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Project: Surface Water Drainage Strategy & FRA Phase 1

Prepared for: Mr. Barry Gray

Reference: 3656 SWDS & FRA

Site Location: 22 The Avenue, Welwyn, Herts, AL6 0PP

Proposed Development: The proposed development is for the removal of the existing parking area and construction of four new houses and new access road.

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Contents

1. Summary 4

2. Introduction 6

Development Proposal 6
Need for Study 6

3. Development Description 7

Existing Drainage Infrastructure 7
Existing Ground Conditions 7

4. Flood Risk 8

Sources of Flooding 8
River (Fluvial) 8
Surface Water (Pluvial) 9
Groundwater 10
Sewer 11

5. SuDS Assessment 11

6. Surface Water Drainage Strategy 14

Runoff rates 14
Long Term Storage 14
On Site Drainage and Attenuation Storage Systems 15
Design Exceedance 15
Water Quality 15
Adoption and Maintenance 16

7. Conclusions 17

Appendix 1 – Supporting Information 19

Appendix 2 – Site Geology and Flood Risk Maps 20

Appendix 3 – Calculations 22

Appendix 4 – Proposed Drainage Strategy Layout 23

Appendix 5 – Information 24

Surface Water Runoff Calculation Method 24

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1. Summary

FLOOD RISK ASSESSMENT SUMMARY		
DEVELOPMENT DESCRIPTION	**Existing**	**Proposed**
Development Type:	Commercial	Residential
EA Vulnerability Classification:	Less Vulnerable	More Vulnerable
Site Topography - External Ground Levels:	110mAOD to 113mAOD	Source: LiDAR
Impermeable Surface Area:	0.2ha	0.087ha
Surface Water Drainage:	N/A[2]	Yes
Development Site Size:	0.33ha	No change
RISK TO PROPOSED DEVELOPMENT		
EA Flood Zone for Planning:	Flood Zone 1	
EA Risk of Flooding from Surface Water:	'Very Low' Risk - Flooding occurring as a result of rainfall with less than 1 in 1000 (0.1%) chance in any given year	
Main Flood Source:	Pluvial	EA Risk of Flooding from Surface Water Map
'High' (>3.3% AEP) Risk Flood Depth	None	
'Medium' (3.3-1% AEP) Risk Flood Depth:	None	
'Low' (1-0.1% AEP) Risk Flood Depth:	None	
Recorded Flood Events in Area:	No	Welwyn Hatfield Strategic Flood Risk Assessment (2009)
Recorded Flood Events at Site:	No	
SFRA Available:	Yes	
MANAGEMENT MEASURES	**SUMMARY**	**COMMENT**
Floor level above extreme flood levels:	Yes	Recommended finished floor levels 150mm above external ground levels, if feasible
Safe Access/Egress Route:	Yes	Site in Flood Zone 1
Flood Resilient Design:	N/A[1]	
Site Drainage Plan:	N/A[2]	Yes
Flood Warning & Evacuation Plan:	N/A[1]	No - Development site outline located in Flood Zone 1
OFFSITE IMPACTS		
Displacement of floodwater:	None	Site is located in Flood Zone 1
Increase in surface runoff generation:	No	The proposed development decreases total runoff volumes. Post-development runoff will be managed on-site by SuDS.
Impact on hydraulic performance of channels:	None	

Table 1: Summary of flood risks, impacts and proposed flood mitigation measures.

N/A[1] not required for this assessment; *N/A[2]* data not available.

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SURFACE WATER DRAINAGE STRATEGY SUMMARY			
SITE DETAILS			
Site Area:	0.33 ha		
Site Area which is positively drained:	0.087 ha		
Open Space:	0.243 ha		
Predevelopment Use:	Developed site (Brownfield)		
Site Constraints:	- Groundwater Source Protection Zone: 3 (Total Catchment)		
	- Groundwater Vulnerability Zone: High		
	- Good Infiltration Rates (Unconfirmed)		
IMPERMEABLE AREA	**EXISTING**	**PROPOSED**	
Impermeable Area:	0.20 ha	0.087 ha	
Drainage Method: (Infiltration/Sewer/Watercourse)	N/A	Infiltration	
PROPOSED TO DISCHARGE SURFACE WATER VIA			
Infiltration:	✓	Potentially good infiltration rates.	
To Watercourse:	x	Watercourse not in proximity to site.	
To Surface water sewer:	x	Infiltration solutions preferred under NPPF.	
PEAK DISCHARGE RATES	**GREENFIELD**	**BROWNFIELD**	**PROPOSED**
Greenfield QBAR:	0.0 l/s	-	Assumed $1x10^{-5}$m/s infiltration rate – To be confirmed by BRE365 infiltration testing.
1 in 1:	0.0 l/s	30 l/s	
1 in 30:	0.1 l/s	64.2 l/s	
1 in 100:	0.1l/s	71.1 l/s	
1 in 100 + 40 % Climate Change:	N/A	-	
SITE STORAGE VOLUME			
Source Control Provided:	Yes	Use of Attenuation Storage – Geocellular Crates and Permeable Pavement	
Attenuation Volume: (Storage - 1 in 100 year + CC) Volume to control discharge rate	54.8 m³		
PROPOSED DRAINAGE COMPONENTS			
Geocellular System	Geocellular systems can be used to control and manage rainwater surface water runoff as a storage tank. The modular/honeycomb nature of geocellular systems means that they can be tailored to suit the specific requirements of any site.		
Permeable Pavement	Pervious surfaces provide a surface suitable for pedestrian and/or vehicular traffic, while allowing rainwater to infiltrate through the surface and into underlying layers.		
DESIGN CHECKS			
Key SuDS Component:	Attenuation Storage – Geocellular Crates		
Drainage Systems Maintenance:	Supplier must provide appropriate guidance for maintenance		
SuDS storage outside Q100 floodplain:	Yes		
Provision for blockage / Design Exceedance:	Yes	Exceedance routes are provided	
Time taken for 50% of storage to drain down:	approx. 15.5 hours		

Table 2 - Surface Water Drainage Strategy Summary

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2. Introduction

2.1 Ambiental Technical Solutions have prepared this report in respect of a planning application for the development at 22 The Avenue, Welwyn, Herts, AL6 0PP.

2.1 Specifically, the site is bounded by A1 motorway towards the east, and other properties to the southwest and northwest. See *Figure 1 – Site Location* below.

