ARDENT CONSULTING ENGINEERS

COUNTRYSIDE PROPERTIES LTD.

LAND NORTH OF CUFFLEY HILL,
GOFFS OAK, EN7 5EX

FLOOD RISK ASSESSMENT

REPORT REF. 162101-03C
PROJECT NO. 162101
July 2021

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APPENDICES

DOCUMENT CONTROL SHEET

REV	ISSUE PURPOSE	AUTHOR	CHECKED	APPROVED	DATE
-	DRAFT	FY	BB	DRAFT	SEP 18
-	FINAL	FY	FY	BB	OCT 18
A	FINAL	AW	FY	BB	DEC 18
B	APPENDICES A AND F UPDATED	JC	JC	BB	NOV 19
C	UPDATED TO SUIT UPDATED LAYOUT AND DRAIANGE	AW	AW	BB	JULY 21

1. INTRODUCTION

1.1. Ardent Consulting Engineers (ACE) has been commissioned by Countryside Properties PLC to carry out a Flood Risk Assessment (FRA) and Drainage Strategy for the proposed development of the Land North of Cuffley Hill, Goffs Oak, EN7 5EX, hereafter referred to as 'The Site'.

1.2. The planning submission will be on the basis of a full planning application for 58 dwellings, access, landscaping, open space and pedestrian routes.

1.3. The Local Planning Authority is the Borough of Broxbourne and the Lead Local Flood Authority is Hertfordshire County Council (HCC).

1.4. This FRA has been prepared in compliance with both the National Planning Policy Framework (NPPF) and the supporting Planning Practice Guidance (PPG). It has also been written with reference to the Borough of Broxbourne Strategic Flood Risk Assessment (SFRA) and HCC SuDS Guidance.

1.5. During the preparation of this FRA, consultation with Thames Water was undertaken.

Scope

1.6. In accordance with the assessment criteria found in NPPF, this FRA will ultimately seek to;

- Ensure that flood mitigation is provided within the development site to avoid detrimental impacts to third parties;
- Ensure that the impact of climate change is assessed;
- Ensure impermeable areas within the development are minimised where practicable; and
- Ensure the use of sustainable drainage systems (SuDS) is optimised in line with current best practice.

Sources of Information

1.7. Key reports/documents reviewed as part of this study are:

- Local Flood Risk Management Strategy for Hertfordshire;
- Hertfordshire County Council Preliminary Flood Risk Assessment (2011);
- Borough of Broxbourne Strategic Flood Risk Assessment (2016);
- HCC SuDS Design Guidance;
- Drainage Asset Plans;
- Flood Maps; and
- Borehole Records.

Existing Site

1.8. The Site is bound by a new housing development currently under construction to the west, residential dwellings to the east, north-east and south, with greenfield land to the north-west. There is an existing private access road off Cuffley Hill.

1.9. The Site is within Hertfordshire and is centred on grid reference 531725E; 203061N. A Site Location Plan is included in **Appendix A**.

Development Proposals

1.10. The proposals comprise the development of 58 residential units (C3 use), including landscaping and associated infrastructure works. The Site is to be served by an access road from Cuffley Hill.

1.11. A copy of the latest development layout is included in **Appendix A**.

2. POLICY CONTEXT

National Planning Policy Framework

2.1 The National Planning Policy Framework (NPPF) was introduced on 27 March 2012. This document was revised in February 2019 and then again in July 2021, where paragraphs 155 to 169 inclusive, establish the Planning Policy relating to flood risk management. The Technical Guide to the NPPF has been superseded by the Planning Practice Guidance (PPG) in March 2014 and updated accordingly.

2.2 The main focus of the policy is to direct development towards areas of the lowest practicable flood risk and to ensure that all development is safe, without increasing flood risk elsewhere. The main considerations are:

- Applying the Sequential Test, and if necessary, applying the Exception Test;
- Safeguarding land from development that is required for current and future flood management;
- Using opportunities offered by new development to reduce the causes and impacts of flooding; and
- Where climate change is expected to increase flood risk so that some existing development may not be sustainable in the long-term, seeking opportunities to facilitate the relocation of development, including housing, to more sustainable locations.

Flood and Water Management Act (2010)

2.3 The Flood and Water Management Act 2010 defines clearer roles and responsibilities for the implementation of SuDS in developments, by requiring drainage systems to be approved against a set of draft national standards.

2.4 In December 2014, the government set out changes to planning that apply for major development from 6 May 2015. This change confirmed that in considering planning applications, Local Planning Authorities should consult the relevant Lead Local Flood Authority on the management of surface water; satisfy themselves that the proposed minimum standards of operation are appropriate and ensure through the use of planning conditions or planning obligations that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

2.5 This means that Schedule 3 of the Flood and Water Management Act (FWMA) will not be enacted at this point in time and that Lead Local Flood Authorities (established at the county or unitary local authority level) will not be required to establish SuDS Approving Bodies (SABs) as previously envisaged by the FWMA.

2.6 In March 2015, the Government confirmed that as of the 15 May 2015, Lead Local Flood Authorities will become a statutory consultee on all major planning applications.

Regional & Local Planning Policy Review

2.7 In the preparation of this report, the following regional and local planning policy documents have been referred to:

- Local Flood Risk Management Strategy for Hertfordshire;
- Hertfordshire County Council Preliminary Flood Risk Assessment;
- Borough of Broxbourne Strategic Flood Risk Assessment (2016); and
- LLFA SuDS Policy Statement.

2.8 Collectively the above documents provide a strategy for not only assessing flood risk at a regional level but also guidance on the management of surface water on a site-specific basis.

2.9 The Site is part of the GO5 site which has been identified for allocation of circa 26 homes within the Broxbourne Borough Council (BBC) emerging Local Plan (2016). A full planning application has been prepared for 58 dwellings, which this FRA relates to.

3. BASELINE CONDITIONS

Topography

3.1. A topographical survey was carried out by Countryside Properties in July 2018 and updated in February 2021. A copy of the survey is included within **Appendix B** and shows that the fall across the Site varies between 1:20 and 1:5, which is steep in development terms. The north-west and south-west corners in particular are the steepest areas of the Site.

3.2. The existing Site is split into two catchments: i) a northern catchment which drains to a ditch in the north-west part of the Site and ii) a southern catchment which drains to a ditch south-west of the Site, outside the extents of land ownership.

3.3. The north-west part of the Site comprises a mixture of woodland and scrubland. A Tree Survey was carried out in March 2021, included in **Appendix C**, which identified a number of Category-U (dead) and Category-C (low quality) trees. An Arboricultural Report has been prepared to support this application, which considers the impact of the development proposals, including the proposed drainage.

Hydrology

3.4. Based on the topographic survey, there are ditches within the northern site boundary and outside of the south-western site boundary, both watercourses are understood to drain to Cuffley Book, approximately 600m to the west of the Site.

Existing Sewer Infrastructure

3.5. The sewer records held by Thames Water indicate that there are no foul or surface water sewers within the Site boundary.

3.6. There is a 150mm diameter foul sewer in the rear gardens of the properties along Cuffley Hill, to the immediate southwest of the site. There is also a 150mm diameter foul sewer to the south of the site within Cuffley Hill and a 225mm diameter foul sewer within Robinson Avenue.

3.7. There is also a 225mm diameter surface water sewer to the east and south of the site, running within the carriageway of Robinson Avenue to Cuffley Hill.

3.8. A copy of the Thames Water Record Plans is included in **Appendix C**.

Ground conditions

3.9. According to the British Geological Survey (BGS) online datasets, the bedrock is made up of London Clay Formation. There are superficial deposits of Lowestoft Formation, which forms extensive sheets of chalky till, together with outwash sands and gravels, silts and clays.

3.10. A geotechnical investigation has been carried out by Rolton Group in August 2018. The investigation confirmed ground conditions consist of clayey gravelly sand topsoil overlying firm to stiff sandy gravelly clay. Groundwater was encountered at depths of circa 2.8m whilst elevated levels of Lead, PAH and glass were encountered during the investigation.

3.11. The report concluded that that the predominantly clay soil across the site are unlikely to be suitable for disposal of stormwater by infiltration. The contamination, steep topography and shallow water table is also likely to preclude the use of infiltration-based SuDS within this development.

3.12. The Site is not located within any Source Protection Zone and therefore has no issues with groundwater recharge.

3.13. Refer to **Appendix D** for a copy of the Geotechnical Investigation.

4. SOURCES OF FLOODING

4.1. The NPPF requires flood risk from the following sources to be assessed, each of which are assessed separately below:

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

Fluvial/Tidal Flooding

4.2. The Environment Agency's mapping indicates that the Site is located within Flood Zone 1 which means that the site has less than a 1 in 1,000 (0.1%) probability of river or sea flooding (low probability).

4.3. The Sequential and Exception Tests are therefore not required for this site, as it is located in Flood Zone 1.

4.4. The risk of flooding from rivers or sea is therefore extremely low.

Groundwater Flooding

4.5. According to the EA's mapping website, the site is located within the Total Catchment (Zone 1) Source Protection Zone, which is defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source.

4.6. The geotechnical investigation confirmed the site is located in an area of clay and no groundwater was encountered within 2m of the existing ground levels.

4.7. Therefore, it is not anticipated that there will be a significant risk of groundwater flooding at the Site.

Pluvial Flooding

4.8. The EA flood maps for surface water indicate that the Site is located within an area of predominantly very low risk of surface water flooding, however, there are small areas of low risk to the north and south of the site and a medium risk of surface water flooding to the south. Refer to **Figure 4-1** below.

4.9. The SFRA sequential test identifies a small extent of surface water flooding for the 1 in 1000 year event, however this is understood to be related to the topography of the site.

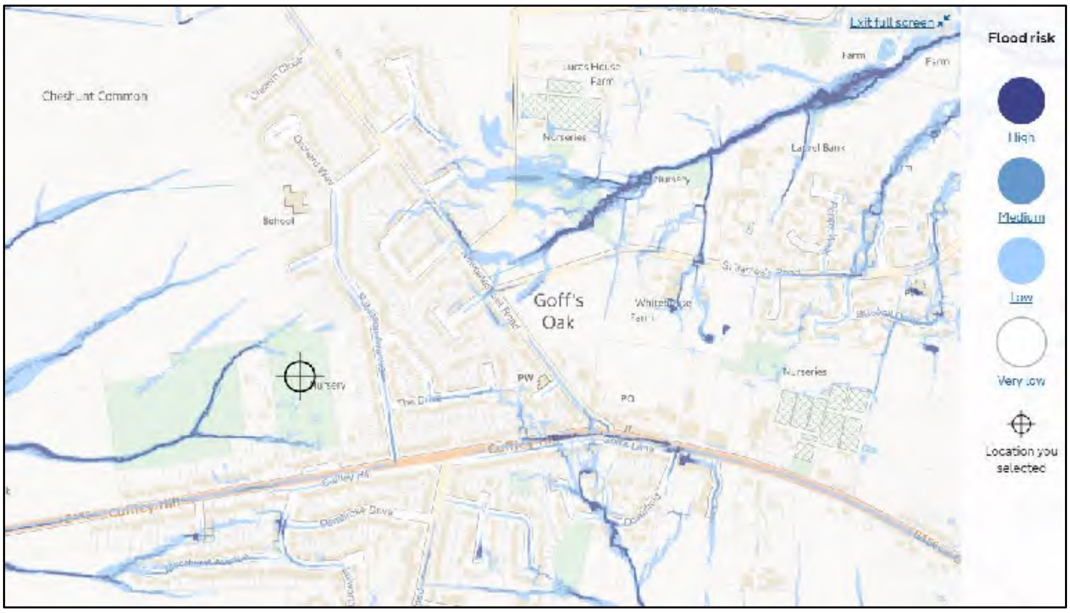

Figure 4-1: Extract of EA Surface Water Flood Mapping

Sewer Flooding

4.10. There have been no known sewer flooding events at the Site.

4.11. Thames Water has advised that there is sufficient capacity in the existing foul sewer network. Therefore, it is not anticipated that any upgrades to the sewer network will be required.

Artificial Sources

4.12. The Environment Agency's flood maps from reservoirs indicate that the site is not within an area as risk of flooding reservoirs, canals or other artificial water bodies.

4.13. The risk to the Site from reservoir flooding and other artificial sources is therefore considered very low.

5. FOUL AND SURFACE WATER MANAGEMENT

5.1. The Lead Local Flood Authority (LLFA) is HCC, who are responsible for reviewing the surface water drainage systems for major developments (ten dwellings or more), following changes to the planning process enacted in May 2015.

5.2. A non-statutory technical standard for sustainable drainage systems was published by the Department of Environment, Food and Rural Affairs in March 2015 to guide planning authorities, designers and developers on the use of SuDS. A Best Practice Guidance was published by the Local Authority SuDS Officer Organisation (LASOO) in July 2015 to accompany the aforementioned document.

5.3. The CIRIA guidance C753 (The SuDS manual) and The SuDS Guidance for Hertfordshire has been used to determine the appropriate SuDS strategy, which considers the spatial and environmental constraints of the site.

5.4. The Guidance to Support the NPPF (Climate Change Allowance for Planners) was updated in May 2016. The new guidance document considers 'Upper end' and 'Central' scenarios for peak rainfall intensity allowances in small urban catchments due to climate change, as shown in **Table 5-1** below.

Table 5-1: Peak Rainfall Intensity Allowance in Small Urban Catchments

Peak Rainfall Scenario	Total Potential Change for 2015 to 2039	Total Potential Change for 2040 to 2069	Total Potential Change for 2070 to 2115
Upper end	10%	20%	40%
Central	5%	10%	20%

5.5. Therefore, under this guidance, a conservative allowance of 40% for the effects of climate change would achieve the policy requirements for the proposed development.

Existing Surface Water Discharge

5.6. In line with CIRIA guidance C753 (The SuDS manual), Greenfield runoff rates have been calculated using the ICP SuDS method using WinDes MicroDrainage and are included in **Appendix E**:

- 1 year Greenfield runoff = 3.3 l/s; and
- 100 year Greenfield runoff = 12.4 l/s.

5.7. The existing Greenfield runoff rates are based on the development parcel within the northern catchment only, which is adjudged to be the contributing area to the existing ditch in the north-west corner of the Site. The runoff rates do not include the existing impermeable area or the southern catchment and therefore represent a conservative approach.

Proposed Surface Water Drainage and Options consideration

5.8. In line with CIRIA guidance C753 (The SuDS manual), the drainage hierarchy needs to be considered and is listed below in order of preference:

- Store rainwater for later use;
- Use infiltration techniques, such as porous surfaces in non-clay areas;
- Attenuate rainwater by storing in tanks or sealed water features for gradual release to a watercourse;
- Discharge rainwater direct to a watercourse;
- Discharge rainwater to a surface water drain; and
- Discharge rainwater to the combined sewer.

Store rainwater for later use

5.9. The potential to reuse a percentage of the rainwater from the site on the proposed development should be explored further during detail design, in particular through the use of water butts. This assessment considers the worst-case runoff rates and assumes this option is not viable.

Use infiltration techniques, such as porous surfaces in non-clay areas

5.10. Rolton Group has confirmed that infiltration is not suitable for the site due to the clay soils and therefore is not feasible as a means of surface water discharge.

Discharge to a watercourse at greenfield rates

5.11. There is an existing ditch in the north-west of the site, which the proposed drainage network will outfall to.

Proposed Sustainable Drainage Systems (SuDS)

5.12. **Table 5-2** below appraises the constraints and opportunities for the use of SuDS techniques within the Site and it adopts the management train approach outlined in CIRIA C753 'The SuDS Manual'.

Table 5-2: C753 SuDS Components - Management Train Approach

Type:	**Infiltration Devices** (Source Control)
Constraints:	The site is underlain by clay with poor infiltration capabilities.
Opportunities:	None.
Type:	**Permeable Paving** (Source Control)
Constraints:	Permeable paving potential is limited due to the presence of London clay.
Opportunities:	None.
Type:	**Swales/Filter Drains** (Permeable Conveyance)
Constraints:	Steep site will limit the potential for the use of above ground SuDS.
Opportunities:	Could be used for conveyance and to improve quality of surface water effluent.
Type:	**Attenuation Basin / Ponds** (end of pipe treatment)
Constraints:	Attenuation basin sizes will be restricted in size due to the number of trees onsite and steep site topography.
Opportunities:	Basins could be used to store water prior to discharging into the nearby ditch and to allow additional treatment of the surface water runoff.
Type:	**Buried Storage** (end of pipe treatment)
Constraints:	None.
Opportunities:	Geocellular storage could be used within the network to provide additional storage if required.

5.13. After consideration of the CIRIA C753 management train approach, the most viable SuDS options for the Site is a series of cascading attenuation basins discharging to the nearby ditch in the northwest corner of the site.

5.14. The LLFA have agreed that the extents of the Ordinary Watercourse, to the west of the site, can be extended up to the outfall of the site once operational.

