brush uncut	Clean bottom - brush on sides
0.080	Channel not maintained, weeds and brush uncut	Dense weeds, high as flow depth

5.20. In order to quantify the volume of floodplain lost through the ground-works required to lift the entire development plateau above the flood levels. A 3D ground terrain model has been created based on the detailed topographic survey.

5.21. In order to provide the volumetric compensation within the channel, it will be necessary to lower the floodplain either side of the channel and create a vegetated ledge / berm. The vegetation will act to slow the passing of water so that the increase in channel capacity does not increase the rate of conveyance. Initial calculations have shown that densely planted vegetation on the ledges will achieve the hydrological requirements whilst also providing an ecological enhancement to the scheme. However, these initial calculations indicate that the full volume of compensation required may not be achievable just within the channel. An additional volume of compensation will be required, possibly through adjacent below ground storage.

5.22. The initial calculations demonstrate that an engineered solution can be provided to ensure that the proposals do not increase flood risk to others. As it is not possible to provide level for level floodplain compensation within the development proposals, the Environment Agency have indicated that they would accept the volume of attenuation lost being provided within an enhanced channel cross section.

5.23. At this stage to assess the viability of providing volumetric compensation within the channel, a simplified form of calculation has been undertaken. It should be emphasised that the detailed design will require further calculation, and potential hydraulic modelling.

Groundwater

5.24. According to the existing ground investigations groundwater ranges from 1.02mbgl to 8.17mbgl. With the highest recorded groundwater levels at the northern end of the site in the vicinity of the stream.

5.25. As it is not proposed to construct any basements or other significant below ground structures it is considered that there is a negligible risk of groundwater flooding.

Pluvial Flooding

5.26. Pluvial flooding occurs when natural and engineered drainage systems are unable to deal with the volume of rainfall, due to insufficient capacity.

5.27. The Site is located in a predominantly urban area, and the mapping produced as part of the SFRA shows a surface water flooding risk area to the north and east, but not to the Site itself. It is therefore considered that the risk of pluvial flooding is negligible, and will reduce as the surrounding drainage is upgraded to modern standards.

Summary

5.28. Although the Site is shown as being within Flood Zone 1, inspection of topographic information and the Environment Agency's predicted flood levels, indicate that an area of the Site would be at risk from a 1% event.

5.29. The proposals include floodplain compensation proposals to ensure that the development does not reduce the volume of the available floodplain storage. This will be achieved by enhancing the existing river edge and providing a soft landscape ledge either side of the existing channel. The remaining volume of compensation will be achieved either through adjacent below ground storage tanks or by lowering the proposed residential car park at the north end of the site, or a combination of both. Lowering a small area of the residential car park, which would result in a maximum of depth of flooding of up to 800mm at the far end of the car park (this will actually reflect the existing depths of flooding in this area. In order to promote the conveyance of water into the car park, any boundary walls would be designed with regular openings so as to not unduly restrict the passage of flood water flow through the development. Proposals for the minimum finished floor levels the properties within Flood Zone 3, are as shown in figure 5-1 below.

5.30. Based on the above desk based assessments it is considered that the Site can be safely operated under the assessment criteria of PPS25.

Figure 5-1: Excerpt from drawing J661-010 of Flood levels – post development

5.31. As well as ensuring the safety of the development from flood risk, PPS25 also requires the risk to others as a result of the development to be assessed. This requires an assessment of the likely increases in surface water flows as a result of the development, this is considered in **Section 6**.

6.0 SURFACE WATER MANAGEMENT

6.1. PPS25 requires an assessment of surface water to be made as part of a FRA. Specifically PPS25 states:

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

6.3. PPS25 states that to allow for the predicted impacts of climate change on surface water runoff the following increases to rainfall intensity should be allowed for:

- 1990 to 2025: + 5% (usually for temporary structures)
- 2025 to 2055: +10% (short lease uses)
- 2055 to 2085: +20% (usually commercial / industrial use)
- 2085 to 2115: +30% (usually residential use)

6.4. Therefore under PPS25 an allowance of 30% for the effects of climate change would achieve the policy requirements.

Allowable surface water discharge

6.5. The existing Site comprises of approximately 2.546 Ha impermeable area. An initial assessment of the existing site run-off rates and volumes has been carried out using the Rational Method/ LLloyd-Davies for a 50mm/hour storm, as per the guidance provided in Ciria 697 **(Ref:06).**

6.6. Applying the Rational Method to estimate the rainfall for the Site (2.546 Ha) yields a predicted peak run-off of 344.7 l/s (3.61 * 0.75

* 50 * 2.546), and this is the rate which the current impermeable surface would generate during a 50mm/hour storm.

6.7. From inspection of the existing topographic and drainage surveys available, it appears that the former Eon Site is drained by a 300mm sewer which connects directly to the culvert. There is also a 600mm overflow to the existing adjacent dry pond

6.8. For the purposes of this assessment the discharge rate from the area being developed within the former Eon site is proposed to be restricted to 220l/s, however this should be reviewed once further information is available regarding the existing provisions on Site. The area in the north east, is proposed to be limited to 31.7l/s and the existing area at the north west is proposed to be limited to Greenfield discharge rates, to ensure problems are not caused downstream of the existing weir. However, as it is generally accepted best practice that when restricting to extremely low greenfield rates, a minimum rate of 5l/s is applied in without causing the additional risk of blockage of the flow control device.

Surface Water Attenuation Requirements

6.9. In order to consider the predicted impacts of climate change, use has been made of the hydraulic modelling package WinDes by Micro Drainage. The proposed surface water drainage has been split into three separate network. The use of the hydraulic simulation modelling module within Windes has been used in order to determine the attenuation volume requirements for the peak storm event of 1 in 100 years + 30% additional flow (climatic change) for a variety of storm durations.

6.10. The geotechnical advise provided in the RSK interpretative letter has (Ref 05) indicated that infiltration techniques for discharging of the surface water would not be suitable due to the low permeability characteristics of the existing underlying soils.

6.11. Preliminary hydraulic simulation modelling has indicated that the a total additional below ground cellular attenuation storage required to cater for storm events up to the 1 in 100 year +30% is approximately 200m^3 for the entire new development.

Sustainable Drainage Systems (SuDS)

6.12. Sustainable Drainage Systems or SuDS, are a variety of surface water management techniques which reduce the velocity of surface water and partially treat it prior to discharge to a watercourse or sewer. **Table 6.1** below apprises the constraints and opportunities for the use of SuDS techniques within the Site and it adopts the hierarchical approach outlined in C697 (**Ref 06**).

Type:	**Living Roofs** (Source Control)
Constraints:	Safety and maintenance implications, additional structural loading for intensive type roofs.
Opportunities:	None. Due to the pitch of the residential roofs
Type:	**Infiltration Devices** (Source Control)
Constraints:	Infiltration rates are expected to be very low due to the existing underlying Clay formations.
Opportunities:	none
Type:	**Permeable Paving** (Source Control)
Constraints:	In order to deliver a viable scheme it is not possible to include permeable pavement.
Opportunities:	None.
Type:	**Rainwater Harvesting** (Source Control)
Constraints:	The benefits of rainwater harvesting on a specific design storm event cannot be quantified, due to the seasonal availability of storage within the structure.
Opportunities:	Not considered as part of the surface water management strategy.
Type:	**Swales, etc.** (Permeable Conveyance)
Constraints:	In order to deliver a viable scheme the development area has to be maximised, therefore it is not possible to include landscaping based SuDS features.
Opportunities:	None
Type:	**Infiltration Basin** (end of pipe treatment)
Constraints:	See Swales above.
Opportunities:	None.
Type:	**Wet Ponds & Wetlands** (end of pipe treatment)
Constraints:	See Swales above.
Opportunities:	None.
Type:	**Attenuation Tanks** (end of pipe treatment)
Constraints:	None.
Opportunities:	Attenuation has been proposed by use of oversized sewers, or geo-cellular attenuation.

Table 6.1: C697 SuDS Hierarchy, Site Assessment.

6.13. After consideration of the C697 (**Ref 09**) approach, the only viable SuDS option for this Site is underground attenuation. However it should also be noted that as part of the scheme proposals to provide flood storage compensation, the existing culvert will be opened up to form a natural water course along with an enhancement and widening of the existing river channel.

Surface Water Management Strategy

6.14. As part of the development proposals, the storm water from the area developed within the extent of the former Eon site will be managed by using oversized pipes and an 80m^3 cellular storage tank. The total discharge from this network is proposed to be restricted to 220l/s via the existing 300mm diameter outfall pipe and 600mm diameter overflow pipe (leading to the adjacent dry pond).

6.15. The storm water drainage from the north eastern corner of the site (former Nursery site) will be managed by restricting flows to Brownfield run-off rates equivalent to 31.7l/s, and attenuating the excess surface water flows within oversized sewers and a 40m^3 cellular attenuation tank.

6.16. Flows from the existing woodland area at the north eastern corner of the site will be restricted to Greenfield run-off rates to reflect the existing pre-developed flows. The excess surface water flows are proposed to be attenuated using oversized pipes and an 80m^3 cellular storage tank.