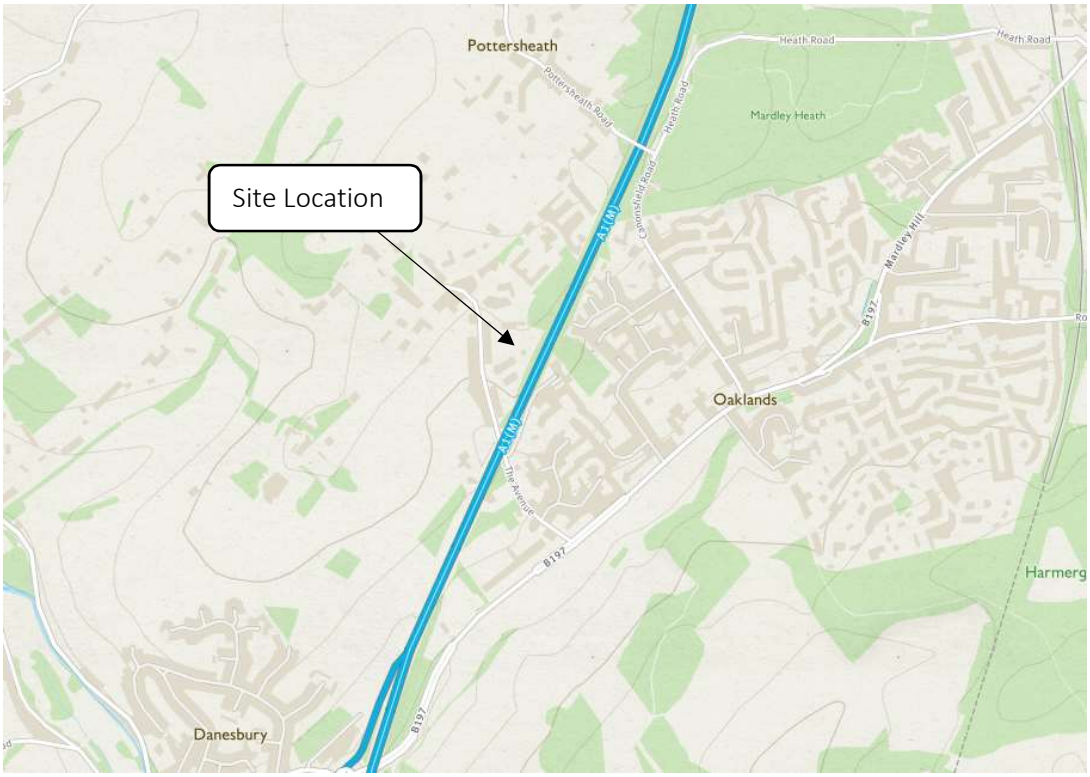

Figure 1 – Site Location (Source: OS)

Development Proposal

2.3 It is understood that the proposed development is for the removal of the existing parking area and construction of four new houses and rebuild the access road. The development proposed is planned on part of the client's wider property, which includes the house to the south of the existing parking area. This study focuses exclusively on the site area proposed for development; the existing parking area and access road.

Need for Study

2.4 The purpose of this assessment is to demonstrate that the development proposal outlined above can be satisfactorily accommodated without worsening flood risk for the area and without placing the development itself at risk of flooding, as per National guidance provided within the National Planning Policy Framework (NPPF).

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3. Development Description

3.1 The total area of the proposed development is approximately 3300m^2 (0.33 Ha), based on plans provided by the client. Following development, the impervious surface area of the site, currently approximately 2000m^2 (0.2 Ha), will decrease to almost 870m^2 (0.087 Ha).

3.2 The topography of the site is approximately 113mAOD towards the north and 110mAOD to the southwest at the access road entrance (Source: 2mLiDAR DTM).

Existing Drainage Infrastructure

3.3 At the time of writing information regarding the existing drainage infrastructure has not been provided, however given that the site is developed it is assumed that drainage infrastructure is present on site or within its vicinity. It is recommended that a CCTV survey be conducted prior to commencement of works to determine the location and condition of the existing drainage infrastructure.

Existing Ground Conditions

3.4 In-situ trial pit logs indicate that the geology at the site varies significantly across the site. A predominantly clay superficial soil texture overlaying a structureless chalk stratum can be found towards the north, whereas sand and gravel soils overlying structured chalk is common towards the south, close to the site's access road entrance. The trial pits ended at 3.2mBGL and no groundwater was not encountered in any of the trial pits. See site investigation report in Appendix 2, Site Geology and Flood Risk Maps.

3.5 The site's lowest topography is towards the south at the site's entrance and as such water will flow naturally towards this location. Due to the high variability of geology at the site, sloping topography, and absence of site-specific infiltration data, it is recommended that infiltration SuDS be assessed at the lowest topography of the site and data used in the SuDS design be based on the nearest trial pit log.

3.6 According to Table 25.1 in The SuDS Manual, the superficial soil deposits at the site are mainly characterised as 'Good Infiltration Media' due to their prevalent sand and gravel composition, with rates varying between $1x10^{-7}$m/s and $3x10^{-4}$m/s. As such, it is proposed an infiltration rate of $1x10^{5}$m/s to assess the feasibility of full infiltration SuDS components for the proposed site.

3.7 It is recommended that BRE365 infiltration testing is undertaken at the detailed design phase to confirm the infiltration rates at the site and reassess the drainage strategy.

3.8 The *EA Groundwater Source Protection Zone Map* indicates that the site is located in a total catchment (Zone 3) groundwater source protection zone. See map in Appendix 2, Site Geology and Flood Risk Maps.

3.9 *Environmental Agency's Groundwater Vulnerability Zone Map* confirms that the site is located in a zone with 'High' groundwater vulnerability. See map in Appendix 2, Site Geology and Flood Risk Maps.

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4. Flood Risk

4.1 Ambiental Technical Solutions Limited has been appointed by Mr Barry Gray to undertake a National Planning Policy Framework (NPPF) compliant Flood Risk Assessment (FRA) for the proposed residential development at 22 The Avenue, Welwyn, Herts, AL6 0PP.

4.2 With reference to the NPPF and the Environment Agency (EA) standing advice on development and flood risk, as well as the low detail, national-scale flood mapping created on behalf of the EA, the proposed site is located within Flood Zone 1. Based on the EA flood map for planning the proposed development has an annual probability of fluvial or tidal flooding less than 0.1% (1 in 1000) in any year.

4.3 The proposed development usage is for residential purposes and as such, under the NPPF, is classified as a 'More Vulnerable'.

4.4 Under the NPPF guidance the development is considered 'More Vulnerable' due to the residential nature of the development. Table 3 below extracted from the NPPF shows the development is appropriate development for this flood zone.

Flood Risk Vulnerability Classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception Test Required	✓	✓
Zone 3a	Exception Test Required	✓	×	Exception Test Required	✓
Zone 3b *Functional Floodplain*	Exception Test Required	✓	×	×	×

Table 3: Flood Risk Vulnerability and Flood Zone 'Compatibility' Table as specified by NPPF. Shaded cells denote the proposed re-development. Please note: ✓ means development is appropriate; × means the development should not be permitted

4.5 Using the principles of the Sequential Test outlined above, the proposed development is categorized as being 'More Vulnerable' and within Zone 1. As such, under the NPPF guidance, this development is not required to implement the Exception Test and the development is appropriate.