5.15. The proposed surface water drainage has been split into two catchments, serving the eastern and western parts of the site. The eastern catchment discharges off-site via both the east and west basins. The western catchment is at the lower part of the site and discharges off-site via the western basin only. The total discharge rates off-site (i.e. from the west catchment into the receiving watercourse) are in line with existing greenfield runoff which are outlined in **Section 6.6**.

5.16. The use of cascading basins will provide appropriate water quality treatment and will remove sediment prior to discharging into the ditch.

5.17. The two basins will provide a total storage volume of 1143m^3 for the entire site for the 1 in 100 year 40% climate change event, providing a minimum freeboard of 0.3m. Storage Calculations are included within **Appendix E**.

5.18. The surface water calculations are based on an assumed impermeable area of 60% of the site area. This is considered conservative for the density of development.

5.19. The design of the basins takes account of the existing site topography - refer to the levels shown on C00185-ACE-IG-XX-DR-C-P100 Proposed Drainage Strategy and C00185-ACE-IG-XX-DR-C-P020_P021 Attenuation Basin Sections, included in **Appendix F**.

Long Term Storage

5.20. Long Term Storage (LTS) will be required as the impermeable area on site is increasing. The LTS volume required is 386m^3, which has been calculated using the method outlined in CIRIA C753 SuDS Manual.

The LTS will be provided within the eastern basin, which has a maximum discharge rate of 2.2l/s (i.e. less than 2/ls/ha).

5.21. Hertfordshire County Council has confirmed that new planning applications do not need to make allowance for future urban creep.

Stages of Treatment

5.22. In terms of surface water treatment, the integration of the SuDS features outlined above allow for a SuDS management train approach to be applied to ensure that surface water runoff is of sufficient quality, so as not to cause pollutant-based detriment to the receiving ditch.

5.23. In determining the necessary SuDS treatment methods, reference is made to Table 26.2, Table 26.3 and Table 26.4 of the SuDS Manual (CIRIA C753), which have been duplicated in **Appendix G**. The tables outline the 'Simple Index Approach' which sets out the water treatment criteria in relation to land use and SuDS performance evidence. To ensure sufficient treatment is proposed for surface waters, the total pollution mitigation index of the selected SuDS methods must equal or exceed the pollution hazard index for the site.

5.24. The assessment has been carried out based on the use of a system of cascading basins. A swale is also proposed upstream of the discharge to the existing watercourse which will aid in pollution control, however the has not been considered due to the short overall length of the swale.

Exceedance Routes

5.25. As a result of heavy or extreme storm events it is sometimes unavoidable for the capacities of sewers and other drainage systems to be exceeded. Drainage exceedance will occur when the rate of surface water runoff exceeds the inlet capacity of the drainage system, when the receiving water or pipe system becomes overloaded, blocked or when the outfall becomes restricted due to flood levels in the receiving water.

5.26. The routes will ultimately mimic the current flow routes associated with the existing site as a result of the topography. Flow arrows have been added to the Proposed Drainage Strategy Plan within **Appendix F** to indicate the exceedance routes through the development.

Future Maintenance

5.27. It is the intention that the piped elements of the surface water network (up to the outfall into the two proposed basins) will be adopted by Thames Water under a S104 agreement. The extent of the network proposed for adoption will be addressed at detailed design stage and agreed with Thames Water.

5.28. A management company will be appointed to maintain the SuDS elements of the surface water drainage strategy. Funding of the maintenance regime will be via the yearly maintenance fees from the development. All maintenance should be in accord with the best practices and the CIRIA Manual C753.

5.29. A maintenance and management plan for the SuDS features is included in **Appendix H**.

Hertfordshire County Council (HCC) – LLFA Correspondence

5.30. A holding objection was raised by HCC as the LLFA in April 2019, requiring further information on the strategy.

5.31. Following the holding objection, multiple engagements have been made with the LLFA, regarding the drainage strategy, including on site meetings, emails and various discussions. From these interactions, the holding objection was removed in March 2020.

5.32. The drainage strategy follows the agreed 2020 approach and it is anticipated that there will be no further comments from the LLFA.

5.33. For the HCC LLFA correspondence, refer to **Appendix I**.

Proposed Foul Water Drainage

5.34. Under the new charging arrangements introduced in April 2018, it is the responsibility of Thames Water to provide capacity within the sewer network to facilitate the proposed development. However, Thames Water has confirmed in their Pre-Planning Response dated March 2021 that there is sufficient capacity within the adjacent foul sewer network to serve the development.

5.35. The proposed foul drainage can connect by gravity to the existing foul network to the south-west of the site. A Section 98 application has been submitted to Thames Water for the off-site gravity sewer.

5.36. A copy of the Thames Water sewer record plans and correspondence is included in **Appendix D**.

6. FLOOD RISK MANAGEMENT

6.1. This site-specific FRA aims to demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, reduce flood risk overall.

Finished Floor Levels and Thresholds

6.2. It is proposed that finished floor levels be set a minimum of 150mm above the surrounding ground levels. In addition, safe access and egress is available to the site via the wider highway network as it is located in Flood Zone 1.

6.3. The surface water runoff from the development will be captured in the drainage system and exceedance routes will ensure the internal highways network direct flows away from the proposed dwellings.

6.4. The measures set out above will mitigate any risk of flooding to the individual properties.

7. CONCLUSIONS

7.1. This FRA and Drainage Strategy is based on observations, a review of published data, a topographic survey and geotechnical investigations.

7.2. The site is assessed to be within Flood Zone 1 and therefore not at risk of flooding from fluvial or tidal sources.

7.3. Flood risk from groundwater, canals and artificial sources, pluvial sources and overland flows are all considered to be low following the application of the proposed surface water drainage strategy outlined in **Section 6** and residual risk management strategy in **Section 7**.

7.4. Various SuDS techniques have been considered viable for this development and have been integrated within the proposals to form a SuDS management train. Cascading attenuation basins are proposed in the north-west corner of the site.

7.5. The SuDS have been designed to achieve adequate surface water treatment in line with CIRIA C753 guidance. The surface water drainage and SuDS strategy has been agreed in principle with Hertfordshire County Council.

7.6. The proposed drainage system will be capable of managing runoff from all rainfall events up to and including the critical duration of a 1 in 100-year storm event plus 40% allowance for climate change. Residual surface water runoff will be wholly stored on-site before discharging to a nearby ditch in the north-west corner of the site by means of a series of SuDS features. Discharge of surface water will mimic existing conditions, with discharge rates limited to existing greenfield run-off rates.

7.7. The proposed foul sewer network within the development will drain by gravity to the existing foul sewer network to the south west of the site. Thames Water has confirmed capacity within the existing sewer network to serve the development.

7.8. In accordance with the requirements of Chapter 10 of the NPPF, the proposed development has been assessed for flood risk. Consideration has been given both to risk to the site, and to risk elsewhere caused by the anticipated development. Based on our assessment of the site setting and the proposed development, it is considered that the proposed development can be constructed and operated safely and will not increase flood risk elsewhere.

Appendix A

Site Layouts

A1

PRIVATE

House Type	No of Bedrooms	SqFt	No	Total SqFt
401	4B	1194	6	7164
404	4B	1281	2	2562
405	4B	1408	3	4224
407	4B	1397	5	6985
410	4B	1466	2	2932
412	4B	1546	2	3092
416	4B	1759	2	3518
419	4B	1790	2	3580
424	4B	1265	8	10120
500	5B	1828	3	5484
TOTALS			35	49661

Private housing plot areas (sqft)	49661

AFFORDABLE

House Type	No of Bedrooms	SqFt	No	Total SqFt
2AH	2B	850	14	11900
3AH	3B	1000	9	9000
TOTALS			23	20900

Affordable housing plot areas (sqft)	20900

SITE TOTALS	58	70561

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Rev	Description	Date	Au	Ch
P4	Plot changes to 35,40,41,44,45,46,47 & 50	24/02/21	KK	TW
P5	Plot changes to as per arb report & comments.	05/03/21	KK	TW
P6	Plot changes as per comments from LPA.	15/03/21	KK	TW
P7	Changes to plots 23/24/25.	16/03/21	KK	TW
P8	Changes to plots 9-32.	06/05/21	KK	TW
P9	Changes to plots 16,17,18,22,24,25	12/05/21	KK	TW
P10	Addition of one plot. Plot 41(HT416) swapped with 2x (HT424).Changes to plots 40-45. Plots 24,25 moved back 0.5m. Accommodation schedule updated to show increase in units to 58. Footpath continued in front of Plot 44.	27/05/21	KK	TW
P11	Changes to plots 9-15, 39,40. Access updated to latest information.	07/06/21	KK	TW
P12	Red line boundary updated in the south east corner.	06/07/21	KK	TW
P13	Affordable units made NDSS compliant.	14/07/21	KK	TW

Project	**Cuffley Hill, Goff Oak**		
Drawing	**Site Layout**		
Client	**Countryside Developments Ltd**		
Job no.	**COUN180506**	Date	**01.12.20**
Dwg no.	**SL.02**	Revision	**P13**
Author	**RP** Checker **TW**	Scale	**1:500 at A1**
Status	PRELIMINARY	Office	**Portishead**
Client ref.			

thrive. architects

Appendix B

Topographical Survey

Rev	Date	By	Description	Chk'd
C	22/2/21	LH	DETAIL OF SHEET PILING TO REAR OF ADJACENT CONSTRUCTION AREA , NO. 104 SHED, FENCE TO NORTHERN BOUNDARY AND MANHOLES ADDED AS CLOUDED	
B	24/7/18	LH	DITCH DETAIL ADDED TO NORTH WEST CORNER	
A	20/10/16	LH	NORTHERN BOUNDARY DETAIL ADDED	

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site: **FAIRMEAD & ROSEMEAD NURSERIES CUFFLEY HILL**

title: **TOPOGRAPHICAL SURVEY UPDATE / BOUNDARY CHECK**

scale: @A1 1/500

drawn by: LH

date: 23/09/16

checked:

drawing no: **SURV 2329**

sheet no: Sheet 1 of 1

revision: C

FS 53054 Quality Management
EMS 61920 Environmental Management

c:\drawings\cuffley hill goffs oak\surv2329 (revc) cuffley topo update and boundary check.dwg

NOTE:
PETER NEWSON SURVEY NO. 913006
SHOWN IN FEINT LINE.

Appendix C

Thames Water Correspondence

Planning your wastewater

We've put together some information on sewerage to help you plan your new development.

How long does it take to get consent to connect to a sewer?

If you're applying for consent to connect to a sewer under Section 106 of the Water Industry Act 1991, you'll need to give us 21 days' notice.

I think I'll need to connect to a trunk sewer – is that possible?

Connecting directly to trunk sewers can be complex and dangerous, and we won't permit this at all in London. If you're considering a trunk sewer as a point of connection, please contact us as soon as possible to discuss.

How do I handle trade effluent and groundwater discharges?

You mustn't discharge non-domestic waste to our sewers without a valid trade effluent consent - doing this is an offence under Section 109(1) of the Water Industry Act 1991. You can call our trade effluent team on 0203 577 9200 to get help with trade effluent consents and ground water discharge permits.

Where can I discharge surface water?

The Lead Local Flood Authority, or if you are in a London Borough, 'The London Plan', advises that your development should utilise sustainable drainage systems (SuDS) unless there are practical reasons for not doing so. You should aim to achieve greenfield run-off rates and ensure you manage surface water run-off as close to its source as possible in line with the following drainage hierarchy:

1. Store rainwater for later use.
2. Use infiltration techniques, such as porous surfaces in non-clay areas.
3. Attenuate rainwater in ponds or open water features for gradual release.
4. Attenuate rainwater by storing in tanks or sealed water features for gradual release.
5. Discharge rainwater direct to a watercourse.
6. Discharge rainwater to a surface water sewer or drain.
7. Discharge rainwater to a combined sewer.

Please note that if you're discharging surface water anywhere other than to a public sewer – such as to a watercourse – you'll need approval from the relevant authority, for example the Environment Agency, the local authority or the Canals and Rivers Trust.

If you don't follow the surface water hierarchy you may not be granted planning permission, and Thames Water may seek to put conditions on the planning application.

There's no right of discharge of highway drainage into the public sewerage system, and we'd need to agree this with the relevant highway authority under Section 115 of the Water Industry Act 1991. You can contact us to discuss this further.

What can I do about redundant sewers and rising mains on my site?

On brownfield sites where existing sewers or rising mains need to be made redundant or diverted, the developer will need to fund the work, as set out in Section 185 of the Water Industry Act. If there's no practical way of making a diversion, we'll apply the standoff distances in Sewers for Adoption 7th edition to assess the width of easement required.

Mr Andrew Wren
Ardent Consulting Engineers
Third Floor, The Hallmark Building
52-56 Leadenhall Street
London
EC3M 5JE

Wastewater pre-planning
Our ref DS6050933

18 March 2021

Pre-planning enquiry: Confirmation of sufficient capacity

Dear Mr Wren,

Thank you for providing information on your development:

Land on the North of Cuffley Hill, Waltham Cross, Herts, EN7 5EX.

Proposed development of 57 dwellings. Foul water discharging by gravity to the foul water manhole 6952. Surface water discharging to an existing ditch onsite in the North East corner.

We have completed the assessment of the foul water flows based on the information submitted in your application with the purpose of assessing sewerage capacity within the existing Thames Water sewer network.

If your proposals progress in line with the details you've provided, we're pleased to confirm that there will be sufficient sewerage capacity in the adjacent foul water sewer network to serve your development.

This confirmation is valid for 12 months or for the life of any planning approval that this information is used to support, to a maximum of three years.

You'll need to keep us informed of any changes to your design – for example, an increase in the number or density of homes. Such changes could mean there is no longer sufficient capacity.

Please see the attached 'Planning your wastewater' leaflet for additional information.

What happens next?

Please make sure you submit your connection application, giving us at least 21 days' notice of the date you wish to make your new connection/s.

If you've any further questions, please contact me on 0203 577 9811.

Yours sincerely

Siva Rajaratnam - Adoptions Engineer

Thames Water

Appendix D

Geotechnical Investigation Results

ROLTON GROUP
ENGINEERING THE FUTURE™

18-0446

GEO-ENVIRONMENTAL AND GEOTECHNICAL REPORT

FOR

COUNTRYSIDE PROPERTIES

AT

CUFFLEY HILL, GOFFS OAK HERTFORDSHIRE

REVISION 1.0

Rolton Group Limited, Registered in England No. 1547400 at The Charles Parker Building, Midland Road, Higham Ferrers, Northants, NN10 8DN

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Versions	Date	Reason for issue
1.0	21.08.2018	First Issue

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CONTENTS

PREFACE

a) The comments given in this report and the opinions expressed are based on the ground conditions encountered during the site work and on the results of tests made in the field and laboratory. However, there may be special conditions prevailing at the site which have not been disclosed by the investigation and which have not been taken into account in the report. Accordingly, a careful watch should be maintained in any future groundworks and the findings and recommendations of this report reviewed, if necessary, as work proceeds.

b) The comments on groundwater conditions are based on observations made at the time the site work was carried out. It should be noted that groundwater levels vary owing to seasonal and other effects.

SUMMARY

CLIENT DETAILS	Countryside Properties.
PROPOSED DEVELOPMENT	Residential houses and flats, with private front and rear gardens, served by new roads. An area of public open space is proposed in the north west of the site.
THE SITE	
Location	North of Cuffley Hill in the west of Goffs Oak, Hertfordshire.
National Grid Ref	531717, 203075.
Topography	Ground level falls from around 101.5mAOD at the north eastern corner of the site to around 91.5mAOD in the south west.
Description	The majority of the site is grassed open space with many mature trees. In the east of the site is a light industrial compound formed of steel containers and heras fencing. There is an area of maintained lawn in the south east of the site.
Site History	The site was historically agricultural fields before use as commercial Nurseries between 1898 and 1999.
ENVIRONMENTAL SETTING	
Geology	BGS mapping shows the site to be underlain by the Lowestoft Formation (superficial Boulder Clay) with London Clay bedrock.
Hydro-geology	The Lowestoft Formation is indicated to be a Secondary Undifferentiated aquifer; the London Clay is Unproductive Strata.
Hydrology	There are drains and ditches at field boundaries within 500m of the site. The nearest is around 50m west. Cuffley Brook is present around 600m west of site.
Radon	No Radon protection measures are required for new dwellings.
LAND USES	
Surroundings	Land to the east and south is predominantly residential housing; there is a light industrial area and an area of woods to the immediate west. Wider land to the north and west is agricultural fields.
Landfills	There are no registered active landfills or waste treatment facilities on site or in the near vicinity. Historic landfills are recorded to the west and northwest; the nearest is 714m away and is indicated to have taken inert and industrial wastes between 1955 and 1968.
Coal Mining / Cavities	The site is not located in a coal mining area. Records indicate a gravel pit as being present around 235m west of site.