6.17. Once the existing surface water discharge rate has been confirmed from the Site it will be possible to more accurately assess the volume of surface water attenuation required. This will require further onsite exploration to confirm the existing surface water drainage provision.

6.18. As the Rawreth Brook is designated as a Main River , under the Water Resources Act 1991, any proposed works to the existing culvert and headwalls or the construction of new headwalls to discharge into the Rawreth Brook will be subject to a Consent with the Environment Agency.

Summary

6.19. From inspection of the Topographic and drainage surveys a 300mm diameter surface water connection is believed to be provided for surface water drainage from the former Eon Site.

6.20. Due to the development layout the only viable SuDS solutions would be geo-cellular attenuation tanks. Suitable attenuation can be provided to limit the rate of discharge from the Site to the capacity of the existing connection, including for the predicted effects of climate change. A concept drainage strategy is provided in **Appendix E** as Drawing **J661-002.**

7.0 FOUL WATER DRAINAGE

7.1. Although not required by PPS25 the drainage strategy has considered the disposal of Foul Water from the Site.

7.2. As it is proposed to redevelop the Site with 103 residential units the anticipated peak foul water discharge from the Site, based on Sewers for Adoption, 4,000 l / day, would be 4.7 l/s (66 x 0.046). The areas of development west of Rawreth Brook are proposed to connect to the existing 225 diameter Anglian foul sewer which runs through the site. The area of to the east of the Brook is proposed to connect to the existing 300mm diameter Anglian Foul sewer within the site as well.

7.3. Anglian Water have confirmed via their pre-development assessment, **Appendix D**, that its existing waste water treatment works has sufficient capacity to deal with the predicted foul discharge from the Site.

8.0 CONCLUSIONS

8.1. According to the Environment Agency's internet flood zone maps, the Site is located in Flood Zone 1, and is therefore considered to be at low probability of flooding. The Site is not shown as benefitting from flood defences.

8.2. Detailed analysis of the Environment Agency flood levels and the topographic survey indicates that when taking account of the predicted impacts of climate change over the life of the development an area at the north end of the site lies within Flood Zone 2&3 and would be at risk of flooding.

8.3. As the development proposals will encroach on the 1% flood extent, the development has included a means of providing floodplain compensation storage within an enhanced widened river edge proposal and within areas of low risk.

8.4. Although the Site is partly located within the 1% AEP floodplain extent safe access and egress can be provided for the Site, including the 300mm freeboard required.

8.5. The desk based assessment of groundwater and pluvial risk undertaken indicates that the Site is not at risk of flooding from these sources.

8.6. In order to achieve the PPS25 SuDS requirements only a nominal amount of surface water attenuation would be required, and this is likely to be accommodated by provision of oversized pipes and underground attenuation tanks . Site constraints and soil conditions preclude the use of infiltration drainage or landscape based SuDS.

8.7. Therefore in conclusion, this FRA demonstrates that the residential proposals are consistent with the aims of PPS25 and the Site will not be at significant risk of flooding, or increase the flood risk to others.

Recommendations

8.8. This information should be made available to prospective buyers and their property insurers to reassure them of the flood risk status of the development.

8.9. A copy of this report should be submitted to the Environment Agency to demonstrate that the FRA has been completed and the development complies with requirements of PPS25.

8.10. The operator of the Site should register with the Environment Agency's floodline. This is a free service provided by the Environment Agency, which gives advanced notice of potential flooding. Registration is either through the Environment Agency's website (http://www.environment-agency.gov.uk) or by calling the Environment Agency on 0845 988 1188.

9.0 REFERENCES

Ref 01 *DCLG 2010. Planning Policy Statement 25: Development and Flood Risk. Department of Communities and Local Government. (PPS25)*

Ref 02 *DCLG 2011 Draft National Planning Policy Framework*

Ref 03 *Scott Wilson, Rochford District Council Level 1&2 Strategic Flood Risk Assessment Report, February 2011.*

Ref 04 *DCLG 2008 East of England Plan*

Ref 05 *RSK Stats GeoConsult, Interpretative Geotechnical Letter Report, May 2011*

Ref 06 *Ciria C697, The SuDS Manual, 2007*

Appendix A
Glossary

Glossary

AEP: Annual Exceedance Probability
The estimated probability of a flood of given magnitude occurring or being exceeded in any year. Expressed as, for example, 1 in 100 chance or 1 per cent.
Attenuation (surface water)
The reduction of a peak flow by restricting the rate at which water discharges. Attenuation usually refers to a design volume associated with a specific AEP event.
Compensatory Floodplain Storage
In order to maintain a similar flood flow profile post development, it is usual to offset any land raising within the 1% AEP + Climate Change floodplain, by lowering land elsewhere. The land lowered has to provide the same volume of floodplain and at the same vertical level.
Climate Change
Under PPS25 the predicted impacts of climate change need to be considered as part of an FRA, this is to protect the development over the lifetime of the development.
Design flood level
The maximum estimated water level during the design event, relates to a specific AEP i.e. 0.5% for tidal or 1% for fluvial Flood Zone 3.
Flood Defences
Flood defence infrastructure, intended to protect an area against flooding to a specified standard of protection, through the use of engineered embankments or walls.
Flood Defence Level
The level required to be achieved by flood defences, usually the design flood level with a freeboard allowance, to account for wave action and modelling uncertainty.
Floodplain
An area of land adjacent to a river or tidal water body that is predicted to become affected by water as the result of a defined flood event.
Fluvial Flooding
Flooding caused by a river overtopping its banks, as a result of high flows exceeding the rivers capacity.
Flood Zone
An area defined by the Environment Agency and/or SFRA as being at risk from a specified flood event. The Flood Zone definitions ignore the benefits of flood defence structures.
Flood Zone 1: Low Probability
An area having a less than 0.1% AEP of flooding for both tidal and fluvial sources.
Flood Zone 2: Medium Probability
An area having a fluvial AEP of between 1% and 0.1%. Or a tidal AEP of between 0.5% and 0.1%.

Flood Zone 3(a): High Probability

An area having a fluvial AEP of between 5% and 1%. Or, a tidal AEP of between 5% and 0.5%.

Flood Zone 3(b): The Functional Floodplain

An area having an AEP of more than 5% for both tidal and fluvial sources.

Flood Zone Map

A map produce by the Environment Agency, or SFRA which designates the flood zones. Site specific FRA usually refine the detail of these maps to provide a more accurate prediction at the Site level.

Freeboard

The difference between the Flood Defence level and the Design Flood level, usually 300mm for fluvial sources and 600mm for tidal sources. But local variations do occur.

Groundwater Flooding

Caused by groundwater rising through permeable soil strata either into basements, or through the ground. Tends to occur at the bottom of a valley in large chalk catchments.

Greenfield Rate

Two definitions of the greenfield rate are used interchangeably. C697 defines it as "The surface water runoff regime from a site before development, or the existing site conditions for brownfield redevelopment sites". However common usage ignores the brownfield status.

National Flood Risk Assessment(NaFRA)

Through the Environment Agency Flood Mapping website the output from the NaFRA study can be selected for a specific location. This NaFRA study is provided to financial institutions so that they can identify if flood insurance can be provided in the normal way (low or moderate likelihood) or if an increase in premiums is likely (significant likelihood)

Pluvial Flooding

Caused by overland run-off exceeding the capacity of natural and artificial drainage systems as a result of the volume of rainfall.

PPS25 Exception Test

PPS25 identifies a number of vulnerability classes within certain flood zones which will require the Exception Test.

The Exception Test can enable development within flood risk areas when taking account of the wider sustainability benefits of the site, i.e. to avoid economic or social blight on previously developed land.

PPS25 Sequential Test

The Flood Zones and Vulnerability Classifications are used

Residual Risk

The risk which remains following the use of all risk reduction, mitigation and management options. Or the risk beyond the design AEP event.

Run-off

The flow of water from an area as a result of a rainfall event.

Tidal Flooding
Caused by sea or estuarine levels rising beyond the level of the land or flood defences. Usually associated with significant offshore storm events.
SFRA
Strategic Flood Risk Assessment, usually undertaken on behalf of Local Authorities to inform their PPS25 Sequential Tests.
SuDS
Sustainable Drainage Systems, a sequence of drainage devices which promote a more natural run-off regime from developments. The use of SuDS can result in a reduction in the volume of water discharged to sewers and watercourses, therefore reducing the risk of Pluvial Flooding.

Appendix B

Development Proposals

Private development					
No	Ref	Sq ft	Beds	Storey	Total Sqft
11	Montrose	750	2	2	8250
4	York	787	2	2	3148
18	Campbell	931	3	2	16758
6	Egerton	941	3	2	5646
11	Cavendish	979	3	2	10769
3	Seymour	1220	4	2	3660
14	Warwick	1854	5	2.5	25956
10	Eaton	1935	4	2.5	19350
77					93537

Affordable Housing					
No	Ref	Sq ft	Beds	Storey	Total Sqft
10	Ha65	700	2	2	7000
6	Ha75	807	2	2	4842
10	Ha88	947	3		9470
26					21312

Total	Total Sq ft
103	114849

Rev O:- 10-11-2011
Exiting tree information updated

Rev M:- 07-11-2011
General amendments to layout including garages, Exiting trees and roads

Rev L:- 04-11-2011
Trees to be removed clarified on drawing

Rev K:- 30-09-2011
Plot 76 reference amended

Rev J:- 29-09-2011
Plots 27 to 38 revised. Road bridge removed and replaced with foot bridge.