Sources of Flooding

River (Fluvial)

4.6 The proposed development is located within Flood Zone 1 and under the NPPF guidance, is classified as 'Low Probability' for flooding, having a less than 1 in 1000 annual exceedance probability of river or sea flooding (<0.1% AEP), all land uses being appropriate at this location. See *Figure 2 – Flood Map for Planning* below.

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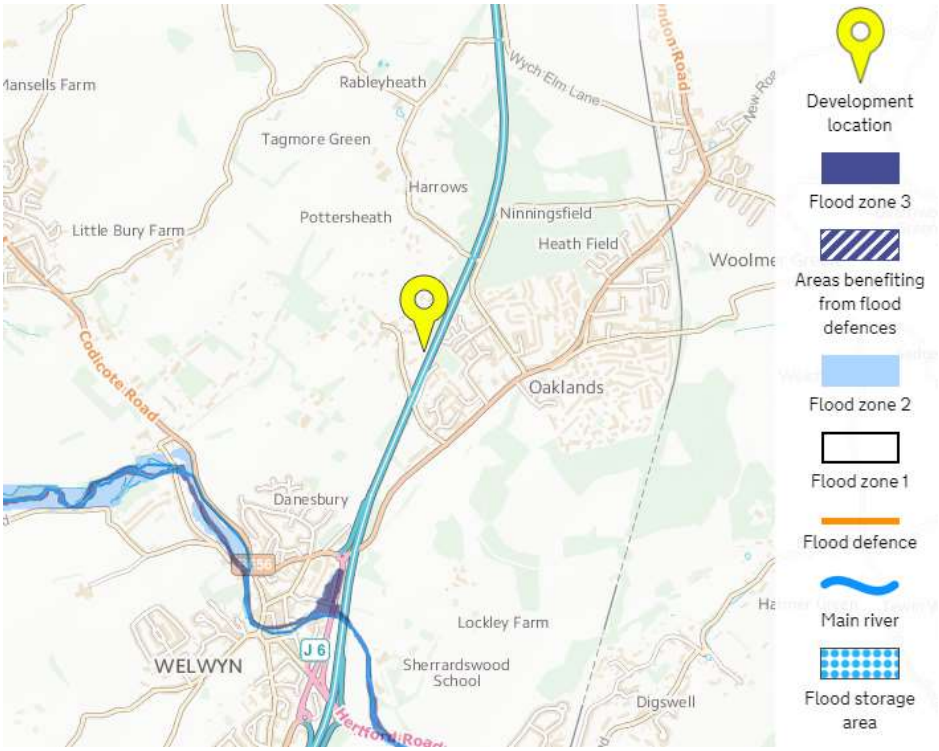

Figure 2 - Flood Risk Map for Planning (Source: Environmental Agency, EA)

Surface Water (Pluvial)

4.7 The EA Risk of Surface Water map has shown the site to be located in an area with a "Very Low" risk of surface water flooding. This means these areas have a chance of flooding of less than 1 in 1000 (0.1%). *Figure 3 – Flood Risk Flood Risk from Surface Water* below.

4.8 No records have been provided by the EA or the Welwyn Hatfield SFRA (2015) to suggest that the site has previously flooded from this source.



Figure 3 – Flood Risk from Surface Water (Source: Environmental Agency, EA)

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Figure 4 - EA Surface Water Depth, Low Chance of Occurring (Source: EA)

4.9 The EA's Surface Water Depth – Low Chance of Occurring Map shows areas of the site not to experience any flood depths, however on The Avenue flood depths of up to 300mm can be expected during such an event (Figure 4). Analysis of the flow velocities indicates that the areas identified at a 'Low' risk of flooding are predominantly flow paths.

4.10 As such, the risk from surface water flooding to the proposed development can be considered to be low.

Groundwater

4.11 Groundwater flooding accounts for a small proportion of the number of properties at risk of flooding across England and Wales, when it does occur it usually lasts longer than flooding from rivers, the sea or surface water. It is most likely to occur in areas underlain by permeable rocks, areas known as aquifers. These can be extensive regional aquifers, such as chalk or sandstone, or more local sand or river gravels in valley bottoms underlain by less permeable rocks.

4.12 The EA has confirmed that the site is located within groundwater protection zone 3, total catchment.

4.13 The EA has confirmed that the site is located within a 'High' groundwater vulnerability zone.

4.14 The EA and the Welwyn Hatfield SFRA have no records of historical groundwater flooding at the site or in the wider area.

4.15 Groundwater Flooding Susceptibility Map indicates that the site is located within an area with no susceptibility of groundwater emergence to the surface (Figure 5).

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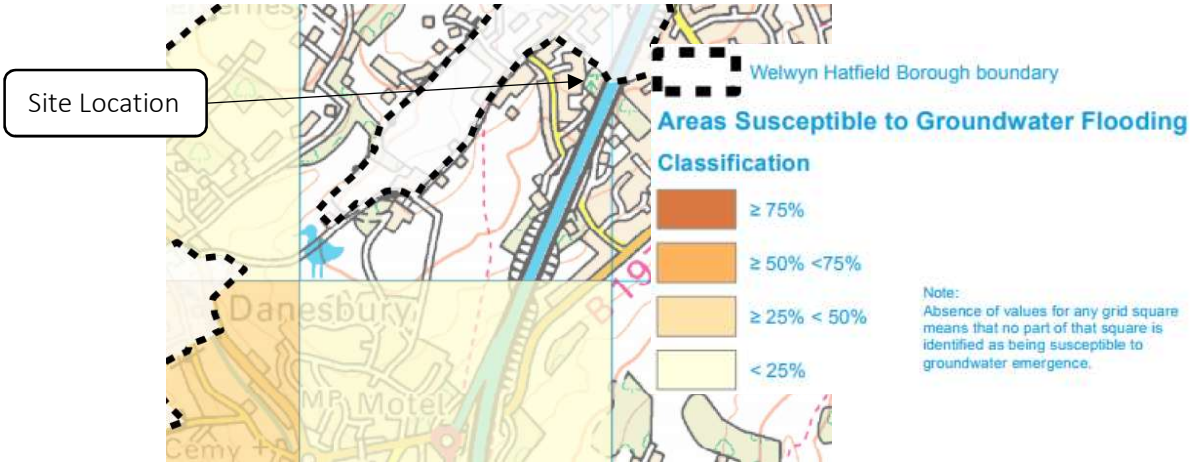

Figure 5 - Groundwater Flooding Susceptibility Map (Source: Welwyn Hatfield SFRA)