GROUND CONDITIONS	
Soils/Rock	Ground conditions consist of clayey gravelly sand topsoil overlying firm to stiff sandy gravelly clay, locally being more granular. The topsoil locally contained large amounts or glass. Made ground was recorded to 600mm depth in one location in the east of the site.
Groundwater	Groundwater was encountered in 2 of the 11 trial pits at 2.80m and 2.85m depth respectively. Damp soils were encountered locally, associated with more granular strata.
Excavations	Excavations should be possible with normal backhoe plant. Some pit wall instability was encountered below 2.1m and 2.7m.
FOUNDATION DESIGN	
Type	Trench fill foundations to 1.0m depth with deepening required in proximity to trees and shrubs, plus heave protection as necessary. Due to the presence of shrinkable soils and trees, foundations are likely to exceed 2.5m depth across much of the site; an alternative foundation solution should be considered. Driven or bored piling is technically feasible – bored CFA may be preferred to reduce noise and vibration.
Bearing Pressure	Minimum 125kN/m^2 for trench fill foundations.
Concrete Mix	Shallow mass concrete conditions: DS-2, AC-3z. Based on foundations placed in natural soils with mobile groundwater.
GROUND FLOOR SLABS	
	Ground bearing slabs are not recommended due to the presence of trees and shrinkable soils. Suspended precast ground floors are recommended throughout over a minimum 300mm ventilated void. No gas protection measures are required (for Radon or landfill gases).
INFRASTRUCTURE DESIGN	
Soakaways	The predominantly clay soils across the site are unlikely to be suitable for disposal of stormwater by soakaways.
Roads and Hardstandings	CBR testing gave values in the range 2.7% - 7.4%. A preliminary design CBR of at least 3% is recommended.

CONTAMINATION AND REMEDIATION WORKS	
Soil Contamination	No asbestos detected (8 samples tested). Lead is elevated above guidance in 6 out of 11 samples tested. Some recorded TPH but not above guidance. Two locations have PAH exceeding guidance. Generally, elevated concentrations are in the eastern part of the site.
Topsoil	Topsoil is not compliant with BS3882 (1 sample tested); non-compliance is for organic content, stone content and nutrients.
Remedial Works / Mitigation Measures	Private gardens will require clean imported topsoil. The existing topsoil may remain in public open spaces provided that it is covered with at least 300mm of clean soils including imported topsoil cover.
Waste Classification	Natural soil arisings are likely to be classed as inert. Topsoil and made ground may be classified as non-hazardous.
Water Supply Mains	Protective materials may be required. The suitability of polymer water supply mains should be confirmed by the water supplier.
ADDITIONAL INVESTIGATIONS	
	It is anticipated that some foundations may exceed 2.5m depth and an alternative foundation solution will be required. Additional deep boreholes will be required for the design of piled foundations. Additional sampling and testing will be required beneath the compound in the east of the site.

1.0 INTRODUCTION

Countryside Properties (the Client) are proposing to develop a parcel of land off Cuffley Hill, Goffs Oak, Hertfordshire, with low-rise residential housing and flats. Rolton Group Ltd (RGL) has been appointed by the Client to undertake a geo-environmental desk study and intrusive investigation of the site for the purposes of assessing contamination presence and to provide recommendations for the design of foundations, ground floors and infrastructure.

The central and western parts of the site are predominantly grassed open space with many mature trees. In the east of the site is a small light industrial compound formed of steel containers and Heras fencing. There is an area of maintained lawn in the south east of the site currently being used by an adjacent property. This site covers an area of around 3.2 hectares.

This report presents the findings of the desk study and describes the investigation works undertaken, producing the findings together with an interpretation of the ground conditions and an assessment of engineering considerations with respect to the design of foundations, ground floors and infrastructure. An assessment of contamination presence and need for any remediation or other mitigation measures is also presented.

The intrusive investigations were carried out in general accordance with the procedures and recommendations of *British Standard BS 5930:2015, Code of Practice for Site Investigations* (Ref. 8.1). The assessment of contamination presence was undertaken in general accordance with the guidance and recommendations of *CLR11* The Model Procedures for the Management of Land Contamination (Ref. 8.2) published by the Environment Agency.

Although comments are given on hydrology this report does not constitute a Flood Risk Assessment; a Flood Risk Assessment report may be required for the site in support of any Planning application.

This report does not generally consider the potential presence of invasive plant species such as Japanese Knotweed or protected flora and fauna (including newts and badgers) unless specifically stated otherwise.

The topsoil currently on site is not suitable to remain in private gardens. It is recommended that a 300mm thickness of clean imported topsoil is placed in private gardens. The imported soils should be sampled and tested and a validation report produced upon completion.

Additional investigation including sampling and testing is recommended in the east of the site beneath the existing compound area following its removal, to determine the presence of any made ground or possible contamination.

Due to the presence of shrinkable soils and mature trees, it is anticipated that a number of plots will have foundations exceeding 2.5m depth; where this is the case, a piled foundation solution could be considered. Additional deep boreholes will be required to facilitate the design of piled foundations.

2.0 THE SITE

2.1 GENERAL COMMENTS

The following Section describes the site and surrounding land and their environmental features and setting. Much of the information is taken from the Envirocheck report in Appendix B – this collates information in the public domain from bodies such as the Environment Agency, Local Planning Authority, British Geological Survey and Natural England; other sources are indicated as appropriate.

Please note the northern site boundary indicated on the Envirocheck Report (Appendix B) is inaccurate – the boundary is shown to extend further north than the actual site boundary. A truer representation can be found on the Site Location Plan in Appendix A.

2.2 SITE LOCATION AND DESCRIPTION

The site is located to the north of Cuffley Hill in the west of Goffs Oak, south Hertfordshire. The site is roughly rectangular measuring approximately 150m by 250m at its widest extents and covering an area of around of 3.2 hectares. The site is shallowly west-dipping although locally undulating; ground level falls from around 101.5m AOD at the north eastern corner of the site to around 91.5m AOD in the south west. Access to the site is via a gated track at the south eastern corner leading off Cuffley Hill. The centre of the site is approximately National Grid Reference 531717 203075.

The eastern part of the site comprises a small light industrial compound including the following:-

- Steel containers;
- Abandoned vehicles;
- Storage containers and racking;
- Areas of hardstanding and gravel surfacing;
- General building materials and machinery (steel piping, bricks, paving slabs and cement mixer);
- Other general waste including: plastic jerry cans, step ladders, wheel barrows, industrial-use trolleys, paint cans, crockery, wood, paper and scrap metal.

Much of the eastern part of the site is also covered with dense nettles and brambles.

A maintained grass lawn of around 0.19 hectares occupies the south eastern part of site – this appears to be associated with the adjacent property and includes children's play equipment and a chicken coop.

The remainder of the site, covering the central and western parts, comprises a variety of mature and semi-mature trees, areas of dense bramble and other vegetation. In the central part of the site there are a number of narrow strips of hardstanding/concrete likely associated with the site's former usage as a commercial plant nursery.

The site boundary is generally formed of trees and hedgerows.

A Site Location Plan is included in Appendix A to this report.

2.3 SITE ENVIRONS

Land to the immediate east and south is predominantly low-rise residential housing with local amenities. There is a light industrial area, apparently associated with a landscaping company (CG Edward Ltd), and an area of woodland to the immediate west.

Wider land to the north, west and south is agricultural fields.

2.4 ENVIRONMENTAL SETTING

2.4.1 Geology

The British Geological Survey (BGS) map for the area, Sheet 239 'Hertford' (1:50,000) (Ref. 8.3) and the BGS online geology viewer (Ref. 8.4) show the site and the surrounding land to be underlain by superficial deposits of the Lowestoft Formation (Boulder Clay); this is described as 'chalky till with sands and gravels, silts and clays'.

Outcropping adjacent to the Lowestoft Formation (and possibility underlying it) are superficial deposits of the Dollis Hill Gravel Member (Pebble Gravel), described as 'gravel, sandy and clayey in part, with some laminated silty beds'.

The bedrock geology at depth is the London Clay Formation, this is described as 'blue-grey or grey-brown silty clays and clayey silts'.

The BGS map does not indicate any geological faults on site or in the immediate vicinity.

2.4.2 Hydro-geology

Mapping presented in the Envirocheck Report shows the Lowestoft Formation to be classified as a 'Secondary Undifferentiated' aquifer; the Dollis Hill Gravel Member is classified as a 'Secondary A Aquifer'. The London Clay Formation is shown to be classified as 'Unproductive Strata'.

Secondary Undifferentiated aquifers are soils or rocks that may have previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type. Secondary Aquifers can support water supplies at a local scale and can be a source of base flow to rivers.

The nearest groundwater abstraction, dating from April 2008, relates to groundwater taken for horticultural watering purposes around 400m north east of the site – it is not indicated if this supply is still in use.

2.4.3 Hydrology

There are drains and ditches at field boundaries within 500m of the site. The nearest is around 50m west; these generally all flow to the west. Cuffley Brook is located around 600m west of site, flowing roughly north to south.

Flood mapping indicates the site is not likely to be affected by flooding from rivers; the nearest affected area is located adjacent to Cuffley Brook around 600m west of the site. Mapping shows a few narrow strips forming low-points on the site surface, predominantly in the north and south of the site, to have a low to medium risk of flooding from surface water.

2.4.4 Radon

No Radon measures are indicated as necessary for the site.

2.5 SITE HISTORY

The table below summarises the features on the historic Ordnance Survey maps for the site and surrounding area. Not all maps are described if features are unchanged from one edition to the next. For full details reference should be made to the maps in the Envirocheck report in Appendix B.

Please note the site boundary indicated on the Envirocheck Report (Appendix B) is inaccurate. The boundary extends too far to the north. A truer representation can be found in the Site Location Plan in Appendix A.

MAP DATE & SCALE	ON SITE	SURROUNDING LAND
1873-1881 (1:2,500) & 1882 (1:10,560)	A number of field boundaries are present on site and at the perimeter.	Most of the surrounding land appears to be open fields with generally tree lined boundaries. An area of trees and rough grass is indicated immediately west of site. Cuffley Hill (a road) is located around 35m south of site. The settlement of Goffs Oak, comprising mostly farms, is shown around 450m east of site. Poydon Pits is shown around 650m south east of site [possible brick or gravel pits]. Cuffley Brook is indicated some 600m west of site.
1898 (1:2,500) & 1898-1899 (1:10,560)	The northern and central part of the site now comprises four smaller fields. A 'Nursery' and a 'Pump' are shown to occupy part of the south east corner of site. A group of smaller glazed buildings and a 'Well' are indicated as encroaching over the southern boundary of site.	A 'Nursery' is shown to the south of site. The wooded area to the west is shown extending to Cuffley Hill. Poplars Farm comprising a cluster of small units is indicated to be around 75m north east of site. Additional Nurseries are shown around 85m south and 180m north east of site. A cluster of Old Chalk and Gravel Pits are indicated around 600-850m north west of site.
1913-1914 (1:2,500) & 1916-1921 (1:10,560)	The Nursery buildings in the south east of the site have been extended. The Pump and the central field are no longer shown. Trees are shown on the south of site.	Additional units are shown immediately south of site. The Nurseries indicated 85m south and 180m north east have expanded. A Nursery is also indicated at Lucas End, around 650m north east of site. Enfield Branch Extension railway is shown around 980m west of site.
1935-1938 (1:2,500) & 1938 (1:10,560)	Two additional buildings are shown in the east of the site.	A Nursery is now present immediately west of the site. The wooded area immediately west of site is shown split into smaller areas. Housing development appears to be taking place along Cuffley Hill and on the land immediately east of site. Further Nurseries are shown around 500-950m north of site.
1945 Aerial Photo	The site appears largely unchanged.	Nurseries are shown around 220m south east of site and in the area around 500m-1km east and north east of site. The remaining land appears largely unchanged.
1960 (1:10,000)	Further buildings are indicated along the eastern boundary of site [likely associated with Nursery]. Two small buildings are shown on the centre of site with a track leading south.	Housing has been built on the land within 450m north of site.
1971-1973 (1:2,500) & 1974 (1:10,000)	The buildings occupying the north east of site are identified as a Nursery. The Nursery in the south east is identified as 'Fairmead Nursery'. Tanks are indicated between the two main Nursery buildings. Trees are indicated in the north and west of site. The buildings located in the centre and south of site are no longer shown. The northern boundary of site is defined by a new field boundary.	A handful of small buildings are shown on the land immediately west of site; the Nursery in this area is no longer present. Housing occupies most of the land to the north, east and south of site within 250-500m radius; Nurseries in this area have been replaced by housing. Nurseries occupy most of the land to the north east and east of site between 450m-1km.

MAP DATE & SCALE	ON SITE	SURROUNDING LAND
1988 (1:10,000)	The site appears unchanged.	Much of the land within 500m of site remains unchanged.
1999 Aerial Photo & 1999 (1:10,000)	The central and western fields on site are shown to be covered by trees and scrub. The Nurseries and Tanks in the east are no longer shown; some small units remain in the central eastern area. A field is shown occupying the south east corner.	Much of the land within 500m of site appears unchanged. A large number of Nurseries have been replaced with housing between 500m and 1km east and north east of site.
2018 (1:10,000)	The site appears unchanged.	Much of the land within 500m of site appears unchanged.

Table 1 – Historic Mapping Summary

2.6 ENVIRONMENTAL SETTING

The following summarises the most relevant environmental features of the site and surrounding land – for full details reference should be made to the Envirocheck report in Appendix B.

- No active landfills are located within 1km of the site;
- A historic landfill of relatively small size is indicated around 730m north west of site, at Lucas House farm - license dated January 1997. The waste type accepted is not specified;
- No Waste Management licenses are recorded within 1km of site;
- The site is not in an area associated with coal mining;
- There are two recorded active or historic mineral sites within 500m of site;
- A record of Man-Made Mining Cavities, described as Possible Crown Hole Collapses, is very approximately located around 186m south east of site [this does not match with any other activities or any other records, identifiable on historical maps];
- Historic Opencast extraction of the Dollis Hill Gravel Member at Poplars Farm Pit is indicated around 236m west of site – extraction indicated to have **ceased**.

A number of current and past industries (or industrial features) are recorded in the vicinity – these may have (or have had) the potential to release contaminants – the nearest are:-

- Tanks [for above ground storage?] - around 8m east of site;
- Washing Machine Servicing and Repairs – recorded as 106m north east of site and **active**;
- Commercial Cleaning Services – 157m south west of site and inactive;
- Road Haulage Services – 287m north of site and **active**;
- Laundries and Laundrettes – 398m east of site and **active**;
- Garage Services – 407m east of site and **active**.

The nearest Fuel Station is recorded as 393m east of site.

The site is not indicated to be in close proximity to any Site of Special Scientific Interest (SSSI), Nature Reserve or other similar sensitive land use.

3.0 PROPOSED DEVELOPMENT

A preliminary Site Layout was provided by the client (drawing number SL.01, dated 25/06/18). The development is understood to comprise the following:-

- 60 residential dwellings comprising a mixture of detached, semi-detached, terraced houses and flats;
- New access road leading off Cuffley Hill from the south;
- The properties will have private front and rear gardens;
- The site will include general and private use parking areas;
- Existing trees are shown largely preserved across the site with new tree/shrub and hedge planting proposed along new access roads and in gardens;
- About a quarter of the site in the north will be public open space incorporating a stormwater storage basin.

There would appear no reason to significantly alter site ground levels to facilitate the development although some local regrading will be required.

Based on the properties being built in brick and block cavity walling, loads to foundations will likely be of the order of 25-75kN/m.run for the houses and up to 150kN/m.run for the flats.

4.0 INVESTIGATIONS

4.1 FIELDWORK

From the above desk studies it was concluded that intrusive site investigation works should be undertaken, initially by machine excavated trial pits. These would identify the general geology across the site and allow sampling and testing of near surface soils. Based on the results of initial trial pit investigation the requirement for boreholes could then be determined.

The investigation locations were determined by RGL to give general coverage of the site. The investigations were undertaken in general accordance with BS 5930 (Ref. 8.1).

The most southern segment of site, where the proposed new site access will be located (indicated on the Exploratory Hole Location Layout – Appendix A), was not accessible at the time of our investigation due to the presence of dense vegetation. Access was also restricted in parts of the east of the site due to the presence of the compound and further dense vegetation adjacent to the eastern site boundary.

It should be borne in mind that the ground investigation was undertaken following a period of extended warm weather, and this may have a bearing on the apparent strength of shallow soils and occurrence of desiccation.

On 11 July 2018 eleven trial pits (TP2-TP12) were excavated across the site. Ten of the trial pits were dug to between 2.9m and 3.2m depth; trial pit TP11 in the south east of the site was dug to 400mm depth to investigate topsoil and shallow soils only. The trial pits were formed with a JCB-3CX backhoe excavator under the supervision of an RGL engineer. The pits were logged as excavation proceeded and the holes were backfilled with arisings upon completion. Selected soil samples were recovered for chemical and geotechnical laboratory testing.

Samples for contamination testing were taken of topsoil or any made ground on the basis that any contaminants were likely to be present here resulting from surface release or deposition. Samples were sealed in amber jars supplied by the testing laboratory and kept in 'cool boxes' prior to dispatch to the laboratory.