Rev I:- 05-07-2011
Plots 2,3 6 & 7 house types amended. Plots 45 to 51 & 58, 59 adjusted.

Rev H:- 03-07-2011
Layout redrawing to accommodate planning comments, root protect & easement zones

Project:-
Eon Site,
London Road
Rayleigh

Description:-
Proposed Development Layout

Bellway

Bellway Homes Essex ,
Bellway House,
1 Rainsford Road,
Chelmsford,
Essex,
CM1 2PZ.
Tel: 01245 - 259989 Fax: 01245 - 259996

Date:- July 2010
Drawing Scale:- 1-500 @ A1
Drawing number:- BW100 - 001
Revision:- O

Appendix C
Correspondence with the Environment Agency

Terry Seymour

From: Matthew Richmond
Sent: 02 September 2011 11:28
To: 'Webster, Roger'
Cc: Downes, Pete; Gardiner, Tim A
Subject: RE: J660/Former Eon Site London Road, Rayleigh, Essex - EA Approval in Principle for Surface Water Outfalls

Hi Roger,

At the meeting We acknowledge the EAs preference for level-for-level. The relocation of open space to the area in question was considered however, due to constraints with the communications mast, this would be unfeasible.

Therefore subject to the constraints we discussed at the meeting and repeated below and assuming it forms part of an acceptable flood risk assessment, the EA would accept the need to re-profile the channel to provide storage.

Sorry if I wasn't clear in earlier emails.

Kindest regards

Matthew Richmond
Senior Engineer

ARDENT
CONSULTING ENGINEERS

Fourth Floor, Diamond House, 36-38 Hatton Garden, London, EC1N 8EB
Tel: 020 74301209 - Fax: 020 74300318 - Web: www.ardent-ce.co.uk

From: Webster, Roger [mailto:roger.webster@environment-agency.gov.uk]
Sent: 02 September 2011 10:48
To: Matthew Richmond
Cc: Downes, Pete; Gardiner, Tim A
Subject: RE: J660/Former Eon Site London Road, Rayleigh, Essex - EA Approval in Principle for Surface Water Outfalls

Matthew,

I thought you were discussing with your client the layout of the site, and as a preference looking to rearrange the site to provide the level for level compensation.

As an alternative profiling the channel and providing "in channel" storage could be a possibility as a "fall back" position. This is more complicated as you will need to do some hydraulic calculations and surveys to prove the acceptability of this type of scheme, along with agreeing the details as highlighted in 2a,b and c of your previous email.

Regards

Roger.

Roger Webster
Development and Flood Risk Engineer (South Essex)
☎ Internal 750 6771
☎ External 01473 706771
roger.webster@environment-agency.gov.uk

Our flood warnings are changing. Be prepared. Find out more by calling Floodline on 0845 988 1188 or by visiting our website.

From: Matthew Richmond [mailto:mrichmond@ardent-ce.co.uk]
Sent: 02 September 2011 10:33
To: Webster, Roger
Subject: RE: J660/Former Eon Site London Road, Rayleigh, Essex - EA Approval in Principle for Surface Water Outfalls

Roger,

Have you had a chance to look over my email below?

Cheers

Matt

From: Matthew Richmond
Sent: 26 August 2011 14:27
To: 'Webster, Roger'
Subject: RE: J660/Former Eon Site London Road, Rayleigh, Essex - EA Approval in Principle for Surface Water Outfalls

Hi Roger and thanks for your response.

As it is not going to be feasible to provided level for level on the current planning layout, I assume you are happy with the principle of profiling to provide compensation as we discussed subject to the requirements outlined below?

Many thanks

Matthew Richmond
Senior Engineer

ARDENT
CONSULTING ENGINEERS

Fourth Floor, Diamond House, 36-38 Hatton Garden, London, EC1N 8EB
Tel: 020 74301209 - Fax: 020 74300318 - Web: www.ardent-ce.co.uk

From: Webster, Roger [mailto:roger.webster@environment-agency.gov.uk]
Sent: 26 August 2011 13:08
To: Matthew Richmond
Cc: Gardiner, Tim A; Downes, Pete; Ben Brooks
Subject: RE: J660/Former Eon Site London Road, Rayleigh, Essex - EA Approval in Principle for Surface Water Outfalls

Matthew,

Thank you for your email and summary of points. They appear to me acceptable in principle and agree with our discussions.

Point (2) does not make sense though. I think you need and I suggest you add something like "A level for level solution ***for floodplain compensation, in hydraulic continuity with the river, is required to mitigate for loss of floodplain to the development footprint along with allocation of open space*** in the northern area."

Regards

Roger.

Roger Webster
Development and Flood Risk Engineer (South Essex)
☎ Internal 750 6771
☎ External 01473 706771
roger.webster@environment-agency.gov.uk

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From: Matthew Richmond [mailto:mrichmond@ardent-ce.co.uk]
Sent: 26 August 2011 11:47
To: Webster, Roger
Cc: Gardiner, Tim A; Downes, Pete; Ben Brooks
Subject: RE: J660/Former Eon Site London Road, Rayleigh, Essex - EA Approval in Principle for Surface Water Outfalls

Gentlemen

You may recall the meeting we had on the 28/6/11 regarding the above project.

I was going over the file earlier and realised I hadn't circulated the outcome of the meeting for your approval (For which I apologise). Below are the main points we discussed. Please feel free to add to my notes if appropriate:

1.) Opening the culvert and returning it to more natural water course is supported and preferred by the Environment Agency

2.) A Level for Level solution to the flood plain is preferred and if possible some open space in the northern area. However if this is unfeasible you have no objection to re-profiling the stream as long as the following is satisfactorily addressed.-

A) The ecologists have no objections (Our only current concern with this now will be the bats in the willow)

B) *The planners are happy.*

C) *Maintenance regime and ownership is satisfactory*

3.) *You have no objections to us discharging to the water course at the equivalent rates* ***but the weir must remain as a control to the flow to avoid problems downstream***

5.) *The EA have no preference with regard to the removal of the 600 overflow and opt for storage on our site. This is now an issue for AW but I suspect we would want to retain it as a feature to minimise storage on site.*

6.) *The on-site drainage solution should include less pipes an manholes and more Soft SUDS. With an emphasis on swales and filter strips.*

With the above in mind the EA now desire to see the above and incorporated into an FRA prior to going to planning to ensure they have no objections at that stage.

I trust this to be an accurate account of our meeting but please feel free to add to any of the points as appropriate.

Kindest regards

Matthew Richmond
Senior Engineer

ARDENT
CONSULTING ENGINEERS

Fourth Floor, Diamond House, 36-38 Hatton Garden, London, EC1N 8EB
Tel: 020 74301209 - Fax: 020 74300318 - Web: www.ardent-ce.co.uk

From: Webster, Roger [mailto:roger.webster@environment-agency.gov.uk]
Sent: 21 June 2011 10:38
To: Matthew Richmond
Cc: Gardiner, Tim A; Downes, Pete
Subject: RE: J660/Former Eon Site London Road, Rayleigh, Essex - EA Approval in Principle for Surface Water Outfalls

Matthew,

I have booked the rest room at the Kelvedon Office for 10.30am to 12.00pm on 28/6/11 for the meeting to discuss the above works.

I am hoping that my colleagues Pete Downes (Operations) and Tim Gardiner (FRB) will also be able to attend.

Regards

Roger Webster
Development and Flood Risk Engineer (South Essex)

☎ Internal 750 6771
☎ External 01473 706771
roger.webster@environment-agency.gov.uk

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From: Matthew Richmond [mailto:mrichmond@ardent-ce.co.uk]
Sent: 20 June 2011 10:20
To: Webster, Roger
Subject: RE: J660/Former Eon Site London Road, Rayleigh, Essex - EA Approval in Principle for Surface Water Outfalls

Roger,

Many thanks for your response, I am available all next week, and the remainder of this week excluding Wednesday. We are proposing to widen the stream and increase the height of the western embankment to allow additional storage. Full proposals will be prepared for the meeting and I will get them over to you prior to the meeting for review.

Kindest regards

Matthew Richmond
Senior Engineer

ARDENT
CONSULTING ENGINEERS

Fourth Floor, Diamond House, 36-38 Hatton Garden, London, EC1N 8EB
Tel: 020 74301209 - Fax: 020 74300318 - Web: www.ardent-ce.co.uk

From: Webster, Roger [mailto:roger.webster@environment-agency.gov.uk]
Sent: 20 June 2011 09:20
To: Matthew Richmond
Subject: RE: J660/Former Eon Site London Road, Rayleigh, Essex - EA Approval in Principle for Surface Water Outfalls

Matthew,

Could you send me your dates of availability so I can arrange a meeting. Do have any details of what you are proposing?

Regards

Roger Webster
Development and Flood Risk Engineer (South Essex)
☎ Internal 750 6771
☎ External 01473 706771

🖰 roger.webster@environment-agency.gov.uk

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From: Matthew Richmond [mailto:mrichmond@ardent-ce.co.uk]
Sent: 17 June 2011 10:21
To: Webster, Roger
Subject: RE: J660/Former Eon Site London Road, Rayleigh, Essex - EA Approval in Principle for Surface Water Outfalls

Click here to report this email as spam.