4.16 As such, risk of future groundwater flooding is deemed to be **relatively low**.

Sewer

4.17 The EA and the Welwyn Hatfield SFRA have no records of historical sewer flooding at the site or in the wider area.

4.18 As such, the risk from this source is considered to be **low**.

5. SuDS Assessment

5.1 Paragraph 80 of the Planning Practice Guidance of the National Planning Policy Framework (NPPF) states that: *Generally, the aim should be to discharge surface run off as high up the following hierarchy of drainage options as reasonably practicable:*

- *into the ground (infiltration);*
- *to a surface water body;*
- *to a surface water sewer, highway drain, or another drainage system;*
- *to a combined sewer.*

5.2 The SuDS management hierarchy is set out as follows:

SuDS Drainage Hierarchy			
		Suitability	Comment
↓	Infiltration	✓	Full infiltration SuDS solutions should be feasible given the soil texture at the site. This study has assumed an infiltration rate of $1x10^{-5}$m/s, however further testing is necessary to confirm the infiltration rates.
	Discharge to Surface Water	x	Surface waters do not bound the site.
	Discharge to Surface Water Sewer, Highway Drain or another Drainage System	x	Discharge through infiltration is preferred under the NPPF, however a CCTV drain survey is recommended to validate the location of any existing drainage infrastructure and possible reuse by the proposed development.

Table 4: SuDS Hierarchy

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5.3 The suitability of SuDS components have been assessed as follows:

Suitability of SuDS Components		
SuDS Component	Description	Suitability
Infiltrating SuDS	Infiltration can contribute to reducing runoff rates and volumes while supporting baseflow and groundwater recharge processes. The suitability and infiltration rate depends on the permeability of the surrounding soils.	✓
Permeable Pavement	Pervious surfaces can be used in combination with aggregate sub-base and/or geocellular/modular storage to attenuate and/or infiltrate runoff from surrounding surfaces and roofs. Liners can be used where ground conditions are not suitable for infiltration.	✓
Green Roofs	Green Roofs provide areas of visual benefit, ecological value, enhanced building performance and the reduction of surface water runoff. They are generally costlier to install and maintain than conventional roofs but can provide many long-term benefits and reduce the on-site storage volumes.	x
Rainwater Harvesting	Rainwater Harvesting is the collection of rainwater runoff for use. It can be collected form roofs or other impermeable area, stored, treated (where required) and then used as a supply of water for domestic, commercial and industrial properties.	x
Swales	Swales are designed to convey, treat and attenuate surface water runoff and provide aesthetic and biodiversity benefits. They can replace conventional pipework as a means of conveying runoff, however space constraints of some sites can make it difficult incorporating them into the design.	x
Rills and Channels	Rills and Channels keep runoff on the surface and convey runoff along the surface to downstream SuDS components. They can be incorporated into the design to provide a visually appealing method of conveyance, they also provide effectiveness in pre-treatment removal of silts.	x
Bioretention Systems	Bioretention systems can reduce runoff rates and volumes and treat pollution through the use of engineer soils and vegetation. They are particularly effective in delivering interception, but can also be an attractive landscape feature whilst providing habitat and biodiversity.	x
Retention Ponds and Wetlands	Ponds and Wetlands are features with a permanent pool of water that provide both attenuation and treatment of surface water runoff. They enhance treatment processes and have great amenity and biodiversity benefits. Often a flow control system at the outfall controls the rates of discharge for a range of water levels during storm events.	x
Detention Basins	Detention Basins are landscaped depressions that are usually dry except during and immediately following storm events, and can be used as a recreational or other amenity facility. They generally appropriate to manage high volumes of surface water from larger sites such as a neighbourhoods.	x
Geocellular Systems	Attenuation storage tanks are used to create a below-ground void space for the temporary storage of surface water before infiltration, controlled release or use. The inherent flexibility in size and shape means they can be tailored to suit the specific characteristics and requirements of any site.	✓
Proprietary Treatment Systems	Proprietary treatment systems are manufactured products that remove specific pollutants from surface water runoff. They are especially useful where site constraints preclude the use of other methods and can be useful in reducing the maintenance requirements of downstream SuDS.	✓
Filter Drains and Filter Strips	Filter drains are shallow trenches filled with stone, gravel that cerate temporary subsurface storage for the attenuation, conveyance and filtration of surface water runoff. Filter strips are uniformly graded and gently sloping strips of grass or dense vegetation, designed to treat runoff from adjacent impermeable areas by promoting sedimentation, filtration and infiltration.	x

Table 5 - Suitability of SuDS Components

5.4 Therefore, several SuDS components are deemed appropriate to be used in the following SuDS management train. It is suggested the use of Geocellular Systems as the main SuDS component to

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attenuate and infiltrate the surface water runoff. Furthermore, it is proposed to intercept, treat and covey runoff using Permeable Pavement SuDS components.

5.5 It is recommended to provide Permeable Pavement for the proposed site's new access road and parking areas. The Permeable Paving should be Type A (Full infiltration), the paving would be formed by the following layers:

- Perforated Concrete Paving Slabs
- Laying Course Material
- Geotextile filter
- Sub-Base: Clean Stone (Depth: 400 mm)
- Permeable geotextile

5.6 It is recommended that infiltration testing be conducted along the entire length of the road to confirm the viability of using Type A (Full Infiltration) pavements. Should infiltration not be deemed feasible the permeable pavement should be lined with an impermeable geomembrane at the formation level and sides.

5.7 At the site's entrance it is proposed to provide SuDS Geocellular Systems – crates to attenuate and infiltrate the surface water runoff. It is recommended to extend the SuDS device geocellular crates beneath the clean stone sub-base of the permeable pavement to allow the passage of runoff into the crates. See plans in Appendix 4 – Surface Water Drainage Strategy. The proposed Geocellular System should be formed by the following layers:

- Permeable Tarmacking/Concrete blocks
- Laying Course Material
- Geotextile filter
- Sub-Base: Clean Stone (Depth: 400 mm)
- Geotextile filter
- Geocellular Tanks (Depth: 800 mm)
- Permeable geotextile

5.8 It is also recommended that a Rain Water Harvesting System is considered at the detailed design phase as part of the wider SuDS scheme of the proposed development. In general terms, the runoff management layout of this type of RWH is to store water underground or at ground level and be used in-between rainfall events in domestic non-potable activities.

5.9 Sediment Traps should be installed on the storm drainage pipework at incoming connections to SuDS features, to reduce the incidence of blockage or silting up of infiltration devices. External hard landscaping should be laid, such that the arising runoff from the hardstanding areas can be collected and managed by the proposed SuDS train.

5.10 SuDS components should be designed to accommodate and dispose of runoff from storms up to and including the 1:100 year +40% climate change event without flooding.

5.11 Guidance about proper use, installation and maintenance of any proprietary system must be provided by the supplier and incorporated into the site proposals at detailed design stage.

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6. Surface Water Drainage Strategy

6.1 In order to mitigate flood risk posed by the proposed development, adequate control measures are required to be considered. This will ensure that surface water runoff is dealt with at source and the flood risk on/off site is not increased over the lifetime of the development.