California Bearing Ratio (CBR) testing was undertaken at 10 locations (CBR01-CBR10) across the site along the routes of the proposed roads. Testing was undertaken by Socotec, a construction materials specialist, by use of an insitu plunger from the back of a 4x4 vehicle. The topsoil or surface soil was excavated to a depth of around 400mm and the test was performed on the underlying strata.

An Exploratory Hole Location Layout is presented in Appendix A. Exploratory hole logs are presented in Appendix C. CBR test results are presented in Appendix D.

4.2 LABORATORY TESTING

Geotechnical laboratory tests were scheduled by RGL on 28 representative soil samples from up to 3.1m depth across the site. The testing was undertaken by Geotechnics, in accordance with BS1377 (Ref. 8.7). Geotechnical tests included:-

- Moisture Content (18 samples);
- Atterberg Limit (18 samples);
- Water Soluble Sulphate (15 samples);
- pH measurement (15 samples).

Chemical laboratory tests were initially scheduled by RGL for 11 selected shallow soil samples (including topsoil and made ground). Chemical analyses for a broad range of determinands were undertaken by Chemtest Ltd, a UKAS (United Kingdom Accreditation Service) accredited laboratory. Chemical testing included:-

- Heavy Metals – Cadmium, Chromium (Total and Hexavalent), Lead, Nickel, Selenium & Mercury;
- Phytotoxic Metals – Copper & Zinc;
- Organic Compounds – Phenols & Soil Organic Matter;
- Speciated Polycyclic Aromatic Hydrocarbons (PAH);
- Total Petroleum Hydrocarbons (TPH);
- Other compounds – Arsenic, Cyanide, Boron & Sulphate;
- Asbestos.

One topsoil sample was tested to topsoil compliance to BS3882:2015 (Ref 8.17).

The results of all the laboratory tests are presented in Appendix E.

5.0 GROUND CONDITIONS

5.1 STRATA ENCOUNTERED

Full details of strata encountered can be found in the Exploratory Hole Logs presented in Appendix C.

5.1.1 Topsoil

The site is generally covered by a dark brown clayey gravelly sand topsoil of between 300mm and 410mm thickness. The gravel was identified as being fine to medium flint and mudstone. Fragments of glass of up to 100mm length were also observed in 7 of 11 trial pits.

5.1.2 Concrete and Made Ground

Concrete strips and pads were observed in the central and eastern parts of the site. The strip immediately adjacent to TP06 in the centre of the site was found to be of 300mm thickness at the edge.

Made ground was found in TP08 in the south east of the site to 620mm depth. This comprised a clayey gravelly sand – gravel included flint, mudstone, brick (whole and fragments), pipe, ash, and glass fragments.

5.1.3 Natural Ground

The natural ground conditions across the site are consistent with the anticipated geology (Lowestoft Formation) based on published mapping. Soils generally comprised sandy gravelly clays and clayey gravelly sands; the sandy soils were generally found towards the southern half of site.

The following localised variable conditions were also encountered on site:-

- Friable clay between 1.3m and 3.0m depth in TP02 in the north west of the site;
- Sand between 2.8m and 3.0m depth in TP05 in the west of the site;
- Dark grey sandy clay between 2.3m to 2.4m depth in TP07 in the east of the site;
- Gravelly sand between 1.4m and 2.9m depth in TP12 in the south of the site.

Soils were generally assessed as firm to stiff where cohesive, or medium dense where granular.

Soil strength was assessed by the resistance to excavation, visual appearance and the short-term stability of trial pits; soils encountered were too friable or granular to enable reliable use of a hand shear vane.

Laboratory testing shows the soils to have a plasticity index in the range 1.5% to 51.5% (when adjusted for granular content); most results were in the range 10-38%.

5.2 GROUNDWATER

During the site investigation fieldwork slight to moderate groundwater flow was encountered in 2 of the 11 trial pits; at 2.8m depth in TP5 in the west of the site, and at 2.85m depth in TP12 in the south of the site. Damp to wet soils were also encountered in:-

- TP09 between 1.5m-2.3m depth;
- TP10 between 2.6m - 3.2m depth;
- TP12 between 2.1m - 2.9m depth.

The groundwater seepages and dampness were generally observed in the predominantly granular soils.

It should be borne in mind however that groundwater levels may vary seasonally and according to prevailing weather conditions and the ground investigation was undertaken following an extended period of dry weather.

6.0 ENGINEERING ASSESSMENT

6.1 SITE CLEARANCE

The proposed redevelopment includes preserving many of the mature trees across the site, however some vegetation including brambles and shrubs will need to be cleared from the east and south of the site. A record should be kept of all cleared vegetation and any removed trees, to assist with foundation design. Care should be taken during all future groundworks to prevent, as far as possible, causing damage to existing trees to remain or their root systems.

Demolition/removal of the compound area in the east of the site is still to be undertaken. The majority of the structures appear temporary/modular however it is not known if they are on concrete bases or foundations. There is a significant proportion of waste and rubbish in this area of the site – a hazardous material survey should be undertaken prior to removal. It should be noted that the metal storage containers were not entered as part of our investigation. Further sampling and testing should be undertaken following the clearing of this area of the site to determine the presence of any made ground and identify if the underlying soils have been contaminated.

Concrete pads and slabs are present in the central and south eastern part of the site – these would appear suitable for crushing and reuse as hardcore.

6.1.1 Topsoil

A number of locations across the site encountered a high proportion of glass within the topsoil. Elevated concentrations of contaminates were also recorded at a number of locations across the site.

One sample of topsoil taken from the central part of the site was tested for topsoil compliance to BS3882 *Specification for topsoil* (Ref 8.17). This shows that the topsoil tested was non-complaint due to insufficient organic matter, high stone content and insufficient available nutrients.

For the above reasons, the topsoil currently present on site would not appear suitable for re-use in private gardens. This is discussed further in Section 7.5 below.

6.2 GROUND STABILITY

The site is only shallowly sloping locally and therefore slope stability is not considered to present problems for development.

The area is not associated with mining.

The exploratory holes did not identify any voids, or especially soft or compressible soils.

It is anticipated that the site will be suitable for normal construction activities without the need for special measures to stabilise the ground – provided that demolition and site clearance is suitably undertaken with all voids appropriately backfilled. It should be noted that the predominantly clay soils may degrade and soften when wet.

6.3 FOUNDATIONS

6.3.1 Traditional Foundations

The sand, gravel and clay soils are considered suitable to provide adequate bearing pressures for conventional trench fill foundations for the low-rise housing proposed.

Plasticity testing shows modified plasticity indices in the range 1.5% to 51.48%; the soils on site should therefore be classified as of '**high**' volume change potential based on NHBC guidance (Ref. 8.10). The foundations should be taken beneath the topsoil, disturbed material or made ground to bear within competent natural ground at a minimum depth of 1.0m.

Additional deepening will be required in proximity to existing trees, trees that will be removed and also proposed trees and shrubs, in order to be beneath soils liable to experience moisture related movements – shrinkage and/or swelling. The basis for such deepening should be NHBC Standards Chapter 4.2 'Building Near Trees' (Ref. 8.10).

In addition, where founding near existing or removed trees and shrubs, foundations should be protected as necessary against the effects of possible heave recovery, by the provision of a compressible liner such as 'claymaster'. Again, guidance is given in NHBC Standards. Note – the Lowestoft Formation can be naturally chalky and dry, and so it will be difficult to differentiate between desiccated and un-desiccated ground. A precautionary approach should be adopted by the foundation designer and clay heave protection measures should not be changed on site without reference to the designer.

Foundations competently designed to the above criteria may adopt a maximum safe bearing pressure of 125kN/m², which will provide an adequate factor of safety against bearing failure and limit total settlements to less than 25mm.

Where mixed foundation formations are encountered (clay and granular soils) there would be no merit in attempting to found any building entirely in one material by attempting, for example, to excavate beneath granular soils where encountered. The above bearing pressure is reasonably conservative, given the soil strengths encountered in the investigation, and the differential settlement that may result from varying soil types will be insignificant. Similarly, there would be no merit in providing reinforcement where formations vary from clay to granular soils.

6.3.2 Special Foundations (Piling)

Because of the presence of trees and shrubs across most of the site and at the boundaries, it is envisaged that all foundations will require significant deepening to the above guidance; where deepening would exceed 2.0-2.5m a piled foundation should be considered.

The site geology is technically suitable for either driven or bored piles; the proximity of existing houses may preclude driven piles because of vibration and noise but a suitable piling specialist should be consulted.

Piles and ground beams will also need to be designed to cater for possible heave recovery of the ground where the ground has been affected by existing or removed trees. Piles will need to be designed to resist any uplift forces; ground beams will require compressible liners beneath them and to inside faces to absorb heave movements. Guidance is given in NHBC Standards (Ref. 8.9).

If a piled foundation solution is adopted further investigation by deep boreholes will be required to facilitate foundation design.

6.4 GROUND FLOOR SLABS

Because of the presence of shrinkable clay and many trees and shrubs, it is recommended that all ground floor slabs are suspended precast concrete. A minimum ventilated void of at least 300mm depth will be required to cater for heave recovery of the ground.

All topsoil or organic matter should be removed under buildings.

The site is not within an area requiring Radon protection measures. There are no plausible sources of hazardous ground gases and therefore no gas protection measures are required to ground floor slabs.

6.5 ROADS AND HARDSTANDINGS

California Bearing Ratio (CBR) testing was undertaken on soils beneath any topsoil at 10 locations across the site – generally along the routes of the proposed roads. Results were in the range 2.7% to 7.4%, with the average of 5.3%. For preliminary design purposes a CBR design value of 3.0% would appear reasonable on natural undisturbed soils.

All topsoil, degradable material and soft soils should be removed from road and hardstanding formations and replaced with suitable well-compacted capping material – all roads and highways works to be in accordance with the recommendations of the Specification for Highway Works (Ref. 8.11).

6.6 EXCAVATIONS AND GROUNDWATER CONTROL

Excavations at the site should generally be readily formed by backhoe excavator. The more granular soils are likely to become unstable quickly (particularly if there is any groundwater in wetter conditions) and excavations should be planned accordingly.

It is essential that all excavation works carried out during construction at the site (and especially any requiring man access) strictly adhere to current legislation & guidance (Refs. 9.5-9.8), including, but not limited to, design, inspections, reporting and provision of appropriate support or other safety measures.

Care should be taken when excavating, especially to depth, in proximity to the trees to remain both on site and close to the boundaries. In general it is less damaging to trees if excavations are not undertaken so as to cut across roots radiating from the tree bowl – in general excavations that are positioned running towards the tree trunk or away from it are preferred. Advice should be taken from a tree specialist.

Groundwater was only encountered at depth in two of the 11 trial pits. It should also be borne in mind that exploratory holes were formed following a period of prolonged dry weather and groundwater conditions can vary seasonally. Perched seepages (in granular layers or at the base of any made ground for example) may result following prolonged periods of wet weather.

6.7 SOAKAWAYS AND DRAINAGE

The trial pits by RGL across the site indicated predominantly clayey soils. The Lowestoft Formation has been demonstrated to be high plasticity and therefore effectively impermeable. The site is not therefore suitable for the adoption of soakaways for the disposal of stormwater.

6.8 CHEMICAL ATTACK ON BURIED CONCRETE

Laboratory testing results taken from topsoil across the site show mildly acidic soils in the range 5.0 to 7.8 with generally low concentrations of soluble sulphates in the range <0.01 g/litre - 0.38g/litre. Testing on natural soils at depth (between 800mm and 2.9m) show mildly acidic soils in the range 4.76 to 7.39 and soluble sulphate in the range 0.02 g/litre - 1.89 g/litre.

From the above, assuming potentially mobile groundwater and that concrete is placed in natural soils, it is considered that buried concrete in accordance with BRE Special Digest 1: 2005 Concrete in Aggressive Ground (Ref. 8.12) should be designed to DS-2 and AC-3z.

7.0 GEO-ENVIRONMENTAL ASSESSMENT

7.1 LEGISLATION AND GUIDANCE

Prior to any development, the Local Planning Authority is required to satisfy itself that the potential for contamination has been properly assessed and that any necessary remedial works will be appropriately incorporated within the development. For any future development, it is the responsibility of the landowner and/or developer to carry out the necessary investigation, assessment and remediation.

Current governmental legislation defines contaminated land in the Environment Act 1995 and Part IIA of the Environmental Protection Act 1990 (Ref. 8.13), as:-

'Any land which appears to the local authority to be in such a condition, by reasons of substances in, on or under the land, that:-

- significant harm is being caused or there is significant possibility of such harm being caused;

Or

- pollution of controlled waters is being, or is likely to be caused'.

Current legislation and guidance recommends the use of source – pathway – receptor linkage model to assess the risk of contamination within a site. These three essential elements are described as:-

Source – a contaminant or hazard which is in, on or under the land and has the potential to cause harm or pollution of controlled waters.
Pathway – means by which a receptor can be exposed to, or affected by, a contaminant or hazard.
Receptor – something that could be adversely affected by a contaminant or hazard e.g. end-users and controlled waters.

A risk can only exist if all three elements are present. For example, even if a contaminant and a receptor are present, they can only create a risk when there is a pathway link between them. The table below (Table 2) represents a Conceptual Site Model with respect to possible contamination presence; it considers plausible pollutant linkages given the site's history, its environmental setting and the initial visual and physical findings of the investigation. This is then used to determine the appropriate chemical testing and risk assessment.

7.2 CONCEPTUAL SITE MODEL

The following table presents a Conceptual Site Model for the site (comments made on the condition of the site were accurate at the time of intrusive investigation works – July 2018):-

CONTAMINATIVE SOURCE	PATHWAY	RECEPTOR(S)	INITIAL RISK ASSESSMENT
Spillages of fuels or oils from vehicles (agricultural plant and Nursery vehicles). Contaminants are likely to be mobile Petroleum Hydrocarbons.	Ingestion, inhalation or direct contact.	Residents, construction personnel	There was no visual evidence of above ground fuel storage tanks currently on site. The Envirocheck report however indicates that 'Tanks' may have been present part way along the eastern boundary between 1971 and 1992. The arrangements for storage and refuelling of machinery and vehicles on site during usage as a Nursery is unknown. The main risk would be chronic exposure to residents in private gardens. Construction personnel would be at less risk due to the short exposure and basic health and safety measures that should be standard practice. The initial risk is assessed as **Moderate.**
	Seepage to depth or leaching to groundwater and flow off site or to surface waters.	Controlled waters.	The Lowestoft Formation underlying the site is classified as a Secondary Undifferentiated aquifer but does not represent a significant resource here – predominantly clay soils were encountered. There was no visual evidence of above ground fuel storage tanks currently on site. The nearest surface water feature is located around 50m west of the site. The initial risk is assessed as **Low to moderate.**
	Direct contact.	Buried services – mainly water supply mains.	Polymer water supply mains can be affected by even low concentrations of hydrocarbons but the effect is tainted water rather than a significant risk to health. The initial risk is assessed as **Low.**
Deposition of wastes at the surface or of burnt wastes or combustion products. Contaminants are likely to be metals, sulphates, asbestos or Polyaromatic Hydrocarbons.	Ingestion, inhalation or direct contact.	Residents, Construction personnel	There is some waste deposited around the container compound and some localised evidence of burning. The main risk would be chronic exposure to residents in private gardens. Construction personnel would be at less risk due to the short exposure and basic health and safety measures that should be standard practice. The initial risk (to residents) is assessed as **Moderate.**
	Leaching to groundwater and flow off site or to surface waters.	Controlled waters.	Groundwater was encountered at around 2.8m below the surface in the Lowestoft Formation. The Lowestoft Formation is classified as a Secondary Undifferentiated aquifer but does not represent a significant resource here. Predominantly clay soils were encountered. The initial risk is assessed as **Low to moderate.**
	Direct contact.	Buried building materials – mainly concrete.	The main risk would appear to be to concrete from potential sulphates. The initial risk is assessed as **Low.**

CONTAMINATIVE SOURCE	PATHWAY	RECEPTOR(S)	INITIAL RISK ASSESSMENT
Landfill gas from degradable buried wastes on site or nearby.	Inhalation and asphyxiation.	Residents, construction personnel	There are no recorded landfills within at least 700m of the site. There is no indication of likely infilled land on site or within the near vicinity and with the potential to generate hazardous gases. The initial risk is assessed as **low.**

Table 2 – Conceptual Site Model

The most significant plausible source-pathway-receptor pollutant linkage is considered to be that of residents (children mainly and to a lesser degree adults) at the site coming into long-term/repeated contact with soils by direct contact or inhalation or ingestion as a result of normal domestic activities in private gardens.

There appears likely to be little risk to controlled waters, construction workers or building materials.

A series of guideline values has been published by the Environment Agency to facilitate assessment of risk of soil contamination in the UK for several types of land use (Ref. 8.14). For residential housing with private gardens these consider 10 potential routes by which site users/occupiers may be exposed to contaminants in soils either directly, as outlined above, and also by consumption of site-grown vegetables. The CLEA Soil Guideline Values (SGVs) have been issued for a restricted range of contaminants however and therefore reference is made to other generally accepted criteria for the assessment of contaminated land.