Roger,

You may recall liaising with my former colleague, Tim regarding the above development.

We have modelled the flood envelope on site following receipt of your flood sections in the area and are drawing up a compensation strategy that we would like to discuss with yourselves.

are you available any time soon for me to come down and discuss the strategy with you?

Kindest regards

Matthew Richmond
Senior Engineer

ARDENT
CONSULTING ENGINEERS

Fourth Floor, Diamond House, 36-38 Hatton Garden, London, EC1N 8EB
Tel: 020 74301209 - Fax: 020 74300318 - Web: www.ardent-ce.co.uk

From: Webster, Roger [mailto:roger.webster@environment-agency.gov.uk]
Sent: 11 March 2011 11:54
To: Tim Sholer
Cc: Downes, Pete
Subject: RE: J660/Former Eon Site London Road, Rayleigh, Essex - EA Approval in Principle for Surface Water Outfalls

Tim,

Having checked the details they appear acceptable in principle, at a first glance, and without the benefit of the consent details. I am assuming that the channel of Rawreth Brook at the site is an open channel where you propose the outfalls, and that the new outfalls are of the same diameter as the original ones that you are removing. As you are aware this is subject to submission of a Flood Defence Consent for the works. I ahve already emailed you the forms.

I am unable to comment on the proposed surface water discharge rates into the Brook as I have no details on how they were calculated and for what return rainfall event they relate.

Regards

Roger Webster
Development and Flood Risk Engineer (South Essex)
☎ Internal 750 6771
☎ External 01473 706771
roger.webster@environment-agency.gov.uk

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Appendix D

Correspondence with the Anglian Water

PRE DEVELOPMENT REPORT PREPARED FOR:

Mr Daniel Rapson

Ardent Consulting Engineers

4th Floor Diamond House
36 - 38 Hatton Garden
Holborn
London
EC1N 8EB

Site: 190 London Road, RAYLEIGH
Proposal: 90 Dwellings
Your ref: J660

Date: 21 Sep 2010

If you would like to discuss any of the points in this report please contact Carly Summers on 01733 414619 or email planningliaison@anglianwater.co.uk

Important Notice

This report is based on the best current information available. This may change if there is further development in the area or for other reasons. You are advised therefore to renew your enquiry should there be a delay in submitting your application for water supply/sewer connection to re-confirm the situation. The information contained in this report may be used to support an application for planning permission.

Contents

1. ASSETS WITHIN OR CLOSE TO THE BOUNDARY OF THE SITE

1.1. Anglian Water's records show that there are public foul/surface water sewers within the boundary of the Development Site. No development will be permitted either over or close to/within the easement strip, the extent of which is detailed in the table below without the prior consent of Anglian Water. Please be aware that the existing public sewers should be located in highway or open space (**not** in private gardens) to ensure access for maintenance and repair and this must be taken into consideration when considering your site layout.

Wastewater	
Sewer Size (mm)	**Easement Required (m)**
300	*TOTAL = 6 metres* (3 m either side of the centre line)

1.2. If it is not possible to avoid Anglian Water's assets, then the sewer may need to be diverted in accordance with Section 185 of the Water Industry Act (1991). Anglian Water is under a duty to divert the water main/sewer if requested to do so by a developer unless it is unreasonable to do so. A formal application will need to be made to Anglian Water for a diversion to be considered. Diversionary Works will be at the expense of the developer.

2. WATER SUPPLY

Water Resource Zone

2.1. Anglian Water is not the water undertaker for the Development Site; it is outside of Anglian Water's water supply area. The views of Essex and Suffolk Water Company should be sought in this respect.

3. WASTEWATER SERVICES

Capacity for non allocated sites is not guaranteed.

3.1. The Development Site is not currently identified in the local planning authority's allocation of land for development. Therefore this Development Site has been assessed in isolation and does not consider similar non allocated proposals and their cumulative effect on Anglian Water infrastructure and its ability to collectively serve them.

Should all the available capacity be taken up at the STW then upgrades to the works may be required that may involve Anglian Water seeking consent from the Environment Agency for an increase in discharge of final effluent.

3.2. For foul water communications to the public sewerage system you must make a formal application under Section 106 of the Water Industry Act (1991) prior to commencement of works to obtain the approved method and location of connection.

3.3. Sewers intended for future adoption by Anglian Water under Section 104 of the Water Industry Act (1991) must be constructed in accordance with 'Sewers for Adoption, Sixth Edition'. A copy is available from the publisher: Water Research Centre, Frankland Road, Blagrove, Swindon, Wilts. SN5 8YF.

Before commencement of any proposed adoption works under Section 104 a formal application should be made.

Wastewater Treatment

3.4. The foul drainage from this development is in the catchment of Rayleigh Sewage Treatment Works that will have available capacity for these flows.

Foul Sewerage Network

3.5. The sewerage system, at present, has available capacity for these flows. The connection point will be to a new manhole between manhole 5824 and 4904 on the 300mm diameter public sewer

Surface Water Disposal

3.6. The preferred method of surface water disposal would be to a Sustainable Urban Drainage System (SUDS) with connection to a public surface water sewer seen as the last option. Planning Policy Statement 25: Development and Flood Risk emphasises the role of SUDS and introduces a presumption that SUDS should be used in all developments.

Building Regulations on Drainage and Waste Disposal for England includes a surface water drainage hierarchy, with infiltration on site as the preferred disposal option, followed by discharge to watercourse and then connection to a sewer. You can view our SUDS adoption policies for more guidance on this matter by visiting www.anglianwater.co.uk, developers page, go to developers, wastewater services, sustainable drainage systems.

3.7. However if this is not feasible then further drainage evidence will need to be submitted before a connection point and flow rate can be determined.

Current Flooding Issues

3.8. There have not been any instances of reportable flooding in the vicinity of the Development Site that can be attributed to the public sewerage system.

4. BUDGET COSTS

Please note that any costs indicated in this report are a current estimate and for budget purposes only.

On receipt of an application for supply and connection a quotation will be provided.

A summary of charges can be found at www.anglianwater.co.uk, developers page, go to developers - summary of charges.

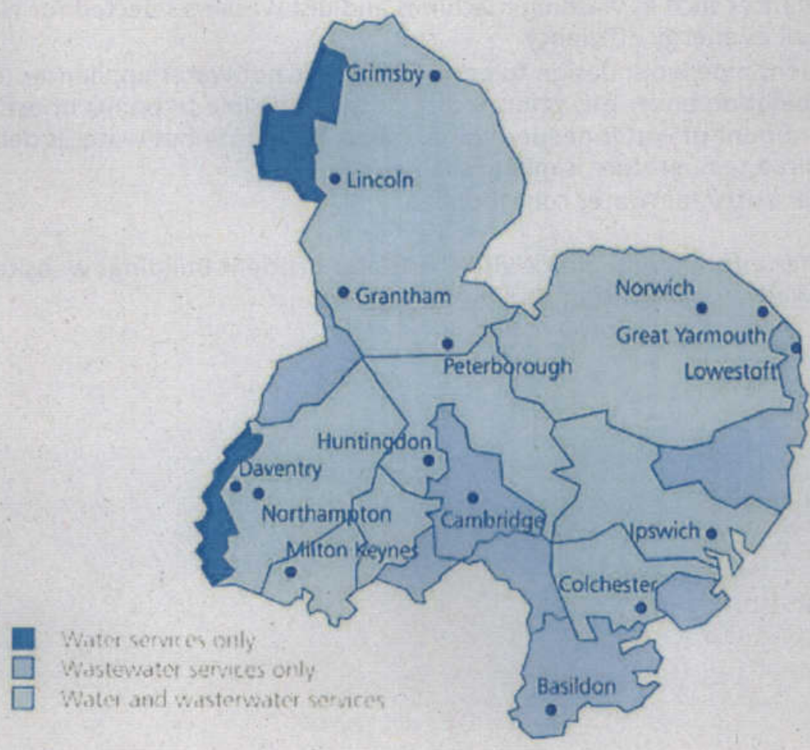
5. USEFUL INFORMATION

An extract of Anglian Water's assets has been sent to you under separate cover from our Asset Data Management Team. If you have not received the plan within 7 days of receiving this report, please contact the team on 01480 323889.

For water and waste water connection applications and enquiries please contact Developer Services, Anglian Water, PO Box 495, Huntingdon, PE29 6YY Tel: 0845 60 66 087, Email: developerservices@anglianwater.co.uk

Website: http://www.anglianwater.co.uk/developers/

Our boundaries



6. WATER EFFICIENCY

The Code for Sustainable Homes replaced the Ecohomes Standard on 1 April 2007. This code provides guidance on how certain levels of water efficiency can be achieved.

We would encourage you to consider ways in which reductions in water consumption can be achieved so that the impact on this precious resource and the environment can be reduced.