6.2 The existing site is developed, thus it is considered brownfield. Following development the total impermeable site area will decrease and as a result a smaller amount of runoff will be generated by the proposed development.

6.3 The provided site plans show the total impermeable surface area post-development will decrease to approximately 870m^2. The runoff generated will need to be managed in accordance with the National Planning Policy Framework (NPPF) policy which requires the use of Sustainable Drainage Systems (SuDS).

6.4 The SuDS system proposed for the new development demonstrates surface water control and attenuation storage on site with the intention of mitigating the impact on the existing flooding regime.

Runoff rates

6.5 Greenfield runoff rates have been calculated using the *Institute of Hydrology Report 124* (Marshall and Bayliss, 1994), as recommended in the *CIRIA 753 'The SUDS Manual'*. See calculations in Appendix 3, Calculations.

6.6 According to the plans provided by the client, the proposed impermeable site area is associated with a Greenfield Runoff Rate (Q_{BAR}) of 0.1 l/s during a 1 in 100 year flood event. Other results properly factored for each return period and area of the site are shown in Appendix 3, Calculations and also in Table 6 – Surface Water Discharge Rates Summary below.

SURFACE WATER DISCHARGE RATES SUMMARY						
	Area (ha)	Discharge Rates (l/s)				
		Q_{BAR}	1 year	30 year	100 year	100 year +CC
Greenfield Site	0.087	0.0	0.0	0.1	0.1	-
Pre-Development Runoff Rates	0.20	-	30	64.2	71.1	-
Designed Discharge for Proposed Site	**0.087**	Full Infiltration SuDS with 1x10^{-5}m/s infiltration rate – To be confirmed by BRE365 infiltration testing.				

Table 6 – Surface Water Discharge Rates Summary.

Long Term Storage

6.7 Long-term storage is required to address the additional runoff caused by the development compared to the volume that would be contributed from the site in its Greenfield state. The proposed development is reducing the total impervious site area therefore long term storage is not required.

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On Site Drainage and Attenuation Storage Systems

6.8 Attenuation storage is needed to temporarily store water during periods when the runoff rates from the development site exceed the allowable discharge rates from the site.

6.9 Rainfall depths for the 1 in 100 years Return Period plus 40% of climate change were produced using the Microdrainage software in order to estimate the largest volume, critical storm, for typical storm durations for the proposed site. See summary calculations in Appendix 3, Calculations.

6.10 **The Attenuation Storage Volume required for the impermeable surface area is 54.8m³ for a SuDS scheme utilising Geocellular Systems from the 1:100 year +40% climate change flood event. 4.35 m ³ of storage is required for the day-to-day rainfall as Interception Volume.**

6.11 It is proposed to provide Permeable Pavement (Full Infiltration) for the access road and parking areas of the development to intercept and treat runoff. The capacity of the pavement sub-base is sufficient to manage day-to-day rainfall events. Additionally, it is recommended to convey runoff arising on the roofs of the proposed houses to the pavement's sub-base for additional treatment and conveyance to the geocellular crate system. See plans in Appendix 4 – Surface Water Drainage Strategy.

6.12 It is proposed to provide Geocellular Systems – crates – are used at the entrance to the proposed development, and be also located under the proposed permeable pavement to allow the runoff accumulated within the pavement's sub-base to be discharged directly into the crate storage system and additional pipework be avoided.

6.13 **It may be necessary to update or alter the drainage strategy at detailed design stage following confirmation of site infiltration rates or alterations to the overall layout. Calculations for, and the design of the SuDS devices, should be reviewed at detailed design stage to ensure a robust drainage strategy is maintained.**

Design Exceedance

6.14 In the event of drainage system failure under extreme rainfall events or blockage, overland flow may occur within the site. In the event of the development's drainage system failure, the runoff flow will be dictated by topography on site. Design of external ground levels should be undertaken at detailed design stage to finalise these overland routes, but some indicative flow paths have been indicated on the outline strategy drawings. External levels should be designed to direct overland flow away from buildings and thresholds.

6.15 In the event of drainage system failure, extreme rainfall events or blockage, flooding may occur within the site. It should be ensured water runoff should not impact on the new dwellings. To mitigate against potential overland flow, dwelling FFL`s should be raised 150mm above adjacent external ground levels, if feasible.

Water Quality

6.16 Adequate treatment must be delivered to the water runoff to remove pollutants through SuDS devices which are able to provide pollution mitigation. Pollution Hazards and the SuDS Mitigation have been indexed in the specialized literature *CIRIA 753 'The SUDS Manual'*.

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6.17 The Pollution Hazard Indices are summarized in Table 7 – Summary of Pollution Hazard Indices for different Land Use below:

POLLUTION HAZARD INDICES FOR DIFFERENT LAND USE CLASSIFICATIONS				
LAND USE	Pollution Hazard Level	Total suspended Solids (TSS)	Metals	Hydrocarbons
Residential Roofs	Very Low	0.2	0.2	0.05
Individual property driveways	Low	0.5	0.4	0.4

Table 7 – Summary of Pollution Hazard Indices for different Land Use.

6.18 Runoff from roof areas is considered to be uncontaminated, being treated by *Sediments Traps* and through the proposed Permeable Pavement.

6.19 The Mitigation Indices of the proposed SuDS techniques are summarized in the Table 8 - Indicative SuDS Mitigation Indices below. It can be seen the water treatment provided by this SuDS train is enough to remove the pollutants.

INDICATIVE SuDS MITIGATION INDICES FOR DISCHARGES TO SURFACE WATER			
SuDS Component	Total suspended Solids (TSS)	Metals	Hydrocarbons
Permeable Pavement	0.7	0.6	0.7
Geocellular Tank	-	-	-

Table 8 – Indicative SuDS Mitigation Indices

Adoption and Maintenance

6.20 All onsite SuDS and drainage systems should be privately maintained. A long term maintenance regime should be agreed with the site owners before adoption. In addition to a long term maintenance regime it is recommended that all drainage elements implemented on site should be inspected following the first rainfall event post construction and monthly for the first quarter following construction.

Proposed Schedule of Maintenance for Below Ground Drainage				
Item	Visual Inspection	Cleanse / De-sludge	CCTV Survey	Comments
Surface Water Drainage System (pipework, chambers etc.)	5 years	10 years	10 years	Cleansing to be carried as necessary
Gullies/Channels	Yearly	Yearly	N/A	Cleansing to be carried as necessary
Permeable Block Paving	Yearly	'Swept' clean of debris every 2 years.	N/A	Lift blocks and remove sand bedding and replace and re-bed paving – refer to individual manufacturers recommendations.
Geocellular Tanks	Yearly	As required	5 years	Remove sediment from pre-treatment structures (e.g. Permeable pavement); Inspect inside of tank for sediment build-up and remove as necessary

Table 9 Proposed Schedule of Maintenance for Below Ground Drainage

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7. Conclusions

7.1 This study has been undertaken in accordance with the principles set out in NPPF. We can conclude that providing the development adheres to the conditions advised in the conclusions of this report, the said development proposals can be accommodated without increasing flood risk within the locality in accordance with objectives set by Central Government, the EA and Welwyn Hatfield Council.