The Chartered Institute of Environmental Health (CIEH) and Land Quality Management (LQM) have developed a series of Suitable For Use Levels (S4ULs) which identify concentrations of contaminants in soils regarded as posing a negligible risk to human health (Ref. 8.15).

There is no longer a SGV for Lead and no S4UL has been developed to replace the disused criteria. DEFRA has developed a series of Category 4 Screening Levels also for the assessment of risk to human health from contaminated land (Ref. 8.16). The C4SL for Lead represents a more cautious criterion for Lead than the old SGV and although only issued on a provisional basis represents current science.

7.3 ASSESSMENT OF CHEMICAL TEST RESULTS

7.3.1 Assessment of Soil Results

From the above model it was considered appropriate to test near-surface soils for a broad range of contaminants. Chemical analysis in a UKAS accredited laboratory was initially undertaken on 11 soil samples from across the site.

The table below summarises the chemical test results and compares these against SGVs or S4ULs for Residential housing use of the site.

DETERMINAND	CONCENTRATION (mg/kg)		RELEVANT GUIDANCE VALUE* (mg/kg)
	RANGE	AVERAGE	
Arsenic	8.3 - 34	15.8	SGV = 32 S4UL = 37
Boron	0.64 – 1.70	1.08	S4UL = 290
Cadmium	<0.10 – 1.40	<0.457	SGV = 10
Total Chromium	18 - 63	31	S4UL (Cr III) = 910
Chromium VI	All <0.5	All <0.5	S4UL = 6
Copper	8.3 – 96.0	42.4	S4UL = 2400
Lead	60 - 1000	337.6	provC4SL = 82 - 210
Mercury	<0.10 – 0.47	<0.27	SGV = 1.0
Nickel	8.5 - 29	16.5	SGV = 130
Selenium	0.31 – 0.72	0.50	SGV = 350
Zinc	40 - 300	148.8	S4UL = 3700
Cyanide	<0.5 – 0.6	<0.51	NA
Total Petroleum Hydrocarbons (TPH)	<10 - 160	<27.1	NA
Polyaromatic Hydrocarbons (PAH)	<2.0 – 38	<10.5	NA
Benzo[a]pyrene (BaP)	<0.1 - 1.8	<0.58	S4UL = 2.2 (1% soil organic matter)
Phenols	All <0.3	All <0.3	S4UL = 280
Other soil properties:			
Asbestos (8 samples)	None Detected	NA	NA
pH	5.0 – 7.8	6.61	NA
Organic matter (%)	1.9 - 11	5.25	NA
Soluble Sulphate (g/l)	<0.01 - 0.038	<0.015	NA

Table 3 – Chemical Test Results for Typical Contaminants in Soils

NA= Not Available or Not Applicable
* Where different values are indicated dependent on the form of the compound or the nature of the soil the lower value has been used.

From the results presented here and the full set of results presented in Appendix E the following observations can be made:-

- Slightly elevated Arsenic was recorded for a single sample, exceeding the SGV of 34mg/kg however below the S4UL limit of 37mg/kg (TP11 topsoil recorded 34mg/kg);
- The Lead provC4SL upper limit of 210mg/kg was exceeded by 6 of the 11 samples with a maximum recorded value of 1000mg/kg recorded in TP11. The average result also exceeds the provC4SL upper limit – the source of the elevated Lead is unknown;
- Other metals are present at low concentrations;
- Petroleum hydrocarbons are present but at low concentrations;
- Polyaromatic Hydrocarbons are generally below the guidance values for residential use but the residential guidance value for Dibenz(a,h)Anthracene was exceeded in 4 of the 11 samples tested;
- Asbestos was not detected in any samples.

7.4 RECOMMENDATIONS WITH RESPECT TO CONTAMINATION PRESENCE

7.4.1 Remediation Works or Mitigation Measures

Much of the topsoil on site is contaminated with broken glass. Most of the topsoil has elevated Lead and/or Dibenzo(ah)Anthracene – unsuitable for residential gardens.

The topsoil on site is not therefore considered suitable to remain in private gardens. Private gardens will require clean imported topsoil (recommended at least 300mm thick to provide a suitable growing medium).

The existing topsoil may remain in public open spaces provided that it is covered with at least 300mm of clean soils including imported topsoil cover.

The topsoil at the surface should be subject to testing to confirm it is suitable and clean and the placed thickness should be confirmed insitu.

The topsoil should be placed on suitably un-compacted subsoil. Guidance for the placement and storage of topsoil is given by DEFRA (Ref. 8.8).

Further soil sampling and chemical testing is recommended in the area around the compound in the east of the site to determine the presence of any made ground and identify any possible contamination.

7.4.2 General Considerations

The possibility of encountering further 'hotspots' of local contamination cannot be ruled out. Should suspicious material be encountered during the course of the development works (e.g. obvious waste or highly coloured or malodorous materials) they should be reported to RGL immediately for assessment and appropriate action.

7.4.3 Waste Classification

The natural soils (below the topsoil or any made ground) arising from excavation at the site are likely to be classified as inert for disposal purposes. The topsoil and any made ground may be classified as non-hazardous, this should be confirmed by the proposed receiving tip which should be provided with the results of the chemical testing carried out for this report.

7.4.4 Water Supply Pipes

Based on the ground investigation undertaken there would appear no requirement to use special materials for water supply mains. It is essential that this report is supplied to the relevant local water authority for them to assess their specific requirements for water pipe and associated construction materials.

7.4.5 Further Investigation

Additional investigations including chemical testing, are recommended for the area beneath the existing light industrial compound in the east of the site. The investigation should confirm the depth and type of any made ground and determine the presence of any contaminants.

The area in the south of the site that will form the site entrance was not accessible at the time of our investigation due to dense vegetation; it is anticipated that this area of the site is likely to be similar to the ground conditions encountered in the vicinity, however confirmatory investigations may be required to facilitate the design of the new access road and junction.

The clean topsoil required for placement in private gardens will require testing to confirm its suitability and validation of its placed thickness.

8.0 REFERENCES

8.1 British Standard 5930:2015, 'Code of Practice for Site Investigations'.

8.2 Defra & Environment Agency, 'CLR11: The Model Procedures for the Management of Land Contamination' (2004)

8.3 British Geological Survey, Sheet 221 'Hitchin' (1:50,000), 1995.

8.4 British Geological Survey, website: http://mapapps.bgs.ac.uk/geologyofbritain/home.html

8.5 British Standard 1377:1990, Part 2, 'Methods of Test for Soils for Civil Engineering Purposes: Classification Tests'.

8.6 British Standard 1377:1990, Part 9, 'Methods of Test for Soils for Civil Engineering Purposes: In-Situ Tests'.

8.7 British Standard 1377:1990, 'Methods of Test for Soils for Civil Engineering Purposes'.

8.8 Defra, 'Construction Code of Practice for the Sustainable Use of Soils on Construction Sites', 2009.

8.9 National House Building Council, NHBC Standards 2017

8.10 National House Building Council Standards - Chapter 4.2 'Building near trees'.

8.11 Highways Agency, 'Specification for Highway Works', 2014 with latest amendments.

8.12 Building Research Establishment, BRE Special Digest 1:2005 3rd edition, 'Concrete in Aggressive Ground'.

8.13 Defra, 'Environmental Protection Act 1990: Part 2A – Contaminated Land Statutory Guidance', 2012.

8.14 Environment Agency/DEFRA, 2009, Contaminated Land Exposure Assessment.

8.15 Chartered Institute of Environmental Health and Land Quality Management, 'The LQM/CIEH S4ULs for Human Health Risk Assessment', 2015.

8.16 DEFRA, 'Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination', 2014.

8.17 British Standard 3882:2015, 'Specification for Topsoil'.

Appendix E

Surface Water Drainage Calculations

Cascade Summary of Results for East Catchment - Storage 180830.srcx

Upstream Structures	Outflow To	Overflow To
(None)	West Catchment - Storage 181029.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	96.220	0.270	2.0	26.0	O K
30 min Summer	96.273	0.323	2.0	32.6	O K
60 min Summer	96.316	0.366	2.0	38.3	O K
120 min Summer	96.342	0.392	2.0	41.9	O K
180 min Summer	96.344	0.394	2.0	42.3	O K
240 min Summer	96.340	0.390	2.0	41.6	O K
360 min Summer	96.328	0.378	2.0	39.9	O K
480 min Summer	96.313	0.363	2.0	37.9	O K
600 min Summer	96.299	0.349	2.0	36.0	O K
720 min Summer	96.285	0.335	2.0	34.1	O K
960 min Summer	96.256	0.306	2.0	30.4	O K
1440 min Summer	96.201	0.251	2.0	23.8	O K
2160 min Summer	96.128	0.178	2.0	15.8	O K
2880 min Summer	96.073	0.123	1.9	10.3	O K
4320 min Summer	96.005	0.055	1.7	4.3	O K
5760 min Summer	95.976	0.026	1.5	2.0	O K
7200 min Summer	95.963	0.013	1.3	1.0	O K
8640 min Summer	95.954	0.004	1.2	0.3	O K
10080 min Summer	95.950	0.000	1.0	0.0	O K
15 min Winter	96.248	0.298	2.0	29.4	O K
30 min Winter	96.307	0.357	2.0	37.0	O K
60 min Winter	96.356	0.406	2.0	43.9	O K
120 min Winter	96.389	0.439	2.0	48.8	O K
180 min Winter	96.396	0.446	2.0	50.0	O K
240 min Winter	96.394	0.444	2.0	49.5	O K
360 min Winter	96.378	0.428	2.0	47.1	O K
480 min Winter	96.358	0.408	2.0	44.2	O K
600 min Winter	96.337	0.387	2.0	41.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	32.227	0.0	28.5	25
30 min Summer	20.656	0.0	36.6	39
60 min Summer	12.800	0.0	45.3	66
120 min Summer	7.758	0.0	55.0	124
180 min Summer	5.757	0.0	61.3	180
240 min Summer	4.652	0.0	65.9	206
360 min Summer	3.438	0.0	73.1	270
480 min Summer	2.760	0.0	78.3	336
600 min Summer	2.327	0.0	82.6	404
720 min Summer	2.024	0.0	86.1	472
960 min Summer	1.624	0.0	92.2	606
1440 min Summer	1.190	0.0	101.3	864
2160 min Summer	0.873	0.0	111.4	1224
2880 min Summer	0.701	0.0	119.4	1568
4320 min Summer	0.514	0.0	131.3	2252
5760 min Summer	0.413	0.0	140.4	2944
7200 min Summer	0.348	0.0	148.0	3672
8640 min Summer	0.302	0.0	154.5	4400
10080 min Summer	0.269	0.0	160.2	0
15 min Winter	32.227	0.0	32.0	25
30 min Winter	20.656	0.0	41.0	39
60 min Winter	12.800	0.0	50.8	66
120 min Winter	7.758	0.0	61.7	122
180 min Winter	5.757	0.0	68.6	178
240 min Winter	4.652	0.0	73.9	232
360 min Winter	3.438	0.0	81.9	292
480 min Winter	2.760	0.0	87.7	366
600 min Winter	2.327	0.0	92.4	442

Cascade Summary of Results for East Catchment - Storage 180830.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
720 min Winter	96.316	0.366	2.0	38.3	O K
960 min Winter	96.273	0.323	2.0	32.5	O K
1440 min Winter	96.187	0.237	2.0	22.2	O K
2160 min Winter	96.083	0.133	1.9	11.3	O K
2880 min Winter	96.017	0.067	1.8	5.3	O K
4320 min Winter	95.969	0.019	1.4	1.4	O K
5760 min Winter	95.953	0.003	1.1	0.2	O K
7200 min Winter	95.950	0.000	1.0	0.0	O K
8640 min Winter	95.950	0.000	0.8	0.0	O K
10080 min Winter	95.950	0.000	0.8	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
720 min Winter	2.024	0.0	96.4	514
960 min Winter	1.624	0.0	103.2	656
1440 min Winter	1.190	0.0	113.5	916
2160 min Winter	0.873	0.0	124.8	1264
2880 min Winter	0.701	0.0	133.6	1588
4320 min Winter	0.514	0.0	147.1	2232
5760 min Winter	0.413	0.0	157.3	2944
7200 min Winter	0.348	0.0	165.8	0
8640 min Winter	0.302	0.0	173.1	0
10080 min Winter	0.269	0.0	179.5	0

Cascade Rainfall Details for East Catchment - Storage 180830.srcx

Rainfall Model	FSR	Ratio R	0.450	Cv (Winter)	0.840
Return Period (years)	1	Summer Storms	Yes	Shortest Storm (mins)	15
Region	England and Wales	Winter Storms	Yes	Longest Storm (mins)	10080
M5-60 (mm)	20.000	Cv (Summer)	0.750	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.473

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.158	4	8	0.158	8	12	0.158

Cascade Model Details for East Catchment - Storage 180830.srcx

Storage is Online Cover Level (m) 97.500

Tank or Pond Structure

Invert Level (m) 95.950

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	75.0	1.550	467.0

Complex Outflow Control

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0068-2200-1200-2200	Sump Available	Yes
Design Head (m)	1.200	Diameter (mm)	68
Design Flow (l/s)	2.2	Invert Level (m)	95.890
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	100
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

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

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.7	0.800	1.8	2.000	2.8	4.000	3.8	7.000	5.0
0.200	1.9	1.000	2.0	2.200	2.9	4.500	4.0	7.500	5.1
0.300	2.0	1.200	2.2	2.400	3.0	5.000	4.3	8.000	5.3
0.400	2.0	1.400	2.4	2.600	3.1	5.500	4.4	8.500	5.5
0.500	1.9	1.600	2.5	3.000	3.4	6.000	4.6	9.000	5.6
0.600	1.6	1.800	2.6	3.500	3.6	6.500	4.8	9.500	5.8

Orifice

Diameter (m) 0.120 Discharge Coefficient 0.600 Invert Level (m) 97.040

Cascade Summary of Results for East Catchment - Storage 180830.srcx

Upstream Structures	Outflow To	Overflow To
(None)	West Catchment - Storage 181029.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	96.778	0.828	2.0	124.9	O K
30 min Summer	96.912	0.962	2.0	159.8	O K
60 min Summer	97.025	1.075	2.1	193.1	O K
120 min Summer	97.109	1.159	4.7	220.2	O K
180 min Summer	97.131	1.181	6.0	228.0	O K
240 min Summer	97.135	1.185	6.2	229.3	O K
360 min Summer	97.132	1.182	6.0	228.0	O K
480 min Summer	97.129	1.179	5.9	227.0	O K
600 min Summer	97.125	1.175	5.6	225.7	O K
720 min Summer	97.120	1.170	5.4	224.1	O K
960 min Summer	97.110	1.160	4.8	220.7	O K
1440 min Summer	97.090	1.140	3.5	214.0	O K
2160 min Summer	97.057	1.107	2.3	203.3	O K
2880 min Summer	97.008	1.058	2.1	188.0	O K
4320 min Summer	96.912	0.962	2.0	159.8	O K
5760 min Summer	96.819	0.869	2.0	135.0	O K
7200 min Summer	96.728	0.778	2.0	113.1	O K
8640 min Summer	96.638	0.688	2.0	93.4	O K
10080 min Summer	96.542	0.592	2.0	74.5	O K
15 min Winter	96.839	0.889	2.0	140.2	O K
30 min Winter	96.980	1.030	2.1	179.5	O K
60 min Winter	97.097	1.147	3.8	216.3	O K
120 min Winter	97.168	1.218	8.8	240.9	O K
180 min Winter	97.183	1.233	10.0	246.2	O K
240 min Winter	97.184	1.234	10.1	246.4	O K
360 min Winter	97.185	1.235	10.2	246.7	O K
480 min Winter	97.181	1.231	9.9	245.4	O K
600 min Winter	97.175	1.225	9.4	243.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	143.954	0.0	127.7	27
30 min Summer	92.629	0.0	160.4	41
60 min Summer	56.713	0.0	201.3	70
120 min Summer	33.583	0.0	238.2	126
180 min Summer	24.424	0.0	259.9	182
240 min Summer	19.389	0.0	275.2	240
360 min Summer	13.924	0.0	296.3	300
480 min Summer	11.018	0.0	312.7	364
600 min Summer	9.182	0.0	325.8	432
720 min Summer	7.908	0.0	336.7	504
960 min Summer	6.245	0.0	354.5	654
1440 min Summer	4.471	0.0	347.3	976
2160 min Summer	3.197	0.0	408.4	1476
2880 min Summer	2.518	0.0	428.8	1908
4320 min Summer	1.796	0.0	458.9	2728
5760 min Summer	1.413	0.0	481.1	3520
7200 min Summer	1.172	0.0	499.0	4328
8640 min Summer	1.006	0.0	513.9	5104
10080 min Summer	0.884	0.0	526.6	5856
15 min Winter	143.954	0.0	142.9	26
30 min Winter	92.629	0.0	162.1	41
60 min Winter	56.713	0.0	225.3	68
120 min Winter	33.583	0.0	266.8	122
180 min Winter	24.424	0.0	291.1	174
240 min Winter	19.389	0.0	308.2	200
360 min Winter	13.924	0.0	332.0	274
480 min Winter	11.018	0.0	350.2	350
600 min Winter	9.182	0.0	364.8	426