Some areas to be considered:

- Dual flush toilets
- Showers with flow rates in the order of 8-10 litres per minute
- Low/flow/spray taps at Wash hand basins
- Appliances such as washing machines and dishwashers selected for water efficiency as well as energy efficiency
- Efficient pipe work design to ensure domestic hot water appliances (cylinder or combination boiler etc) is located as close as possible to points of use thus ensuring the amount of water needed to be drawn off before hot water is delivered at the required temperature is minimised.
- Water butts/ rainwater collection

For further information, please visit the Water Efficient Buildings website: http://wwww.water-efficient-buildings.org.uk/

anglianwater

REQUEST FOR REFUND OF PRE DEVELOPMENT ENQUIRY FEE

(form to be submitted once water and or wastewater application payment has been made)

PRE DEVELOPMENT REFERENCE: **0409/SP41(001)**

COMPANY NAME AND ADDRESS:	Ardent Consulting Engineers 4th Floor Diamond House 36 - 38 Hatton Garden Holborn London EC1N 8EB
SITE ADDRESS:	190 London Road, RAYLEIGH
FEE PAID:	£351.32
WATER	☐
WASTEWATER	☐

To be completed by the applicant once the above scheme has been progressed and payment has been made to Anglian Water for a water and/or wastewater application as indicated above.

Please note refund can only be made against a like for like enquiry and connection type. I.e. a water and wastewater pre development fee can only be refunded once payment for both a water and wastewater connection has been received.

AW REFERENCE
Work order or
sewer connection number *. ______

DATE PAYMENT MADE *: ______

Print Name:______________________ Signed: ______________________

Date:______________________ Telephone No. ______________________

Please sign and return completed form to:
Anglian Water, Planning & Equivalence, PO Box 1067, PETERBOROUGH, PE1 9JG

** Required*

Appendix E
Drainage Strategy Drawings

NOTES:

1. LEVELS SHOWN ARE METRES ABOVE ORDNANCE SURVEY DATUM.
2. EXISTING SURVEY BASED ON INFORMATION PRODUCED BY RAMOWSKI CLARKE LIMITED AUGUST 2010 (DRAWING 1385-01-a) AND SURVEY SOLUTIONS MAY 2011 (DRAWING 6999se-01).
3. EXISTING PUBLIC SEWERS SHOWN BASED ON ANGLIAN WATER RECORDS RECEIVED 20 SEPTEMBER 2010 AND MANESTREAM CCTV SURVEY RECEIVED 22 JUNE 2011. FOUL SEWER CONNECTIVITY AT EXISTING MANHOLE 4901 TO BE CONFIRMED.
4. MASTERPLAN LAYOUT BASED ON DRAWING BW100 - 001 (rev G) PRODUCED BY JCN ARCHITECTS JUNE 2011.
5. FOUL AND SURFACE WATER DRAINAGE STATEGY SUBJECT TO DRAINAGE INVESTIGATION TO CONFIRM LOCATION, EXTENT AND LEVELS OF EXISTING SEWER NETWORKS. COVER LEVELS SHOWN ARE SUBJECT TO CONFIRMATION OF FLOOD COMPENSATION STRATEGY BY THE ENVIRONMENT AGENCY
6. PRIVATE FOUL WATER AND SURFACE WATER DRAINAGE IS TO BE CONSTRUCTED IN ACCORDANCE WITH THE BUILDING REGULATIONS, BS EN 752 AND RELEVANT AGREEMENT CERTIFICATES.
7. PROPOSED OUTFALL TO EXISTING DRY BASIN TO BE CONFIRMED BY THE ENVIRONMENT AGENCY.
8. ALL OUTFALL LOCATIONS ARE SUBJECT TO LAND DRAINAGE CONSENT FROM THE ENVIRONMENT AGENCY.
9. ALL OUTFALLS REQUIRE THE INSTALLATION OF A 'CLASS 1' SEPARATOR IN ACCORDANCE WITH PLANNING POLICY GUIDELINE 3.
10. ACCESS FITTINGS AND INSPECTION CHAMBERS LESS THAN ONE METRE DEEP ARE TO BE CLAYWARE OR PRE-FORMED POLYPROPYLENE AS APPROPRIATE TO THE DEPTH AND NUMBER OF CONNECTIONS. CHAMBERS GREATER THAN ONE METRE DEEP ARE TO BE PRE-CAST CONCRETE CONSTRUCTION WITH 150mm IN SITU CONCRETE SURROUND. INSPECTION CHAMBER SIZES ARE TO BE IN ACCORDANCE WITH THE BUILDING REGULATIONS PART H; TABLE 11 AND MANHOLE SIZES TABLE 12.
11. BACKFILLING OF DRAIN TRENCHES ADJACENT TO DWELLINGS OF OTHER STRUCTURES TO BE IN ACCORDANCE WITH THE BUILDING REGULATIONS PART H; DIAGRAM 8.
12. INSPECTION CHAMBER COVERS IN PRIVATE AREAS SHOULD BE GROUP 1 CLASS A15. IN PEDESTRIAN AREAS INACCESSIBLE TO WHEELED VEHICLES AND GROUP 4 CLASS D400 IN VEHICULAR AREAS.
13. SURFACE WATER FROM PRIVATE AREAS IS NOT TO BE DISCHARGED ONTO PROPOSED HIGHWAY.

KEY:

EX MH 2901
EXISTING FOUL WATER PUBLIC SEWER
EXISTING SURFACE WATER PUBLIC SEWER TO BE DIVESTED UNDER A S116 AGREEMENT WITH ANGLIAN WATER
PROPOSED SURFACE WATER PRIVATE SEWER
PROPOSED FOUL WATER PRIVATE SEWER
PROPOSED FOUL WATER PUBLIC SEWER
PROPOSED SURFACE WATER PUBLIC SEWER
PROPOSED SURFACE WATER ATTENUATION TANK (PRIVATE)
FOUL WATER SEWER EASEMENT (3m EITHER SIDE OF SEWER)

REV	AMENDMENTS	DRN	CHK	APP	DATE
A	ISSUE FOR PLANNING	RW	TS	DJR	28.10.11

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London
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t 020 7430 1209
f 020 7430 0318
w www.ardent-ce.co.uk
e enquiries@ardent-ce.co.uk