7.2 With reference to the NPPF and the Environment Agency (EA) standing advice on development and flood risk, as well as the low detail, national-scale flood mapping created on behalf of the EA, the redline application boundary of the site is located within Flood Zone 1. Based on the EA flood map for planning the proposed development has an annual probability of fluvial flooding less than 0.1% (1 in 1000) in any year. The development is classed as 'More Vulnerable' and under the principles of Sequential Test it is deemed appropriate.

7.3 The existing site is developed, with structures and hardstanding covering most of the proposed site. Post development there will be a reduction of impermeable surfaces on site to approximately 870m^2 total impermeable surface area.

7.4 It is proposed that runoff generated by the impermeable surface areas managed through the implementation of SuDS Geocellular Systems as the main attenuation component and SuDS Permeable Pavements for interception, treatment and conveyance. The Geocellular System should be provided at the lowest topography and ideally below the Permeable Pavement to allow for flows directly into the geocellular crate system. The geocellular crates have been designed to allow for infiltration at a rate of $1x10^{-5}$ m/s. This infiltration rate is based on the nearest soil texture from the proposed SuDS component, largely defined as sand and gravel with little clay composure overtopping a structured chalk bedrock.

7.5 Additional testing is recommended along the proposed access road, within the outline of the proposed SuDS components, to confirm the infiltration rates at the detailed design stage.

7.6 Initial calculations indicate a storage requirement of approximately 54.8m^3 for attenuation of the 1 in 100 year event + 40% climate change allowance being properly managed by the proposed SuDS Geocellular System. Additionally, 4.35 m^3 of storage is required for the day-to-day rainfall as Interception Volume. This can be accommodated within the permeable pavement as outlined in this report.

7.7 In the event of drainage system failure, extreme rainfall events or blockage, flooding may occur within the site. It should be ensured water runoff should not impact on the new dwellings. To mitigate against potential overland flow dwelling FFL`s should be raised 150mm above adjacent external ground levels, where feasible. As the site is sloped it is accepted that, in some instances, this may not be feasible – in all cases, external levels should be designed to drain away from entrances and thresholds.

7.8 The Treatment train of Permeable Pavements is suitable to offer acceptable contamination treatment to runoff prior to being discharged to the ground.

7.9 All onsite SuDS and drainage systems should be privately maintained. A long term maintenance regime should be implemented by the land owners as outlined in this report. In addition to a long

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term maintenance regime it is recommended that all drainage elements implemented on site should be inspected following the first rainfall event post construction and monthly for the first quarter following construction.

The findings and recommendations of this report are for the use of the client who commissioned the assessment, and no responsibility or liability can be accepted for the use of the report or its findings by any other person or for any other purpose.

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Appendix 1 – Supporting Information

- *Existing and Proposed Site Plans*

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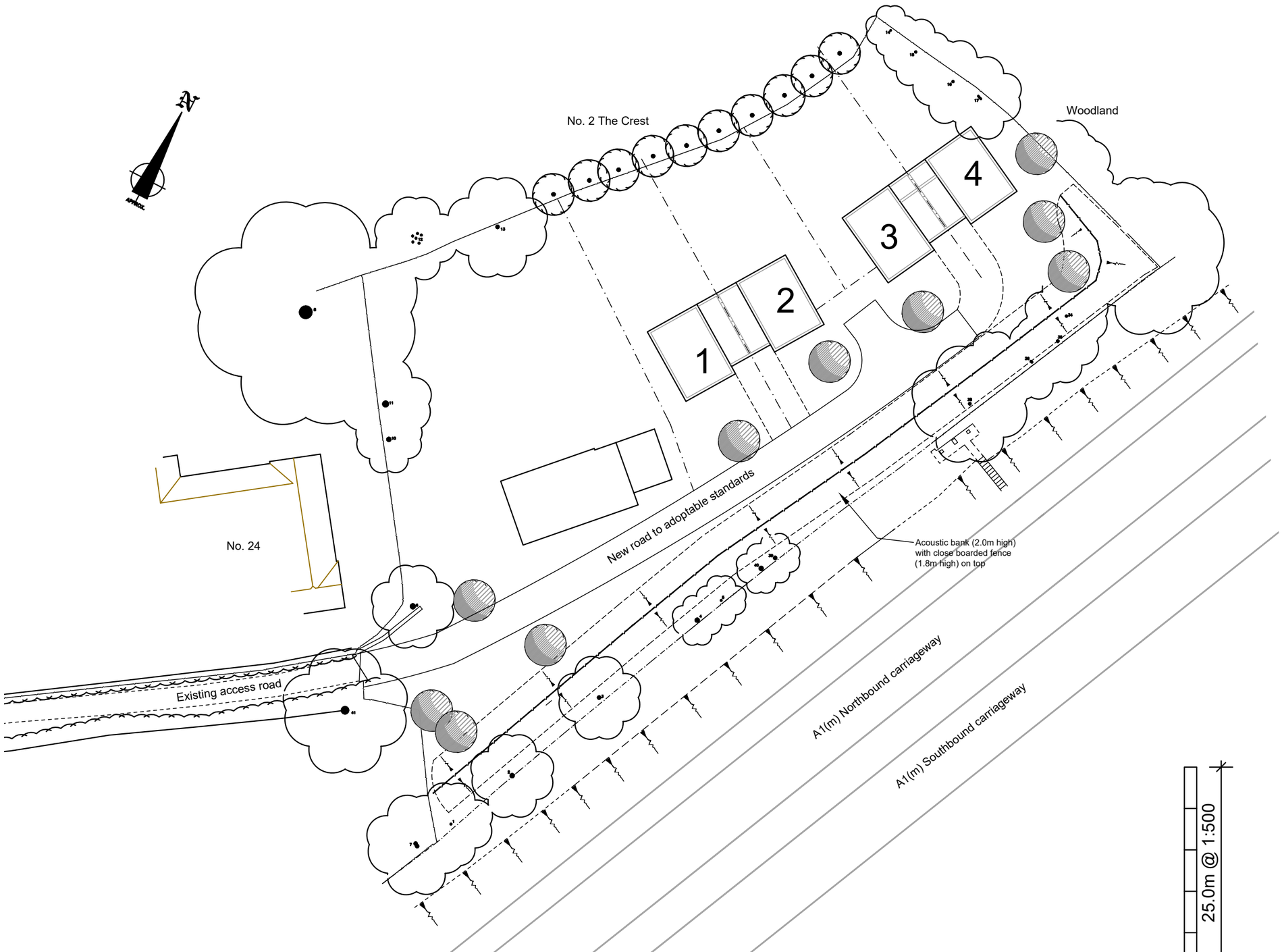

Existing dwelling plus 4 new build link detached houses at 120m2 each.