Cascade Summary of Results for East Catchment - Storage 180830.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
720 min Winter	97.168	1.218	8.8	240.9	O K
960 min Winter	97.155	1.205	7.7	236.1	O K
1440 min Winter	97.130	1.180	6.0	227.6	O K
2160 min Winter	97.102	1.152	4.2	218.0	O K
2880 min Winter	97.076	1.126	2.8	209.4	O K
4320 min Winter	96.962	1.012	2.1	174.1	O K
5760 min Winter	96.831	0.881	2.0	138.0	O K
7200 min Winter	96.697	0.747	2.0	106.1	O K
8640 min Winter	96.545	0.595	2.0	75.1	O K
10080 min Winter	96.311	0.361	2.0	37.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
720 min Winter	7.908	0.0	377.0	500
960 min Winter	6.245	0.0	397.0	654
1440 min Winter	4.471	0.0	390.3	962
2160 min Winter	3.197	0.0	457.1	1448
2880 min Winter	2.518	0.0	480.3	1988
4320 min Winter	1.796	0.0	513.9	2948
5760 min Winter	1.413	0.0	538.6	3808
7200 min Winter	1.172	0.0	558.8	4616
8640 min Winter	1.006	0.0	575.5	5456
10080 min Winter	0.884	0.0	589.9	5856

Cascade Rainfall Details for East Catchment - Storage 180830.srcx

Rainfall Model	FSR	Ratio R	0.450	Cv (Winter)	0.840
Return Period (years)	100	Summer Storms	Yes	Shortest Storm (mins)	15
Region	England and Wales	Winter Storms	Yes	Longest Storm (mins)	10080
M5-60 (mm)	20.000	Cv (Summer)	0.750	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.473

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.158	4	8	0.158	8	12	0.158

Cascade Model Details for East Catchment - Storage 180830.srcx

Storage is Online Cover Level (m) 97.500

Tank or Pond Structure

Invert Level (m) 95.950

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	75.0	1.550	467.0

Complex Outflow Control

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0068-2200-1200-2200	Sump Available	Yes
Design Head (m)	1.200	Diameter (mm)	68
Design Flow (l/s)	2.2	Invert Level (m)	95.890
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	100
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

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

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.7	0.800	1.8	2.000	2.8	4.000	3.8	7.000	5.0
0.200	1.9	1.000	2.0	2.200	2.9	4.500	4.0	7.500	5.1
0.300	2.0	1.200	2.2	2.400	3.0	5.000	4.3	8.000	5.3
0.400	2.0	1.400	2.4	2.600	3.1	5.500	4.4	8.500	5.5
0.500	1.9	1.600	2.5	3.000	3.4	6.000	4.6	9.000	5.6
0.600	1.6	1.800	2.6	3.500	3.6	6.500	4.8	9.500	5.8

Orifice

Diameter (m) 0.120 Discharge Coefficient 0.600 Invert Level (m) 97.040

Cascade Summary of Results for West Catchment - Storage 181029.srcx

Upstream Structures	Outflow To	Overflow To
East Catchment - Storage 180830.srcx	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	91.717	0.217	3.3	47.8	O K
30 min Summer	91.771	0.271	3.3	60.9	O K
60 min Summer	91.825	0.325	3.3	74.6	O K
120 min Summer	91.875	0.375	3.3	88.0	O K
180 min Summer	91.900	0.400	3.3	95.0	O K
240 min Summer	91.916	0.416	3.3	99.2	O K
360 min Summer	91.930	0.430	3.3	103.2	O K
480 min Summer	91.932	0.432	3.3	103.8	O K
600 min Summer	91.930	0.430	3.3	103.1	O K
720 min Summer	91.925	0.425	3.3	101.8	O K
960 min Summer	91.916	0.416	3.3	99.3	O K
1440 min Summer	91.898	0.398	3.3	94.3	O K
2160 min Summer	91.866	0.366	3.3	85.7	O K
2880 min Summer	91.819	0.319	3.3	73.1	O K
4320 min Summer	91.713	0.213	3.3	46.8	O K
5760 min Summer	91.634	0.134	3.3	28.3	O K
7200 min Summer	91.589	0.089	3.3	18.5	O K
8640 min Summer	91.572	0.072	3.0	14.8	O K
10080 min Summer	91.562	0.062	2.8	12.8	O K
15 min Winter	91.741	0.241	3.3	53.6	O K
30 min Winter	91.801	0.301	3.3	68.4	O K
60 min Winter	91.860	0.360	3.3	83.8	O K
120 min Winter	91.914	0.414	3.3	98.8	O K
180 min Winter	91.943	0.443	3.3	106.9	O K
240 min Winter	91.960	0.460	3.3	111.9	O K
360 min Winter	91.979	0.479	3.3	117.3	O K
480 min Winter	91.984	0.484	3.3	118.7	O K
600 min Winter	91.983	0.483	3.3	118.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	32.227	0.0	77.3	26
30 min Summer	20.656	0.0	99.1	41
60 min Summer	12.800	0.0	122.8	70
120 min Summer	7.758	0.0	148.9	128
180 min Summer	5.757	0.0	165.8	188
240 min Summer	4.652	0.0	178.6	246
360 min Summer	3.438	0.0	198.0	364
480 min Summer	2.760	0.0	212.0	482
600 min Summer	2.327	0.0	223.4	600
720 min Summer	2.024	0.0	233.1	690
960 min Summer	1.624	0.0	249.5	808
1440 min Summer	1.190	0.0	274.3	1062
2160 min Summer	0.873	0.0	301.8	1456
2880 min Summer	0.701	0.0	323.2	1824
4320 min Summer	0.514	0.0	355.6	2472
5760 min Summer	0.413	0.0	380.3	3120
7200 min Summer	0.348	0.0	400.8	3752
8640 min Summer	0.302	0.0	418.4	4416
10080 min Summer	0.269	0.0	433.9	5144
15 min Winter	32.227	0.0	86.6	26
30 min Winter	20.656	0.0	111.0	40
60 min Winter	12.800	0.0	137.5	70
120 min Winter	7.758	0.0	166.8	126
180 min Winter	5.757	0.0	185.8	184
240 min Winter	4.652	0.0	200.1	242
360 min Winter	3.438	0.0	221.8	356
480 min Winter	2.760	0.0	237.5	468
600 min Winter	2.327	0.0	250.2	580

Cascade Summary of Results for West Catchment - Storage 181029.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
720 min Winter	91.979	0.479	3.3	117.4	O K
960 min Winter	91.968	0.468	3.3	114.1	O K
1440 min Winter	91.944	0.444	3.3	107.3	O K
2160 min Winter	91.892	0.392	3.3	92.6	O K
2880 min Winter	91.800	0.300	3.3	68.2	O K
4320 min Winter	91.632	0.132	3.3	28.0	O K
5760 min Winter	91.573	0.073	3.1	15.0	O K
7200 min Winter	91.557	0.057	2.6	11.8	O K
8640 min Winter	91.548	0.048	2.3	9.8	O K
10080 min Winter	91.542	0.042	2.0	8.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
720 min Winter	2.024	0.0	261.1	688
960 min Winter	1.624	0.0	279.4	884
1440 min Winter	1.190	0.0	307.3	1110
2160 min Winter	0.873	0.0	338.0	1540
2880 min Winter	0.701	0.0	362.0	1884
4320 min Winter	0.514	0.0	398.3	2472
5760 min Winter	0.413	0.0	426.0	3000
7200 min Winter	0.348	0.0	448.9	3688
8640 min Winter	0.302	0.0	468.6	4408
10080 min Winter	0.269	0.0	486.0	5072

Cascade Rainfall Details for West Catchment - Storage 181029.srcx

Rainfall Model	FSR	Ratio R	0.450	Cv (Winter)	0.840
Return Period (years)	1	Summer Storms	Yes	Shortest Storm (mins)	15
Region	England and Wales	Winter Storms	Yes	Longest Storm (mins)	10080
M5-60 (mm)	20.000	Cv (Summer)	0.750	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.808

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.269	4	8	0.269	8	12	0.269

Cascade Model Details for West Catchment - Storage 181029.srcx

Storage is Online Cover Level (m) 93.300

Tank or Pond Structure

Invert Level (m) 91.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	200.0	1.800	640.0

Complex Outflow Control

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0094-3300-0500-3300	Sump Available	Yes
Design Head (m)	0.500	Diameter (mm)	94
Design Flow (l/s)	3.3	Invert Level (m)	91.470
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	150
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.500	3.3	Kick-Flo®	0.359	2.8
Flush-Flo™	0.160	3.3	Mean Flow over Head Range	-	2.8

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.0	0.800	4.1	2.000	6.3	4.000	8.7	7.000	11.4
0.200	3.3	1.000	4.5	2.200	6.6	4.500	9.2	7.500	11.8
0.300	3.1	1.200	4.9	2.400	6.8	5.000	9.7	8.000	12.2
0.400	3.0	1.400	5.3	2.600	7.1	5.500	10.1	8.500	12.6
0.500	3.3	1.600	5.7	3.000	7.6	6.000	10.6	9.000	13.0
0.600	3.6	1.800	6.0	3.500	8.2	6.500	11.0	9.500	13.3

Orifice

Diameter (m) 0.058 Discharge Coefficient 0.600 Invert Level (m) 91.980

Cascade Summary of Results for West Catchment - Storage 181029.srcx

Upstream Structures	Outflow To	Overflow To
East Catchment - Storage 180830.srcx	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	92.276	0.776	7.7	213.9	O K
30 min Summer	92.430	0.930	9.0	272.2	O K
60 min Summer	92.562	1.062	10.0	326.6	O K
120 min Summer	92.671	1.171	10.7	374.9	O K
180 min Summer	92.726	1.226	11.0	400.4	O K
240 min Summer	92.755	1.255	11.2	414.5	O K
360 min Summer	92.774	1.274	11.3	423.7	O K
480 min Summer	92.769	1.269	11.2	421.1	O K
600 min Summer	92.757	1.257	11.2	415.3	O K
720 min Summer	92.743	1.243	11.1	408.8	O K
960 min Summer	92.713	1.213	10.9	394.3	O K
1440 min Summer	92.644	1.144	10.5	362.7	O K
2160 min Summer	92.554	1.054	9.9	323.2	O K
2880 min Summer	92.481	0.981	9.4	292.6	O K
4320 min Summer	92.371	0.871	8.5	249.0	O K
5760 min Summer	92.289	0.789	7.9	218.8	O K
7200 min Summer	92.228	0.728	7.3	197.1	O K
8640 min Summer	92.183	0.683	6.8	181.5	O K
10080 min Summer	92.152	0.652	6.5	171.3	O K
15 min Winter	92.346	0.846	8.3	239.6	O K
30 min Winter	92.512	1.012	9.6	305.3	O K
60 min Winter	92.655	1.155	10.6	367.8	O K
120 min Winter	92.789	1.289	11.4	431.0	O K
180 min Winter	92.859	1.359	11.8	465.9	O K
240 min Winter	92.899	1.399	12.0	486.5	O K
360 min Winter	92.932	1.432	12.2	503.8	O K
480 min Winter	92.936	1.436	12.2	506.0	O K
600 min Winter	92.923	1.423	12.1	498.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	143.954	0.0	331.4	26
30 min Summer	92.629	0.0	382.3	40
60 min Summer	56.713	0.0	544.9	70
120 min Summer	33.583	0.0	645.1	128
180 min Summer	24.424	0.0	703.8	188
240 min Summer	19.389	0.0	745.1	246
360 min Summer	13.924	0.0	802.5	362
480 min Summer	11.018	0.0	846.7	464
600 min Summer	9.182	0.0	882.1	516
720 min Summer	7.908	0.0	911.5	574
960 min Summer	6.245	0.0	942.7	694
1440 min Summer	4.471	0.0	945.0	942
2160 min Summer	3.197	0.0	1105.6	1324
2880 min Summer	2.518	0.0	1161.0	1712
4320 min Summer	1.796	0.0	1242.5	2468
5760 min Summer	1.413	0.0	1302.8	3184
7200 min Summer	1.172	0.0	1351.2	3896
8640 min Summer	1.006	0.0	1391.4	4592
10080 min Summer	0.884	0.0	1426.2	5344
15 min Winter	143.954	0.0	352.2	26
30 min Winter	92.629	0.0	412.6	40
60 min Winter	56.713	0.0	610.2	68
120 min Winter	33.583	0.0	722.7	128
180 min Winter	24.424	0.0	788.4	186
240 min Winter	19.389	0.0	834.6	244
360 min Winter	13.924	0.0	899.0	358
480 min Winter	11.018	0.0	948.3	468
600 min Winter	9.182	0.0	987.9	570

Cascade Summary of Results for West Catchment - Storage 181029.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
720 min Winter	92.902	1.402	12.0	487.7	O K
960 min Winter	92.862	1.362	11.8	467.6	O K
1440 min Winter	92.771	1.271	11.3	421.9	O K
2160 min Winter	92.621	1.121	10.3	352.2	O K
2880 min Winter	92.496	0.996	9.5	299.0	O K
4320 min Winter	92.349	0.849	8.4	240.9	O K
5760 min Winter	92.247	0.747	7.5	203.6	O K
7200 min Winter	92.177	0.677	6.7	179.7	O K
8640 min Winter	92.139	0.639	6.3	167.1	O K
10080 min Winter	92.108	0.608	5.9	157.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
720 min Winter	7.908	0.0	1017.8	644
960 min Winter	6.245	0.0	1043.5	758
1440 min Winter	4.471	0.0	1054.5	1056
2160 min Winter	3.197	0.0	1238.2	1480
2880 min Winter	2.518	0.0	1300.4	1820
4320 min Winter	1.796	0.0	1391.7	2592
5760 min Winter	1.413	0.0	1459.0	3296
7200 min Winter	1.172	0.0	1513.2	3968
8640 min Winter	1.006	0.0	1558.5	4672
10080 min Winter	0.884	0.0	1597.5	5448

Cascade Rainfall Details for West Catchment - Storage 181029.srcx

Rainfall Model	FSR	Ratio R	0.450	Cv (Winter)	0.840
Return Period (years)	100	Summer Storms	Yes	Shortest Storm (mins)	15
Region	England and Wales	Winter Storms	Yes	Longest Storm (mins)	10080
M5-60 (mm)	20.000	Cv (Summer)	0.750	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.808

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.269	4	8	0.269	8	12	0.269

Cascade Model Details for West Catchment - Storage 181029.srcx

Storage is Online Cover Level (m) 93.300

Tank or Pond Structure

Invert Level (m) 91.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	200.0	1.800	640.0

Complex Outflow Control

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0094-3300-0500-3300	Sump Available	Yes
Design Head (m)	0.500	Diameter (mm)	94
Design Flow (l/s)	3.3	Invert Level (m)	91.470
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	150
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.500	3.3	Kick-Flo®	0.359	2.8
Flush-Flo™	0.160	3.3	Mean Flow over Head Range	-	2.8

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.0	0.800	4.1	2.000	6.3	4.000	8.7	7.000	11.4
0.200	3.3	1.000	4.5	2.200	6.6	4.500	9.2	7.500	11.8
0.300	3.1	1.200	4.9	2.400	6.8	5.000	9.7	8.000	12.2
0.400	3.0	1.400	5.3	2.600	7.1	5.500	10.1	8.500	12.6
0.500	3.3	1.600	5.7	3.000	7.6	6.000	10.6	9.000	13.0
0.600	3.6	1.800	6.0	3.500	8.2	6.500	11.0	9.500	13.3

Orifice

Diameter (m) 0.058 Discharge Coefficient 0.600 Invert Level (m) 91.980

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.450
Area (ha)	0.920	Urban	0.000
SAAR (mm)	675	Region Number	Region 6

Results	**l/s**
QBAR Rural	3.9
QBAR Urban	3.9
Q100 years	12.4
Q1 year	3.3
Q30 years	8.8
Q100 years	12.4