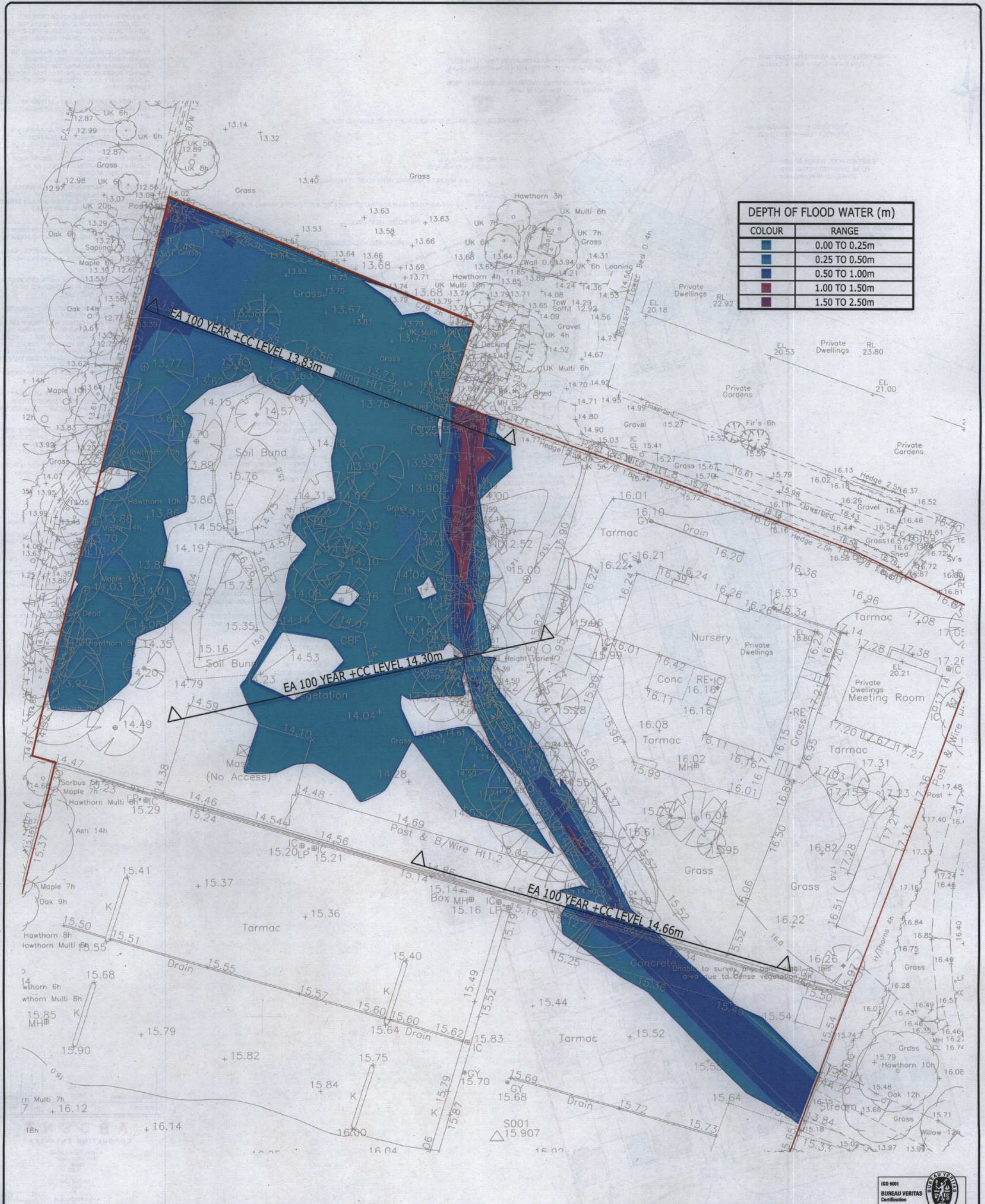
CLIENT: BELLWAY HOMES LTD

PROJECT TITLE: FORMER EON SITE, LONDON ROAD RAYLEIGH, ESSEX

DRAWING TITLE: PROVISIONAL FOUL AND SURFACE WATER DRAINAGE STRATEGY

SCALE:	DATE:	DESIGNED:
1:500 @ A1	25.10.11	TS
DRAWN: RW	CHECKED: TS	APPROVED: DJR

DRAWING NO. J661-007 REV: A



DEPTH OF FLOOD WATER (m)	
COLOUR	RANGE
	0.00 TO 0.25m
	0.25 TO 0.50m
	0.50 TO 1.00m
	1.00 TO 1.50m
	1.50 TO 2.50m

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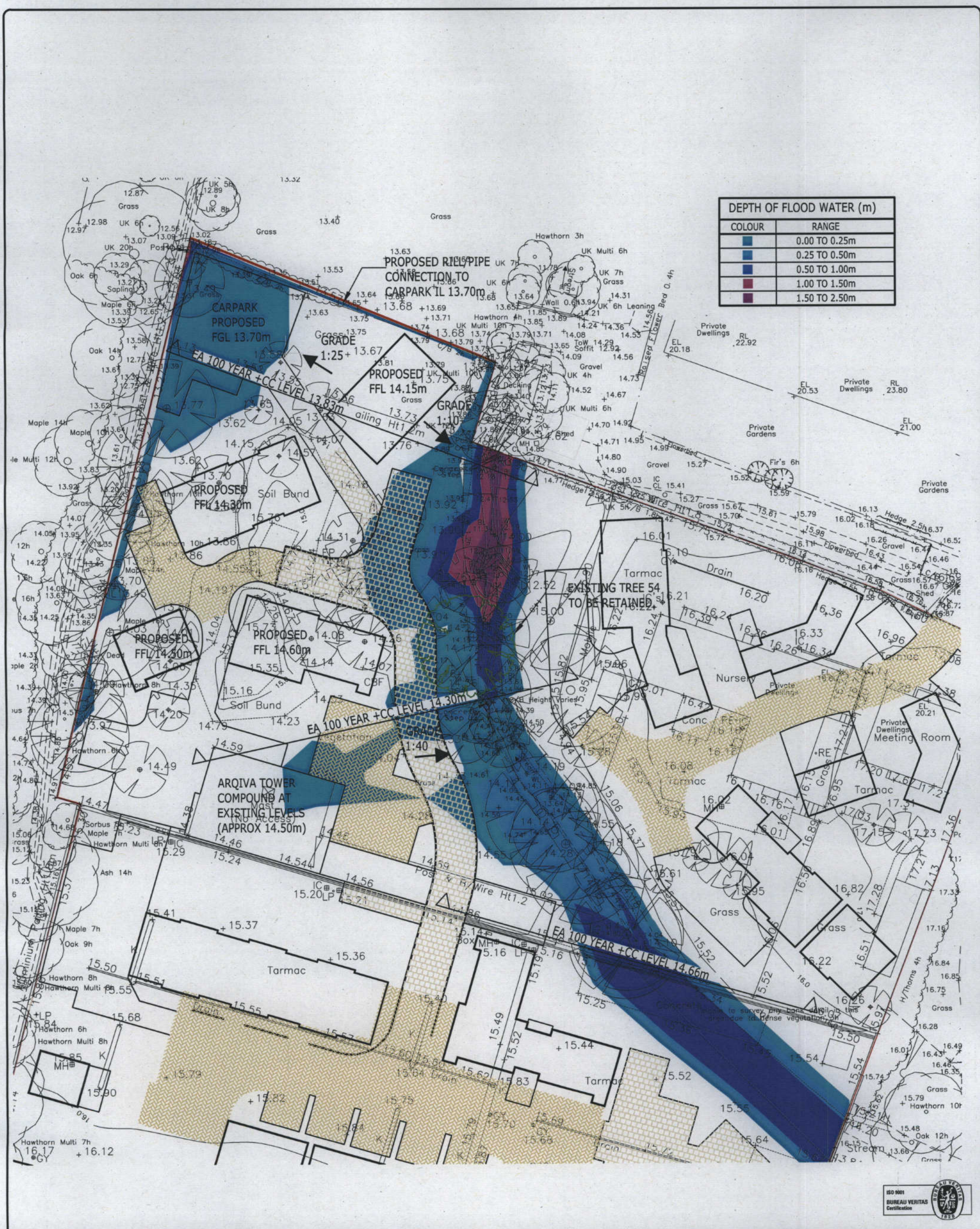
PROJECT TITLE: J661 EON SITE, LONDON ROAD	SCALE: 1:500	DATE: 28/10/11	DESIGNED: DG
DRAWING TITLE: EXISTING FLOOD STORAGE	DRAWN: DG	CHECKED: TS	APPROVED: DJR
CLIENT: BELLWAY HOMES	DRAWING NO. J661-009		REV -



ARDENT CONSULTING ENGINEERS 4th Floor, Diamond House, 36/38 Hatton Garden, London, EC1N 8EB t 020 7430 1209 f 020 7430 0318 w www.ardent-ce.co.uk e enquiries@ardent-ce.co.uk	PROJECT TITLE: J661 EON SITE, LONDON ROAD	SCALE: 1:500	DATE: 04/11/11
	DRAWING TITLE: PROPOSED FLOOD STORAGE	DRAWN: DG	CHECKED: TS
	CLIENT: BELLWAY HOMES	DRAWING NO. J661-010	REV A
		DESIGNED: DG	APPROVED: DJR

Appendix F
Hydraulic modelling calculations

Existing Network Details for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	13.073	0.200	65.4	0.056	5.00	0.0	0.600	o	150
1.001	9.156	0.671	13.6	0.026	0.00	0.0	0.600	o	300
2.000	10.000	0.520	19.2	0.074	5.00	0.0	0.600	o	150
1.002	18.500	0.074	250.0	0.000	0.00	0.0	0.600	o	1050
3.000	11.941	0.048	248.8	0.000	5.00	0.0	0.600	o	525
3.001	16.973	0.027	628.6	0.131	0.00	0.0	0.600	o	525
1.003	10.200	0.108	94.4	0.000	0.00	0.0	0.600	o	300

Network Results Table

PN	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Vel (m/s)	Cap (l/s)
1.000	14.100	0.056	0.0	1.25	22.0
1.001	13.750	0.082	0.0	4.28	302.4
2.000	13.000	0.074	0.0	2.31	40.8
1.002	12.329	0.156	0.0	2.18	1883.4
3.000	12.300	0.000	0.0	1.42	306.4
3.001	12.252	0.131	0.0	0.89	191.8
1.003	12.208	0.287	0.0	1.62	114.4

Simulation Criteria for Storm

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)	480
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	4

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

Synthetic Rainfall Details

Rainfall Model FSR Region England and Wales
Return Period (years) 100 M5-60 (mm) 20.000

Synthetic Rainfall Details

Ratio R	0.400	Cv (Winter)	0.840
Profile Type	Winter	Storm Duration (mins)	240
Cv (Summer)	0.750		

Online Controls for Storm

Non Return Valve Manhole: SWAMH 3, DS/PN: 3.001, Volume (m^3): 6.6

Hydro-Brake® Manhole: SWMH 4.5, DS/PN: 1.003, Volume (m^3): 22.6

Design Head (m) 1.250 Hydro-Brake® Type Md6 SW Only Invert Level (m) 12.208
Design Flow (l/s) 5.0 Diameter (mm) 88

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.5	1.200	4.8	3.000	7.7	7.000	11.7
0.200	3.5	1.400	5.2	3.500	8.3	7.500	12.1
0.300	3.3	1.600	5.6	4.000	8.8	8.000	12.5
0.400	3.2	1.800	5.9	4.500	9.4	8.500	12.9
0.500	3.3	2.000	6.2	5.000	9.9	9.000	13.3
0.600	3.5	2.200	6.6	5.500	10.4	9.500	13.6
0.800	4.0	2.400	6.8	6.000	10.8		
1.000	4.4	2.600	7.1	6.500	11.3		

Offline Controls for Storm

Pipe Manhole: SWMH 4.5, DS/PN: 1.003, Loop to PN: 3.000

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	100.0	Coefficient of Contraction	0.600
Length (m)	10.000	Upstream Invert Level (m)	13.500