Rev.	Description.	Date.

AT Design (Welwyn) Ltd
Architectual Design Services
22 School Lane, Welwyn, Herts AL6 9PH
Tel: 07931703297 - email: adamtrigg@hotmail.com

Title;

Proposed development
22 The Avenue
Welwyn
Herts, AL6 0PP
Proposed Site Plan Option A

Scale : 1:500 @ A3
Date : Nov 2017
Drawn by: AT

Drg.No: AT176-20

Appendix 2 – Site Geology and Flood Risk Maps

- *Site Investigation Report*
- *EA Groundwater Maps*

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REPORT ON

SITE INVESTIGATION

carried out at

22 THE AVENUE,

WELWYN, HERTFORDSHIRE AL6 0PP

Prepared for

BMG Limited
Unit 5
Tewin Road Business Centre,
Welwyn Garden City
Hertfordshire
AL6 0PP

Contract No: 50411

Date: September 2005

Ian Farmer Associates (1998) Limited
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CONTENTS

1.0	INTRODUCTION		3
2.0	SITE SETTING		3
	2.1	Site Location	3
	2.2	Site Description	3
	2.3	Geological Setting	4
3.0	SITE WORK		4
4.0	LABORATORY TESTS		4
	4.1	Geotechnical Testing	4
5.0	GROUND CONDITIONS ENCOUNTERED		5
	5.1	Sequence	5
	5.2	Made Ground	5
	5.3	Glacial Gravel	5
	5.4	Upper Chalk	5
	5.5	Groundwater	6
6.0	GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS IN RELATION TO PROPOSED DEVELOPMENT		6
	6.1	Structural Details	6
	6.2	Foundation Design	6
	6.3	Ground Floor Slabs	6
	6.4	Excavations	7
	6.5	Road and Hard Standing Design	7
	6.6	Earth Bund	7
	6.7	Chemical Attack on Buried Concrete	8
7.0	RECOMMENDATIONS IN RELATION TO GAS GENERATION		8
	7.1	Assessment of Gas Emission	8
8.0	REFERENCES		8

APPENDIX 1	-	DRAWINGS	
Figure A1.1	-	Site Location and Aerial Photograph	
Figure A1.2	-	Site Plan	
APPENDIX 2	-	SITE WORK	
		General Notes on Site Work	ii/i-ii/ii
Figures A2.1-A2.7	-	Trial Pit Records	

APPENDIX 3	-	LABORATORY TESTS **General Notes on** **Laboratory Tests on Soils**	iii/i-iii/ii
Figure A3.1	-	Results of Laboratory Tests	
Figure A3.2	-	Plasticity Classification Chart	
Figures A3.3-A3.4	-	Particle Size Distribution	
Figures A3.5-A3.6	-	Compaction Tests	
APPENDIX 4	-	DESIGN CONSIDERATIONS	
Figure A4.1	-	Determination of Water Demand and Mature Height of Trees	
Figure A4.2	-	Determination of Foundation Depth - Low Shrinkage Soils	
Figure A4.3	-	Aggressive Chemical Environment for Concrete (ACEC)	
APPENDIX 5	-	GAS GENERATION **General Notes on Gas Generation**	v/i-v/iv

1.0 INTRODUCTION

1.1 It is understood that it is proposed to develop the site for three detached residential properties with gardens and access road, together with an earth sound barrier.

1.2 On the instructions of BMG Limited, a site investigation was undertaken to determine ground conditions to enable foundation and road/hard standing design to be carried out, together with compaction testing on the surface soil.

1.3 This report has been prepared for the sole use of the Client for the purpose described and no extended duty of care to any third party is implied or offered. Third parties using any information contained within this report do so at their own risk.

1.4 The comments given in this report and the opinions expressed herein are based on the information received, the conditions encountered during site works, and on the results of tests made in the field and laboratory. However, there may be conditions prevailing at the site which have not been disclosed by the investigation and which have not been taken into account in the report.

1.5 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 or other effects.

2.0 SITE SETTING

2.1 Site Location

2.1.1 The site is situated on the eastern side of The Avenue adjacent to the Al(M), in Welwyn, Hertfordshire, and may be located by National Grid reference TL 239 175. A site location plan and aerial photograph are included in Appendix 1, Figure A1.1.

2.2 Site Description

2.2.1 The site which slopes gently up in a broadly northerly direction is predominantly open landscaping with a few trees. A residential property with outbuildings is situated at the southern end and an access track leading to a rectangular building is situated at the northern end of the site. The majority of the site boundaries are substantially wooded with the A1(M) running adjacent to the eastern boundary.

2.2.2 A site plan is included in Appendix 1, Figure A1.2.

2.3 Geological Setting

2.3.1 Details of the geology underlying the site have been obtained from the British Geological Survey map, Sheet No.239, 'Hertford', drift edition, 1:50,000 scale, published 1978.

2.3.2 The geological map indicates the site to be directly underlain by solid deposits of Upper Chalk, described as soft white chalk with many flints. However, to the south and north, the site is indicated as being close to the boundaries with areas of Glacial Gravel.

2.3.3 The site is within an urban area and, although not indicated as present upon the site, the possibility that Made Ground is present cannot be discounted.

3.0 SITE WORK

3.1 The site work was carried out on the 11 August 2005. The site works were carried out on the basis of the practices set out in BS 5930:1999 ref. 8.1.

3.2 Seven trial pits were dug by mechanical excavator at the positions shown on the site plan, Appendix 1, Figure A1.2. The depths of trial pits, descriptions of strata encountered and comments on groundwater conditions are given in the trial pit records, Appendix 2, Figures A2.1 to A2.7. Trial pit 8 comprised a single bulk surface sample only.

3.3 Representative disturbed samples were taken at the depths shown on the trial pit records and despatched to the laboratory.

3.4 The ground levels at the trial pit locations were not determined.

4.0 LABORATORY TESTS

4.1 Geotechnical Testing

4.1.1 The natural moisture content was determined of a single sample and liquid and plastic limit tests were carried out on a single sample and the results included in Appendix 3, Figure A3.1 and on the plasticity classification chart, Figure A3.2.

4.1.2 The particle size distributions of two samples were determined by wet sieving method and the results included in Figures A3.3 to A3.4.

4.1.3 Chemical tests were carried out on two soil samples to determine the sulphate concentrations as a 2:1 water/soil extract and the pH values. The results of these tests are included in Figure A3.1.

5.0 GROUND CONDITIONS ENCOUNTERED

5.1 Sequence

5.1.1 The sequence of the strata encountered during the investigation generally confirms the anticipated geology as interpreted from the geological map.