Appendix F

Drainage Strategy

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE RELEVANT SPECIFICATION AND ALL OTHER RELATED DRAWINGS ISSUED BY THE ENGINEER.
2. DO NOT SCALE FROM THIS DRAWING. WORK FROM FIGURED DIMENSIONS ONLY.
3. ALL DIMENSIONS SHOWN ON THIS DRAWING ARE IN METERS UNLESS OTHERWISE STATED.
4. ALL DIMENSIONS, LEVEL AND SURVEY GRID CO-ORDINATES ARE TO BE CHECKED ON SITE AND THE ENGINEER NOTIFIED IMMEDIATELY OF ANY DISCREPANCIES PRIOR TO THE COMMENCEMENT OF WORKS.
5. NO DEVIATION FROM THE DETAILS SHOWN ON THIS DRAWING IS PERMITTED WITHOUT PRIOR PERMISSION FROM THE ENGINEER.
6. ANY WORKS OUTSIDE RED SITE BOUNDARY ARE FOR INFORMATION PURPOSES ONLY. UNLESS SPECIFICALLY NOTED, ALL WORKS OUTSIDE THE SITE BOUNDARY WILL BE UNDERTAKEN BY OTHERS UNDER A SEPARATE.
7. ALL EXISTING SERVICE ROUTES HAVE BEEN TRANSCRIBED FROM THE RESPECTIVE UNDERTAKERS RECORDS AND AS SUCH NO RESPONSIBILITY IS ACCEPTED BY ARDENT CONSULTING ENGINEERS FOR THE ACCURACY OF ROUTES SHOWN.
8. THE AVOIDANCE AND PROTECTION OF SERVICES DURING THE WORKS IS THE RESPONSIBILITY OF THE CONTRACTOR.
9. THE CONTRACTOR IS REMINDED OF HIS OBLIGATION TO VERIFY THE ROUTE OF ALL SERVICES ON SITE PRIOR TO THE COMMENCEMENT OF THE WORKS.
10. THE CONTRACTOR SHOULD ALLOW FOR ANY NECESSARY LIAISON WITH THE STATUTORY UTILITIES DURING THE COURSE OF THE WORKS TO AVOID ANY DISRUPTION TO RETAINED SERVICES.
11. THE CONTRACTOR SHOULD NOTE THAT THE SERVICES SHOWN ARE NOT TO BE CONSIDERED EXHAUSTIVE. PRIVATE SERVICES MAY BE PRESENT WITHIN THE LIMIT OF WORKS AND CARE SHOULD BE TAKEN TO LOCATE AND AVOID THESE DURING CONSTRUCTION.
12. TREES SURVEY INFORMATION HAS BEEN TAKEN FROM TRACEY CLARKE TREE CONSULTANCY DRAWING DATED MARCH 2021 DRAWING REF. TCTC-18023-PL-01

Rev	Description	Drn	Chk	App	Date
PL3	SITE LAYOUT UPDATED	CI	AW	BB	26.07.21
PL2	EXCEEDANCE ROUTES ADDED	AW	AW	BB	15.07.21
PL1	ISSUED FOR PLANNING	BT	AW	BB	30.06.21

ARDENT CONSULTING ENGINEERS
Third Floor
The Hallmark Building
52-56 Leadenhall Street
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Tel: 020 7680 4088
Web: www.ardent-ce.co.uk
E-mail: enquiries@ardent-ce.co.uk

Client
COUNTRYSIDE PROPERTIES (UK) Ltd

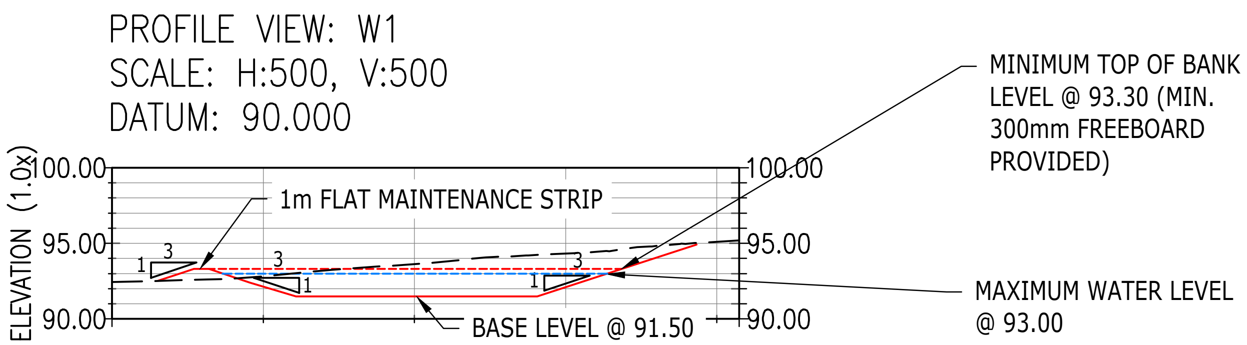
Project Title:
CUFFLEY HILL, GOFFS OAKS

Drawing Title:
PROPOSED DRAINAGE STRATEGY

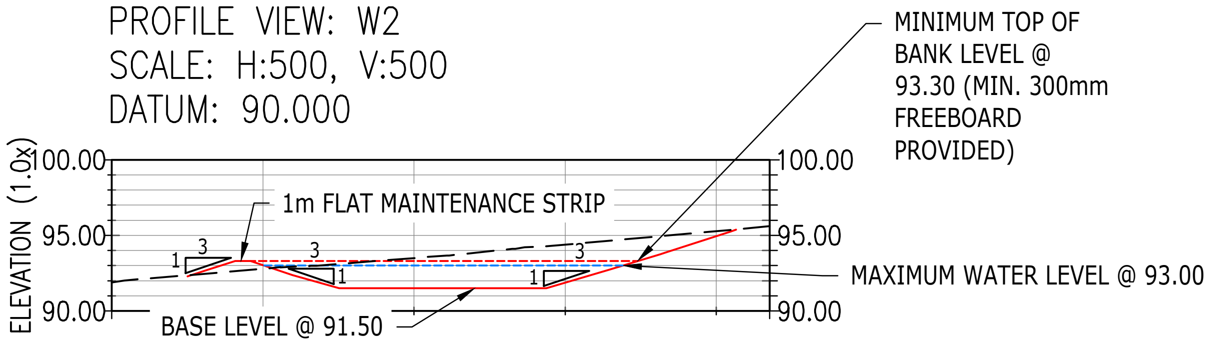
A1 Scale	Date	Designed by
1:500	MARCH 2021	AW
Drawn by	Checked by	Approved by
AW	AW	BB

Drawing Number: C00185-ACE-IG-XX-DR-C-P100 — Rev PL3

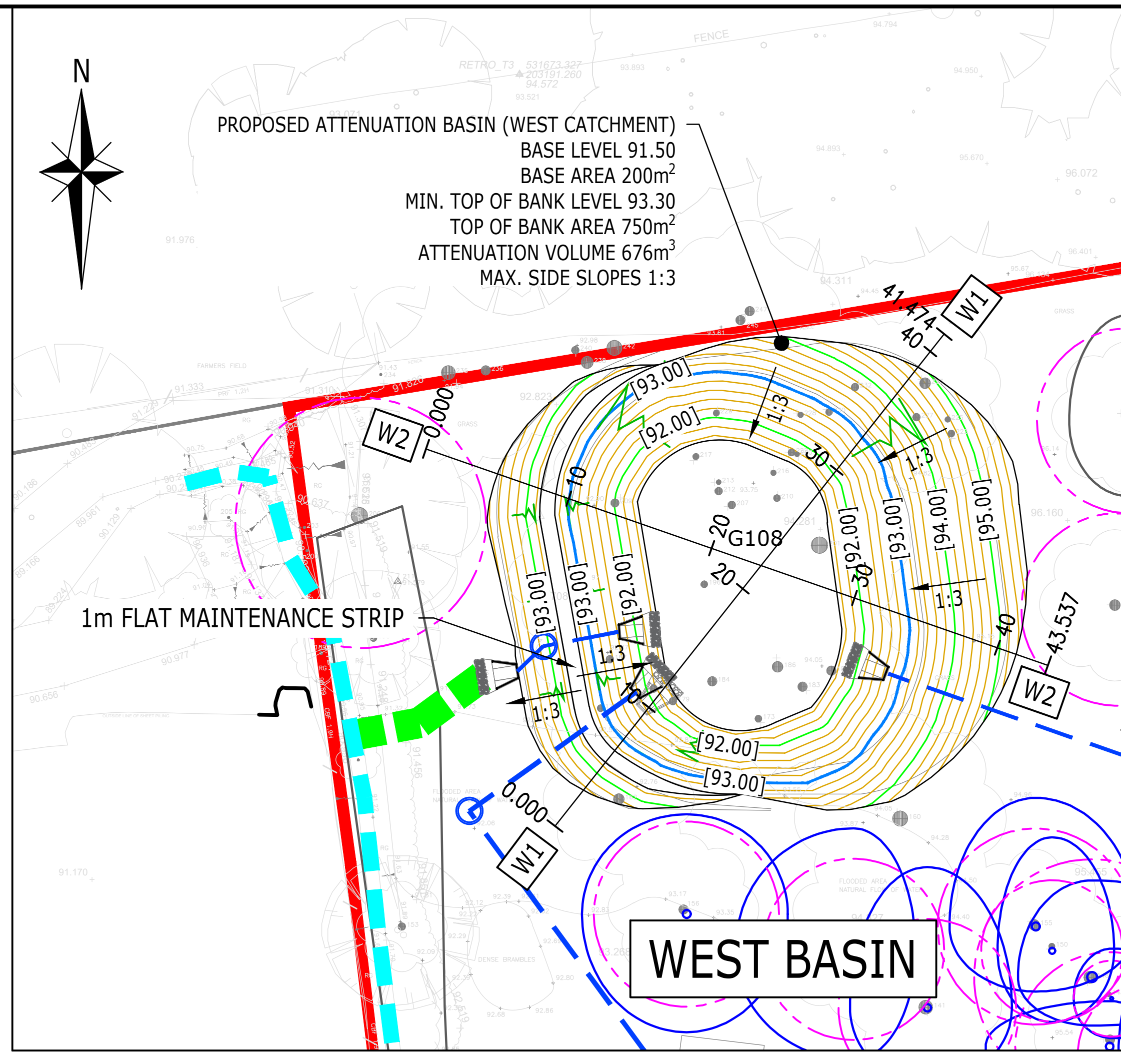
File Location: y:\ardent projects\...\cuffley hill, goffs oak (planning application)\technical\acad\drawings\c00185-ace-ig-xx-dr-c-p100 proposed drainage strategy.dwg



CHAINAGE	0.000	10.000	20.000	30.000	40.000	41.474
EXISTING LEVELS	92.435	92.824	93.634	94.322	95.108	95.200
HOR FINISHED LEVELS VER		92.135	91.500	92.108		



CHAINAGE	0.000	10.000	20.000	30.000	40.000	43.537
EXISTING LEVELS	91.894	92.787	93.501	94.394	95.279	95.610
HOR FINISHED LEVELS VER		93.032	91.500	91.872	94.948	



SECTIONS KEY
- EXISTING SURFACE
- PROPOSED BASIN
- MAXIMUM WATER LEVEL
- MINIMUM TOP OF BANK

KEY
- MAJOR (1.0m) CONTOUR
- MINOR (0.2m) CONTOUR
- SITE BOUNDARY
- MAXIMUM WATER LEVEL
- ROOT PROTECTION AREA
- EXISTING DITCH
- PROPOSED SURFACE WATER SEWER & MANHOLE
- PROPOSED HEADWALL
- PROPOSED SWALE

0m 5m 25m

Scale: 1:500 @ A3

NOT FOR CONSTRUCTION

FOR PLANNING

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CDM NOTES

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6. THE CONTRACTOR MUST ENSURE ALL WORKING AREAS ARE FULLY SECURE.

Rev	Description	Drn	Chk	App	Date
PL1	ISSUED FOR PLANNING	BT	AW	BB	30.06.21

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Tel: 020 7680 4088
Web: www.ardent-ce.co.uk
E-mail: enquiries@ardent-ce.co.uk

Client
COUNTRYSIDE PROPOERTIES (UK) Ltd

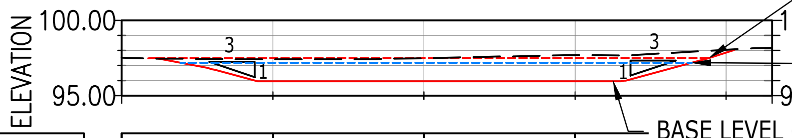
Project Title:
CUFFLEY HILL, GOFFS OAK

Drawing Title:
ATTENUATION BASIN SECTIONS (SHEET 1 OF 2)

A3 Scale	Date	Designed by
1:500	JUNE 2021	AW
Drawn by	Checked by	Approved by
AW	AW	BB

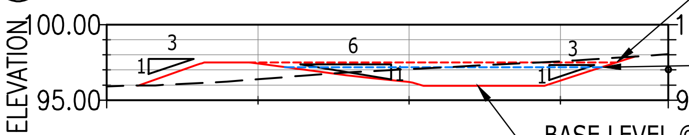
Drawing Number: C00185-ACE-IG-XX-DR-C-P020 Rev PL1

PROFILE VIEW: E1
SCALE: H:500, V:500
DATUM: 95.000

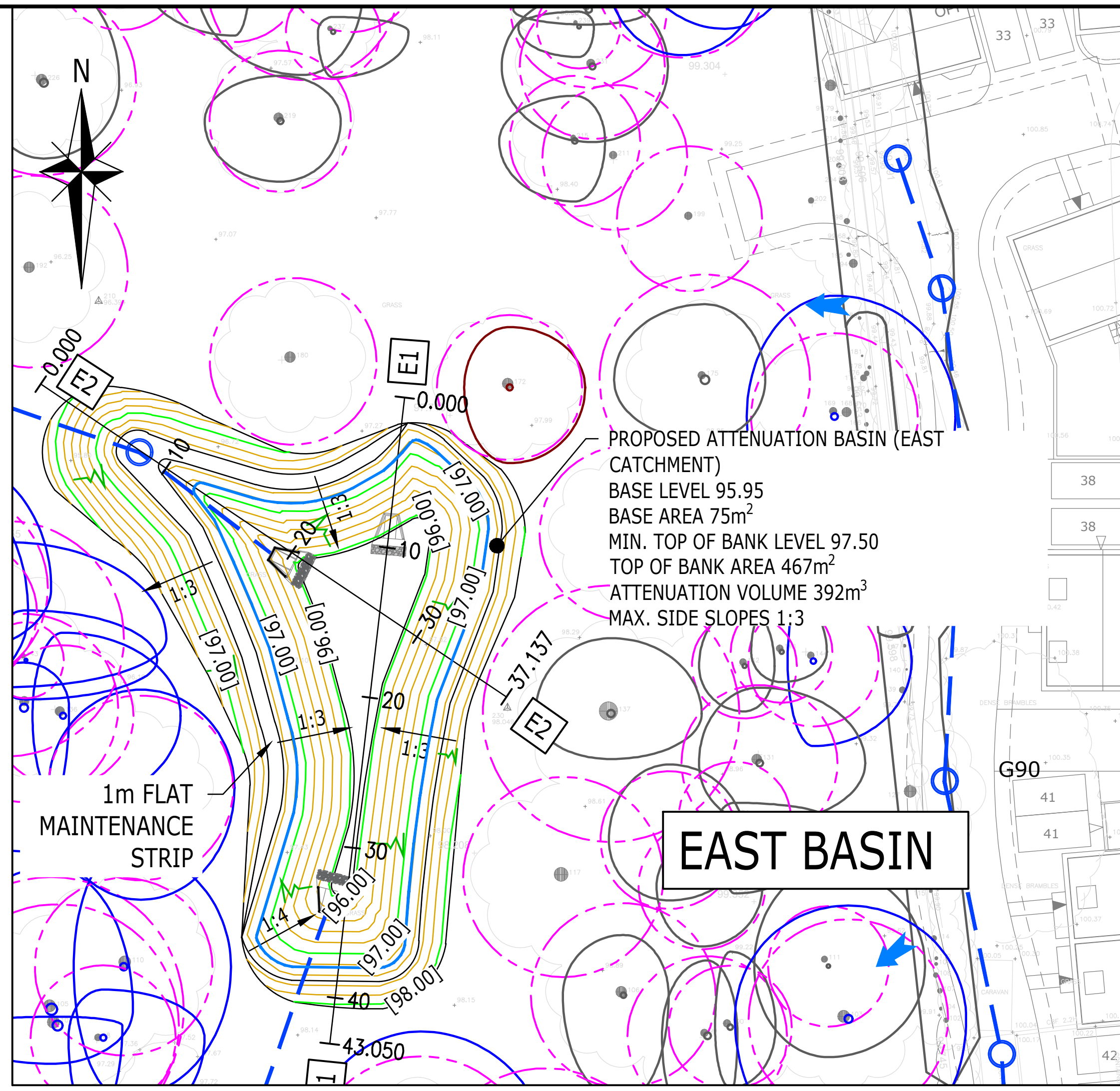


CHAINAGE	0.000	10.000	20.000	30.000	40.000	43.050
EXISTING LEVELS	97.524	97.415	97.488	97.681	98.037	98.167
HOR FINISHED LEVELS VER		95.950	95.950	95.950	97.863	

PROFILE VIEW: E2
SCALE: H:500, V:500
DATUM: 95.000



CHAINAGE	0.000	10.000	20.000	30.000	37.137
EXISTING LEVELS	95.901	96.383	97.049	97.572	98.041
HOR FINISHED LEVELS VER		97.423	96.196	96.291	



SECTIONS KEY
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- PROPOSED BASIN
- MAXIMUM WATER LEVEL
- MINIMUM TOP OF BANK