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

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	OFF
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	30, 100
Climate Change (%)	0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+30%	100/15 Summer				
1.001	120 Winter	100	+30%					
2.000	15 Winter	100	+30%	30/15 Summer				
1.002	120 Winter	100	+30%	30/15 Winter				
3.000	120 Winter	100	+30%	100/15 Winter				
3.001	120 Winter	100	+30%	30/120 Winter				
1.003	120 Winter	100	+30%	30/15 Summer		30/30 Winter	22	

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	SWMH 4.0	14.533	0.283	0.000	1.55	0.0	31.2	SURCHARGED
1.001	SWMH 4.1	13.878	-0.172	0.000	0.07	0.0	15.3	OK
2.000	SW MH 4.6	14.125	0.975	0.000	0.93	0.0	33.6	SURCHARGED
1.002	SWMH 4.2	13.877	0.498	0.000	0.03	0.0	29.0	SURCHARGED
3.000	TANK	13.878	1.053	0.000	0.02	0.0	3.7	FLOOD RISK
3.001	SWAMH 3	13.878	1.101	0.000	0.04	0.0	4.1	FLOOD RISK
1.003	SWMH 4.5	13.877	1.370	0.000	0.07	23.8	5.7	SURCHARGED

STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	5.000	0.050	100.0	0.000	5.00	0.0	0.600	o	150
1.001	9.263	0.093	99.6	0.000	0.00	0.0	0.600	o	150
1.002	28.503	0.225	126.7	0.075	0.00	0.0	0.600	o	300
2.000	18.722	0.062	300.0	0.069	5.00	0.0	0.600	o	600
3.000	11.590	0.116	99.9	0.034	5.00	0.0	0.600	o	225
3.001	19.583	0.065	300.0	0.034	0.00	0.0	0.600	o	600
1.003	8.874	0.059	150.4	0.000	0.00	0.0	0.600	o	300

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.08	15.000	0.000	0.0	0.0	0.0	1.00	17.8	0.0
1.001	50.00	5.24	14.950	0.000	0.0	0.0	0.0	1.01	17.8	0.0
1.002	50.00	5.58	14.707	0.075	0.0	0.0	0.0	1.40	98.6	10.2
2.000	50.00	5.22	14.850	0.069	0.0	0.0	0.0	1.40	396.0	9.3
3.000	50.00	5.15	14.950	0.034	0.0	0.0	0.0	1.31	52.0	4.6
3.001	50.00	5.38	14.459	0.068	0.0	0.0	0.0	1.40	396.0	9.2
1.003	50.00	5.69	14.394	0.212	0.0	0.0	0.0	1.28	90.5	28.7

Simulation Criteria for Storm

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

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

Synthetic Rainfall Details

Rainfall Model FSR Return Period (years) 30

Synthetic Rainfall Details

Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.000	Cv (Winter)	0.840
Ratio R	0.400	Storm Duration (mins)	30
Profile Type	Summer		

Online Controls for Storm

Non Return Valve Manhole: PSW MH 1.1, DS/PN: 1.002, Volume (m³): 2.7

Hydro-Brake® Manhole: PSW MH 1.2, DS/PN: 1.003, Volume (m³): 15.9

Design Head (m) 1.716 Hydro-Brake® Type Md4 Invert Level (m) 14.394
Design Flow (l/s) 31.7 Diameter (mm) 176

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.2	1.200	26.5	3.000	41.8	7.000	63.9
0.200	15.1	1.400	28.6	3.500	45.2	7.500	66.1
0.300	24.2	1.600	30.5	4.000	48.3	8.000	68.3
0.400	25.7	1.800	32.4	4.500	51.2	8.500	70.4
0.500	23.3	2.000	34.1	5.000	54.0	9.000	72.4
0.600	21.6	2.200	35.8	5.500	56.6	9.500	74.4
0.800	22.1	2.400	37.4	6.000	59.1		
1.000	24.2	2.600	38.9	6.500	61.5		

Offline Controls for Storm

Weir Manhole: PSW MH 1.1, DS/PN: 1.002, Loop to PN: 1.001

Discharge Coef 0.544 Width (m) 0.927 Invert Level (m) 15.300

Storage Structures for Storm

Cellular Storage Manhole: 1, DS/PN: 1.000

Invert Level (m) 15.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	40.0	0.0	1.300	0.0	0.0
0.100	40.0	0.0	1.400	0.0	0.0
0.200	40.0	0.0	1.500	0.0	0.0
0.300	40.0	0.0	1.600	0.0	0.0
0.400	40.0	0.0	1.700	0.0	0.0
0.500	40.0	0.0	1.800	0.0	0.0
0.600	0.0	0.0	1.900	0.0	0.0
0.700	0.0	0.0	2.000	0.0	0.0
0.800	0.0	0.0	2.100	0.0	0.0
0.900	0.0	0.0	2.200	0.0	0.0
1.000	0.0	0.0	2.300	0.0	0.0
1.100	0.0	0.0	2.400	0.0	0.0
1.200	0.0	0.0	2.500	0.0	0.0

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

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep 2.5 Second Increment (Extended)	
DTS Status	OFF
DVD Status	OFF
Inertia Status	ON

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

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	30 Winter	100	+30%	100/15 Summer				
1.001	15 Winter	100	+30%	30/15 Summer				
1.002	15 Winter	100	+30%	30/15 Summer		100/15 Summer	7	
2.000	15 Winter	100	+30%	100/15 Summer				
3.000	15 Winter	100	+30%	30/15 Winter	100/15 Winter			2
3.001	15 Winter	100	+30%	30/15 Summer	100/15 Winter			1
1.003	15 Winter	100	+30%	30/15 Summer	100/15 Winter			1

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	15.338	0.188	0.000	0.91	0.0	12.8	SURCHARGED
1.001	PSW MH 1.0	15.503	0.403	0.000	0.79	0.0	12.4	SURCHARGED
1.002	PSW MH 1.1	15.564	0.557	0.000	0.38	32.7	33.9	SURCHARGED
2.000	PSW MH 2.0	16.002	0.552	0.000	0.09	0.0	27.9	FLOOD RISK
3.000	4	16.001	0.826	0.854	0.33	0.0	14.4	FLOOD
3.001	PSW MH 3	16.000	0.941	0.242	0.07	0.0	20.5	FLOOD
1.003	PSW MH 1.2	16.000	1.306	0.036	0.50	0.0	30.5	FLOOD

Ardent Consulting Engineers		Page 1
4th Floor, Diamond House 36-38 Hatton Garden London EC1N 8EB		Micro Drainage
Date 27/10/2011 13:57 File NETWORK 1 - 1 IN ...	Designed by tseymour Checked by	
Micro Drainage	Network W.12.6	

Existing Network Details for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	57.013	0.000	0.0	0.095	5.00	0.0	0.600	o	225
2.000	30.729	0.000	0.0	0.056	5.00	0.0	0.600	o	225
1.001	21.846	0.900	24.3	0.076	5.00	0.0	0.600	o	225
1.002	24.466	0.909	26.9	0.000	0.00	0.0	0.600	o	225
3.000	12.626	0.050	252.5	0.030	5.00	0.0	0.600	o	150
3.001	6.620	0.050	132.4	0.050	0.00	0.0	0.600	o	150
3.002	43.421	0.259	167.6	0.021	0.00	0.0	0.600	o	225
1.003	5.088	0.338	15.1	0.000	0.00	0.0	0.600	o	300
4.000	26.628	0.200	133.1	0.082	5.00	0.0	0.600	o	225
1.004	45.193	0.915	49.4	0.086	0.00	0.0	0.600	o	300
5.000	23.892	0.262	91.2	0.054	5.00	0.0	0.600	o	150
6.000	28.773	0.262	109.8	0.077	5.00	0.0	0.600	o	150

Network Results Table

PN	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Vel (m/s)	Cap (l/s)
1.000	18.950	0.095	0.0	0.00	0.0
2.000	18.950	0.056	0.0	0.00	0.0
1.001	18.875	0.227	0.0	2.67	106.0
1.002	17.975	0.227	0.0	2.53	100.7
3.000	17.500	0.030	0.0	0.63	11.1
3.001	17.450	0.080	0.0	0.87	15.4
3.002	17.400	0.101	0.0	1.01	40.0
1.003	16.991	0.328	0.0	4.07	287.9
4.000	17.000	0.082	0.0	1.13	45.0
1.004	16.653	0.496	0.0	2.24	158.5
5.000	16.150	0.054	0.0	1.05	18.6
6.000	16.150	0.077	0.0	0.96	16.9

Existing Network Details for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)
1.005	7.088	0.050	141.8	0.000	0.00	0.0	0.600	o	900
1.006	18.375	0.250	73.5	0.014	0.00	0.0	0.600	o	900
1.007	21.407	0.200	107.0	0.053	0.00	0.0	0.600	o	900
7.000	25.536	0.200	127.7	0.068	5.00	0.0	0.600	o	150
1.008	34.957	0.200	174.8	0.055	0.00	0.0	0.600	o	800
8.000	45.900	1.000	45.9	0.187	5.00	0.0	0.600	o	225
8.001	25.200	0.150	168.0	0.074	0.00	0.0	0.600	o	900
8.002	26.689	0.400	66.7	0.072	0.00	0.0	0.600	o	900
8.003	8.221	0.010	822.1	0.117	0.00	0.0	0.600	o	900
8.004	22.000	0.044	500.0	0.062	0.00	0.0	0.600	o	900
8.005	23.000	0.046	500.0	0.078	0.00	0.0	0.600	o	900
8.006	7.372	0.050	147.4	0.037	0.00	0.0	0.600	o	900
1.009	30.961	0.015	2064.1	0.000	0.00	0.0	0.600	o	900
1.010	4.835	0.050	96.7	0.039	0.00	0.0	0.600	o	900

Network Results Table

PN	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Vel (m/s)	Cap (l/s)
1.005	14.900	0.627	0.0	2.63	1673.0
1.006	14.850	0.641	0.0	3.66	2326.7
1.007	14.600	0.694	0.0	3.03	1926.6
7.000	15.500	0.068	0.0	0.89	15.7
1.008	14.400	0.817	0.0	2.20	1106.0
8.000	16.475	0.187	0.0	1.94	77.0
8.001	14.800	0.261	0.0	2.41	1536.2
8.002	14.650	0.333	0.0	3.84	2442.4
8.003	14.250	0.450	0.0	1.08	690.1
8.004	14.240	0.512	0.0	1.39	887.1
8.005	14.196	0.590	0.0	1.39	887.1
8.006	14.150	0.627	0.0	2.58	1640.3
1.009	14.100	1.444	0.0	0.68	432.7
1.010	14.085	1.483	0.0	3.19	2027.4

Existing Network Details for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)
9.000	5.223	0.005	1152.9	0.000	8.00	0.0	0.600	o	1500
9.001	4.835	0.065	74.4	0.000	0.00	0.0	0.600	o	900
1.011	16.431	0.004	4107.8	0.000	0.00	0.0	0.600	o	900

Network Results Table

PN	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Vel (m/s)	Cap (l/s)
9.000	14.150	0.000	0.0	1.25	2216.9
9.001	14.100	0.000	0.0	3.64	2312.8
1.011	14.035	1.483	0.0	0.48	304.7

Simulation Criteria for Storm

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	30	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 Storm

Non Return Valve Manhole: SW AMH 1, DS/PN: 9.001, Volume (m³): 11.6

Hydro-Brake® Manhole: SW MH 1.11, DS/PN: 1.011, Volume (m³): 9.6

Design Head (m) 2.200 Hydro-Brake® Type Md1 Invert Level (m) 14.035
Design Flow (l/s) 220.0 Diameter (mm) 365

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	10.7	1.200	163.3	3.000	256.9	7.000	392.4
0.200	39.6	1.400	175.6	3.500	277.5	7.500	406.2
0.300	77.6	1.600	187.6	4.000	296.6	8.000	419.5
0.400	115.0	1.800	199.0	4.500	314.6	8.500	432.4
0.500	143.1	2.000	209.7	5.000	331.6	9.000	444.9
0.600	158.6	2.200	220.0	5.500	347.8	9.500	457.1
0.800	158.6	2.400	229.8	6.000	363.3		
1.000	153.8	2.600	239.1	6.500	378.1		

Offline Controls for Storm

Pipe Manhole: SW MH 1.11, DS/PN: 1.011, Loop to PN: 9.001

Diameter (m)	0.300	Roughness k (mm)	0.600
Section Type	Pipe/Conduit	Entry Loss Coefficient	0.500
Slope (1:X)	250.0	Coefficient of Contraction	0.600
Length (m)	5.000	Upstream Invert Level (m)	14.035

Storage Structures for Storm

Cellular Storage Manhole: TANK, DS/PN: 9.000

Invert Level (m) 14.150 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	80.0	0.0	2.600	0.0	0.0
0.200	80.0	0.0	2.800	0.0	0.0
0.400	80.0	0.0	3.000	0.0	0.0
0.600	80.0	0.0	3.200	0.0	0.0
0.800	80.0	0.0	3.400	0.0	0.0
1.000	80.0	0.0	3.600	0.0	0.0
1.200	0.0	0.0	3.800	0.0	0.0
1.400	0.0	0.0	4.000	0.0	0.0
1.600	0.0	0.0	4.200	0.0	0.0
1.800	0.0	0.0	4.400	0.0	0.0
2.000	0.0	0.0	4.600	0.0	0.0
2.200	0.0	0.0	4.800	0.0	0.0
2.400	0.0	0.0	5.000	0.0	0.0

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

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+30%	30/15 Summer				
2.000	15 Winter	100	+30%	30/15 Summer				
1.001	15 Winter	100	+30%	100/15 Summer				
1.002	15 Winter	100	+30%	100/15 Summer				
3.000	15 Winter	100	+30%	30/15 Summer				
3.001	15 Winter	100	+30%	30/15 Summer				
3.002	15 Winter	100	+30%	100/15 Summer				
1.003	15 Winter	100	+30%	100/15 Summer				
4.000	15 Winter	100	+30%	100/15 Summer				
1.004	15 Winter	100	+30%	30/15 Winter				
5.000	15 Winter	100	+30%	100/15 Summer				
6.000	15 Winter	100	+30%	30/15 Summer				
1.005	30 Winter	100	+30%	100/30 Winter				
1.006	30 Winter	100	+30%	100/30 Summer				
1.007	30 Winter	100	+30%	100/15 Winter				
7.000	15 Winter	100	+30%	30/15 Summer				
1.008	30 Winter	100	+30%	100/15 Summer				
8.000	15 Winter	100	+30%	100/15 Summer				
8.001	30 Winter	100	+30%	100/30 Winter				
8.002	30 Winter	100	+30%	100/15 Winter				
8.003	30 Winter	100	+30%	100/15 Summer				
8.004	30 Winter	100	+30%	100/15 Summer				
8.005	30 Winter	100	+30%	100/15 Summer				
8.006	30 Winter	100	+30%	100/15 Summer				
1.009	30 Winter	100	+30%	100/15 Summer				
1.010	30 Winter	100	+30%	100/15 Summer				
9.000	30 Winter	100	+30%	100/30 Winter				
9.001	30 Winter	100	+30%	100/15 Summer				
1.011	30 Winter	100	+30%	100/15 Summer		1/15 Summer	66	

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

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	SW MH 12	19.958	0.783	0.000	2.95	0.0	45.8	FLOOD RISK
2.000	SM MH 13	19.676	0.501	0.000	2.53	0.0	30.0	SURCHARGED
1.001	SW MH 1.0	19.616	0.516	0.000	0.96	0.0	93.2	SURCHARGED
1.002	SW MH 1.1	18.789	0.589	0.000	1.01	0.0	93.3	SURCHARGED
3.000	SW MH14	18.567	0.917	0.000	1.34	0.0	13.6	FLOOD RISK
3.001	SW MH 15	18.482	0.882	0.000	2.65	0.0	34.5	FLOOD RISK
3.002	SW MH 16	18.180	0.555	0.000	1.08	0.0	41.1	SURCHARGED
1.003	SW MH 1.2	17.910	0.619	0.000	0.94	0.0	137.0	SURCHARGED
4.000	SW MH 17	17.838	0.613	0.000	0.95	0.0	39.6	SURCHARGED
1.004	SW MH 1.3	17.652	0.699	0.000	1.33	0.0	196.7	SURCHARGED
5.000	SW MH 2.0	16.735	0.435	0.000	1.62	0.0	28.6	SURCHARGED
6.000	SWMH 18	17.429	1.129	0.000	2.29	0.0	37.2	FLOOD RISK
1.005	SW M H 1.5	16.253	0.453	0.000	0.30	0.0	234.2	SURCHARGED
1.006	SW MH 1.6	16.248	0.498	0.000	0.20	0.0	230.2	SURCHARGED
1.007	SW MH 1.7	16.235	0.735	0.000	0.23	0.0	230.9	SURCHARGED
7.000	SW MH 19	16.528	0.878	0.000	2.31	0.0	34.5	SURCHARGED
1.008	SW MH 1.8	16.185	0.985	0.000	0.32	0.0	253.8	SURCHARGED
8.000	SW MH 3.0	17.424	0.724	0.000	1.31	0.0	96.0	SURCHARGED
8.001	SW MH 3.1	16.172	0.472	0.000	0.11	0.0	107.4	SURCHARGED
8.002	SW MH 3.2	16.170	0.620	0.000	0.09	0.0	121.3	SURCHARGED
8.003	SW MH 3.3	16.165	1.015	0.000	0.33	0.0	136.7	FLOOD RISK
8.004	SW MH 3.4	16.164	1.024	0.000	0.26	0.0	148.9	FLOOD RISK
8.005	SW MH 3.5	16.165	1.069	0.000	0.27	0.0	158.0	FLOOD RISK
8.006	SW MH 3.6	16.167	1.117	0.000	0.20	0.0	152.7	FLOOD RISK
1.009	16.15	16.169	1.169	0.000	0.96	0.0	351.4	FLOOD RISK
1.010	SW MH 1.10	16.161	1.176	0.000	0.43	0.0	349.8	FLOOD RISK
9.000	TANK	16.155	0.505	0.000	0.05	0.0	77.4	FLOOD RISK
9.001	SW AMH 1	16.155	1.155	0.000	0.08	0.0	71.4	FLOOD RISK
1.011	SW MH 1.11	16.155	1.220	0.000	0.76	165.4	207.5	FLOOD RISK