KEY
- MAJOR (1.0m) CONTOUR
- MINOR (0.2m) CONTOUR
- SITE BOUNDARY
- MAXIMUM WATER LEVEL
- ROOT PROTECTION AREA
- EXISTING DITCH
- PROPOSED SURFACE WATER SEWER & MANHOLE
- PROPOSED HEADWALL

0m 5m 25m

Scale: 1:500 @ A3

NOT FOR CONSTRUCTION

FOR PLANNING

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Rev	Description	Drn	Chk	App	Date
PL1	ISSUED FOR PLANNING	BT	AW	BB	30.06.21

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E-mail: enquiries@ardent-ce.co.uk

worksafe consultant www.smasltd.com SSIP

Client: COUNTRYSIDE PROPOERTIES (UK) Ltd

Project Title: CUFFLEY HILL, GOFFS OAK

Drawing Title: ATTENUATION BASIN SECTIONS (SHEET 2 OF 2)

A3 Scale	Date	Designed by
1:500	JUNE 2021	AW
Drawn by	**Checked by**	**Approved by**
AW	AW	BB

Drawing Number: C00185-ACE-IG-XX-DR-C-P021 Rev PL1

Appendix G

SuDS Treatment Methods

Pollution hazard indices for different land use classifications (land use shaded grey applicable for the development)

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydrocarbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, home zones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (e.g. hospitals, retail), all roads except low traffic roads and trunk roads/motorways	Medium	0.7	0.6	0.7
Sites with heavy pollution (e.g. haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways	High	0.8	0.8	0.9

Indicative SuDS mitigation indices for discharges to surface waters (SuDS components shaded grey applicable to this development)

	Mitigation indices		
Type of SuDS component	**TSS**	**Metals**	**Hydrocarbons**
Filter strip	0.4	0.4	0.5
Filter drain	0.4	0.4	0.4
Swale	0.5	0.6	0.6
Bio retention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond	0.7	0.7	0.5
Wetland	0.8	0.8	0.8
Proprietary treatment systems	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

Indicative SuDS mitigation indices for discharges to groundwater

(SuDS components shaded grey applicable to this development)

	Mitigation indices		
Characteristic of the material overlying the proposed infiltration surface, through which the runoff percolates	**TSS**	**Metals**	**Hydro-carbons**
A layer of dense vegetation underlain by a soil with good contaminant attenuation potential of at least 300mm in depth	0.6	0.5	0.6
A soil with good contaminant attenuation potential of at least 300mm in depth	0.4	0.3	0.3
Infiltration trench underlain by a soil with good contaminant attenuation potential of at least 300mm in depth	0.4	0.4	0.4
Constructed permeable paving underlain by a soil with a good contaminant attenuation potential of at least 300mm in depth	0.7	0.6	0.7
Bio retention underlain by a soil with good contaminant attenuation potential of at least 300mm in depth	0.8	0.8	0.8
Proprietary treatment systems	These must demonstrate that they can address each of the contaminant types to acceptable levels for inflow concentrations relevant to the contributing drainage area.		

Indicative SuDS mitigation indices for discharges to surface waters

For surface water discharge from Residential Parking Areas and Low Traffic Roads <300 traffic movements/day			
	Required mitigation indices		
Source	**TSS**	**Metals**	**Hydrocarbons**
Low	0.5	0.4	0.4
Drainage Network			
Detention Basin	0.5	0.5	0.6
Check	+0.0	+0.1	+0.2

Total SuDS mitigation index = mitigation index$_1$ + (0.5 x mitigation index$_2$)

Appendix H

SuDS Maintenance & Management Plan

Maintenance and Management

The swale and attenuation basins would be maintained by a management company set up by the developer. As construction has not yet commenced, the process of finalising the management company contract has not yet commenced. The developer will ensure that the measures as outlined below form part of the management company contract details, for the ongoing maintenance of all SuDS features on site.

The indicative maintenance requirements for each proposed SuDS component is given below. Taken from CIRIA report C753 "The SuDS Manual".

Drainage Pipes

Maintenance schedule	Required action	Typical frequency
Regular Maintenance	Remove sediment and debris from inspection chambers and hydrobrake chambers	Annually
	Cleaning of gutters and any filters on downpipes	Annually
	Remove any root ingress	As required
Occasional Maintenance	CCTV survey of drains to check alignment, cracking and joint displacement	10 year intervals

Swales/Filter Drains

MAINTENANCE SCHEDULE	REQUIRED ACTION	FREQUENCY
Regular Maintenance	Litter and debris removal	Monthly (or as required)
	Grass cutting – to retain grass height within specified design range	Monthly (during growing season, or as required
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required
Occasional Maintenance	Check for poor vegetation growth due to lack of sunlight or dropping of leaf litter, and cut back adjacent vegetation where possible	Annually

	Re-seed areas of poor vegetation growth.	Annually, or if bare soil is exposed over 10% or more of the swale treatment area
Remedial Actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Re-level uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Remove build-up of sediment on gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required
Monitoring	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies	Half Yearly

Detention Basins

MAINTENANCE SCHEDULE	REQUIRED ACTION	FREQUENCY
Regular Maintenance	Litter and debris removal	Monthly (or as required)
	Cut the grass – for spillways and access routes	Monthly (during growing season, or as required)
	Cut the meadow grass in and around the basin	Half yearly (spring, before nesting season, and autumn)
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets, outlets and overflows for evidence of blockage and clear if required	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
	Inspect inlets and facility structure for all silt accumulation. Establish appropriate silt removal frequencies	Monthly (for first year) then annually or as required
	Check any mechanical devices e.g. penstocks	Half yearly
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from inlet, outlet and forebay	Annually or as required
	Manage wetland plants in outlet pool – where provided	Annually
Occasional Maintenance	Re-seed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every 2 years, or as required
	Remove sediment from inlets, outlets, forebay and main basin where required	Every 5 years, or as required (likely to be minimal requirements where effective upstream source control is provided)

Remedial Actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Realign rip-rap	As required
	Repair / rehabilitate inlets, outlets and overflows	As required

Appendix I

Hertfordshire Conty Council Correspondence

Director of Environment & Infrastructure:
Mark Kemp

Hertfordshire

Lead Local Flood Authority
Post Point CHN 215
Hertfordshire County Council
County Hall, Pegs Lane
HERTFORD SG13 8DN

Contact Charlotte Kemp
Tel 01992 556791
Email [redacted]

Peter Quaile
Borough of Broxbourne
Borough Offices
Bishops College
Churchgate
Cheshunt
Herts
EN8 9XB

Date 09 April 2019

RE: 07/19/0200/F – Fairmead, 90 Cuffley Hill, Goffs Oak, Hertfordshire, EN7 5EX

Dear Peter,

Thank you for consulting us on the above application for the erection of 58 dwellings (17no. 2 bed , 14no. 3 bed, 22no. 4 bed, 1no. 5 bed) with associated infrastructure at Fairmead, 90 Cuffley Hill, Goffs Oak, Hertfordshire, EN7 5EX.

The applicant has provided a Flood Risk Assessment prepared by Ardent Consulting Engineers, report ref. 162101-03, dated December 2018, to support the application. Unfortunately the information provided to date does not provide a suitable basis for an assessment to be made of the flood risks arising from the proposed development.

Therefore, we object to the grant of planning permission and recommend refusal until the following is clarified:

1) Confirmation of feasible discharge mechanism/location
2) Justification of SuDS features with appropriate management and treatment

Overcoming our objection

1) The proposed drainage strategy is based on attenuation and discharge via a variable flow control device, restricted to greenfield run-off rates to an existing ditch. There are mapped ordinary watercourses beginning just west of the site. However, this ditch is not a mapped ordinary watercourse, and as such there are no records of this ditch connecting on to the ordinary watercourses. There is no evidence provided as to where this ditch goes.

   The ditch identified by the applicant appears to be along the site boundary line, which may flow towards the mapped ordinary watercourses in the west, however it is not confirmed that this ditch connects to an ordinary watercourse.

If there is a connection to either of the mapped ordinary watercourses, the LLFA may consider the "ditch" to be an ordinary watercourse. However, at present, we would not consider the ditch to be a feasible discharge mechanism.

As this is a full planning application, confirmation of a feasible surface water discharge mechanism/location is required.

Please note that any works to an ordinary watercourse, permanent and / or temporary, require the prior written consent from the Lead Local Flood Authority (Hertfordshire County Council), under the Land Drainage Act 1991, regardless of any planning permission.

2) The applicant has discounted permeable paving due to underlying clay soils. However, permeable paving with sub-base can be lined when installed in clay soils; providing both a level of treatment for surface water and also providing additional storage. The LLFA would consider this to be a more sustainable option than directly into a piped system. Permeable paving would also provide additional management and treatment, especially considering the proposed discharge into a channel. Permeable paving could be used for the private roads and driveways, especially considering that the road will not be adopted.

   As the applicant is proposing to discharge into an open channel additional management and treatment is required to ensure and maintain water quality.

For more information on ordinary watercourse, please consult our ordinary watercourse webpages: https://www.hertfordshire.gov.uk/services/recycling-waste-and-environment/water/ordinary-watercourses/ordinary-watercourses.aspx

For more information on what we require within a surface water drainage assessment, including the developers guide and checklist, please see our surface water drainage webpages: https://www.hertfordshire.gov.uk/services/recycling-waste-and-environment/water/surface-water-drainage/surface-water-drainage.aspx

Informative to the LPA

The applicant can overcome our objection by submitting information which covers the deficiencies highlighted above and demonstrates that the development will not increase risk elsewhere and where possible reduces flood risk overall, and gives priority to the use of sustainable drainage methods. If this cannot be achieved we are likely to maintain our objection to the application. We would be happy to be re-consulted with the above clarifications addressed and will provide you with bespoke comments within 21 days.

Please note if the LPA decides to grant planning permission we wish to be notified for our records.

Yours sincerely,

Charlotte Kemp
SuDS & Watercourses team leader, Environmental Resource Planning

Director of Environment & Infrastructure:
Mark Kemp

Hertfordshire

Lead Local Flood Authority
Post Point CHN 215
Hertfordshire County Council
County Hall, Pegs Lane
HERTFORD SG13 8DN

[redacted]

Peter Quaile
Broxbourne Borough Council
Borough Offices
Bishops College
Churchgate
Cheshunt
EN8 9XB

Date 25 March 2020

RE: 07/19/0200/F – Fairmead, 90 Cuffley Hill, Goffs Oak, Hertfordshire, EN7 5EX

Dear Peter,

Thank you for re-consulting us on the above application for the erection of 58 dwellings (17no. 2 bed, 14no. 3 bed, 22no. 4 bed, 1no. 5 bed) with associated infrastructure at Fairmead, 90 Cuffley Hill, Goffs Oak, Hertfordshire, EN7 5EX.

We previously provided comments on 27 August 2019.

The applicant has submitted the following additional information in support of the application:

- Flood Risk Assessment prepared by Ardent Consulting Engineers, reference 162101-03B, dated November 2019.

Following our meeting on site in September, we are satisfied that the proposed outfall ditch flows to the ordinary watercourse northwest of the site.

We therefore recommend the following conditions to the LPA should planning permission be granted.

Condition 1

The development permitted by this planning permission shall be carried out in accordance with the approved surface water drainage assessment carried out by Ardent Consulting Engineers, reference 162101-03B dated November 2019, and the following mitigation measures detailed within the FRA:

1. Limiting the surface water run-off generated by the critical storm events so that it will not exceed the surface water run-off rate of 12.4 l/s during the 1 in 100 year event plus 40% of climate change event.

2. Providing storage to ensure no increase in surface water run-off volumes for all rainfall events up to and including the 1 in 100 year + climate change event providing a minimum of 870 m^3 (or such storage volume agreed with the LLFA) of total storage volume in basins.

3. Discharge of surface water from the private drain into the ditch northwest of the site.

The mitigation measures shall be fully implemented prior to occupation and subsequently in accordance with the timing / phasing arrangements embodied within the scheme, or within any other period as may subsequently be agreed, in writing, by the local planning authority.

Reason

1. To prevent flooding by ensuring the satisfactory disposal and storage of surface water from the site.
2. To reduce the risk of flooding to the proposed development and future occupants.

Condition 2

No development shall take place until a detailed surface water drainage scheme for the site based on the approved drainage strategy and sustainable drainage principles, has been submitted to and approved in writing by the local planning authority. The drainage strategy should demonstrate the surface water run-off generated up to and including 1 in 100 year + climate change critical storm will not exceed the run-off from the undeveloped site following the corresponding rainfall event. The scheme shall subsequently be implemented in accordance with the approved details before the development is completed.

1. Detailed engineered drawings of the proposed SuDS features including cross section drawings, their size, volume, depth and any inlet and outlet features including any connecting pipe runs.
2. Detailed, updated post-development calculations and half drain down times in relation to surface water for all rainfall events up to and including the 1 in 100 year + 40% climate change return period.
3. Final detailed management plan to include arrangements for adoption and any other arrangements to secure the operation of the scheme throughout its lifetime.

Reason

1. To prevent the increased risk of flooding, both on and off site.

Informative to the LPA

Please note that if the LPA decides to grant planning permission we wish to be notified for our records.

Yours sincerely,

David Uncle
SuDS Officer
Environmental Resource Planning

From: Ben Brooks
Sent: 16 April 2020 13:21
To: FRMConsultations
Cc: Andrew Wren; John Rumble
Subject: RE: 90 Cuffley Hill, Goffs Oak, En7 5EX (Planning Ref 07/19/0200/F) [Filed 16 Apr 2020 17:25]

Great,

Thanks David.

I have reviewed the response and the team are happy with the proposed conditions.

Kind Regards,

Ben Brooks
Associate

ARDENT
CONSULTING ENGINEERS

Third Floor, The Hallmark Building, 52-56 Leadenhall Street, London EC3M 5JE

T 020 7680 4088

www.ardent–ce.co.uk

From: David Uncle <David.Uncle@hertfordshire.gov.uk> **On Behalf Of** FRMConsultations
Sent: 16 April 2020 08:40
To: Ben Brooks <bbrooks@ardent-ce.co.uk>
Cc: FRMConsultations <FRMConsultations@hertfordshire.gov.uk>; Andrew Wren <awren@ardent-ce.co.uk>; John Rumble <John.Rumble@hertfordshire.gov.uk>
Subject: RE: 90 Cuffley Hill, Goffs Oak, En7 5EX (Planning Ref 07/19/0200/F)

Hi Ben,

We have had a look at our records and we issued our consultation response to Broxbourne Borough Council on 25/03/2020. From a review of the planning portal, it seems our response was uploaded on 31/03/2020 titled "HCC Flood". You will be pleased to see we recommend conditions in our response.

We hope this helps.

Kind regards,

David Uncle
Sustainable Drainage System Officer | Environmental Resource Planning | Environment & Infrastructure
Hertfordshire County Council
County Hall, Pegs Lane, Hertford, SG13 8DN Postal Point: CHN215
E: FRMConsultations@hertfordshire.gov.uk

Update me

From: Ben Brooks <bbrooks@ardent-ce.co.uk>
Sent: 08 April 2020 18:44
To: John Rumble <John.Rumble@hertfordshire.gov.uk>
Cc: FRMConsultations <FRMConsultations@hertfordshire.gov.uk>; Andrew Wren <awren@ardent-ce.co.uk>
Subject: RE: 90 Cuffley Hill, Goffs Oak, En7 5EX (Planning Ref 07/19/0200/F)

John,

Are you able to provide a timeframe for your review/response to my email below?

Many Thanks,

Ben Brooks
Associate

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Third Floor, The Hallmark Building, 52-56 Leadenhall Street, London EC3M 5JE

T 020 7680 4088

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From: Ben Brooks
Sent: 01 April 2020 19:38
To: John.Rumble@hertfordshire.gov.uk
Cc: Andrew Wren <awren@ardent-ce.co.uk>
Subject: RE: 90 Cuffley Hill, Goffs Oak, En7 5EX (Planning Ref 07/19/0200/F)

John,

Have you had a chance to look at my enquiry below?

We are hoping to close out any remaining items on the planning application, one of which being the HCC Holding Objection.

I am happy to discuss if that would be helpful.

Many Thanks,

Ben Brooks
Associate

ARDENT
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Third Floor, The Hallmark Building, 52-56 Leadenhall Street, London EC3M 5JE

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From: Ben Brooks
Sent: 19 March 2020 22:52
To: John.Rumble@hertfordshire.gov.uk

Cc: Andrew Wren <awren@ardent-ce.co.uk>
Subject: 90 Cuffley Hill, Goffs Oak, En7 5EX (Planning Ref 07/19/0200/F) [Filed 19 Mar 2020 22:54]

John,

I hope you are well.

Following you site meeting with Andy Wren on the above scheme, we submitted a revised FRA in November 2019 (attached), however as far as I can see from the planning portal the latest HCC response is the holding objection from August 2019 (attached).

Are you able to review the latest FRA and advise what you now require to remove the holding objection?

Many Thanks,

Ben Brooks
Associate

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