5.1.2 The sequence and indicative thicknesses of strata are provided below:

Strata Encountered	Depth Encountered (m)		Strata Thickness (m)
	From	To	
Made Ground	0.00	0.40 to 0.90	0.40 to 0.90
Glacial Gravel	0.40 to 0.90	0.70 to >3.20	0.30 to >2.60
Upper Chalk	0.70 to 3.00	>3.20	>2.30

5.2 Made Ground

5.2.1 Made Ground was found in all locations across the site to a depth of between 0.40m and 0.90m as dark greyish brown sandy gravelly clayey topsoil with occasional brick, concrete and tile, with traces of wood, metal and plastic. Roots and rootlets were noted.

5.3 Glacial Gravel

5.3.1 These were encountered below the Made Ground in all locations to a thickness ranging from 0.30m in trial pit 7 to greater than 2.60m in trial pit 3. The stratum consisted of orange brown clayey to very clayey sand or sand and gravel, and occasionally gravelly clay.

5.3.2 Trial pits 2 and 3 were terminated in this stratum.

5.4 Upper Chalk

5.4.1 Upper Chalk was found to underlie the Glacial Gravel in trial pits 1, and 4 to 7, the stratum appeared to dip away in the eastern half of the site, and was not encountered in trial pits 2 and 3 which terminated at 3.20m.

5.4.2 Generally the Upper Chalk was found to comprise weathered structureless chalk of Grade Dc or Dm, overlying structured medium to high-density white chalk of Grade A4.

5.4.3 Trial pit 1 only penetrated the Upper Chalk to a depth of 0.20m, and thus only encountered structureless chalk, grade Dc.

5.4.4 The description of chalk and references to Chalk Grade under the heading 'Description' in the records are based on the guidelines given in CIRIA Report C574 ref 8.2. Details of the Grades are included in Appendix 2.

5.5 Groundwater

5.5.1 Groundwater was not encountered in any of the exploratory holes.

6.0 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS IN RELATION TO PROPOSED DEVELOPMENT

6.1 Structural Details

6.1.1 It is understood that the proposed development is to consist of a residential development consisting of three properties and an earth sound barrier.

6.2 Foundation Design

6.2.1 The results of laboratory tests indicate the Glacial Gravel when encountered as gravelly clay is of very high plasticity and of low swell potential as defined by the National House Building Council, ref 8.3 and other published data, refs 8.4 and 8.5. Changes in moisture content will result in small changes in volume, seasonal changes being exacerbated by the presence of trees.

6.2.2 On the basis of observations made on site together with results of in-situ and laboratory tests, it is recommended that consideration could be given to the adoption of strip or trench fill foundations to support the proposed structures.

6.2.3 It is recommended that conventional shallow spread footings should be taken through any Made Ground and placed in the underlying Glacial Gravel or Structureless Upper Chalk at a minimum depth of 0.75m. Due to the depth of Made Ground encountered in the trial pits, it is likely that foundations would have to be placed at depths up to 0.90m.

6.2.4 Such foundations may be designed to an allowable bearing pressure of 150kN/m^2, which would provide an adequate factor of safety against shear failure and limit settlements to the order of 10mm.

6.2.5 It is recommended that the Building Control Officer at the local council is contacted as to whether they have any special design requirements in this area.

6.3 Ground Floor Slabs

6.3.1 On the basis of observation on site together with the results of laboratory tests it is recommended that consideration is given to constructing the ground floor slab on formation prepared in the natural strata. Any soft or deleterious material should be removed and replaced with properly compacted granular fill.

6.3.2 Where the final levels dictate that the depth of sub floor fill exceeds 600mm, ground floor slabs should be suspended in accordance with NHBC requirements.

6.4 Excavations

6.4.1 On the basis of observations on site, together with the results of in-situ and laboratory tests, it is considered that excavations to less than 0.90m should stand unsupported in the short term. Side support for safety purposes should of course be provided to all excavations in excess of 0.90m deep in accordance with Health and Safety Regulations.

6.4.2 Groundwater should not be expected in shallow excavations for foundations or services.

6.5 Road and Hard Standing Design

6.5.1 The structural design of a road or hard standing is based on the strength of the subgrade, which is assessed on the California Bearing Ratio, **CBR**, scale. Experience has indicated that the measurement of the in-situ CBR value tends to give unreliable results because of the influence of the moisture content of the materials. In practice, the correlation given in Transport and Road Research Laboratory, Report 1132, ref. 8.6, is usually more appropriate than direct determination of the CBR.

6.5.2 On the basis of laboratory classification tests it is recommended that for formation prepared in the Made Ground or Glacial Gravel, a subgrade CBR value of 6% be adopted for design purposes. Any areas of soft or deleterious material in the Made Ground should be excavated and replaced with a properly compacted granular fill.

6.5.3 All chalks are highly frost-susceptible; therefore, in the unlikely event of the Upper Chalk being encountered within the access road a minimum of 450mm of road construction should be provided.

6.6 Earth Bund

6.6.1 It is understood that soil excavated during levelling operations in the northwestern section of the site is to be used for an earth sound barrier, which is to be constructed adjacent to the A1(M).

6.6.2 Bulk samples were collected from the uppermost natural soil in trial pit locations 1 and 7 to enable the determination of optimum moisture content and maximum dry density to be carried out.

6.6.3 The optimum moisture content was in the range of 11% to 14% and the maximum dry density in the range of 1.93Mg/m^3 to 2.03Mg/m^3. It is considered that this material would be suitable to be placed in the earth bund.

6.7 Chemical Attack on Buried Concrete

6.7.1 The results of chemical tests indicate a sulphate concentration in the soil of between 49mg/l and 115mg/l as a 2:1 water/soil extract with pH values in the range of 7.4 to 7.6. It is recommended that the guidelines given in BRE Special Digest 1, ref. 8.7, be adopted. Relevant details of this digest are included in Appendix 4, Figure A4.3.

6.7.2 It is recommended that for conventional shallow foundations, the groundwater should be regarded as mobile.

6.7.3 On the basis of the laboratory test results it is considered that a Design Sulphate Class for the site may by taken as DS-1. The site conditions would suggest that an ACEC class for the site of AC-1 would be appropriate.

7.0 RECOMMENDATIONS IN RELATION TO GAS GENERATION

7.1 Assessment of Gas Emission

7.1.1 Although no gas monitoring was undertaken, based upon the ground conditions encountered on site, it is considered that no special precautions need be adopted within the proposed structures to prevent the ingress of toxic gases.

7.1.2 The National Radiological Protection Board, ref. 8.9, indicates the site to lie within an area where there is a probability of <1% of present or future homes being above the action level of 200Bq/m^3. As such, the site is not classified as a Radon Affected Area. This is confirmed by the Building Research Establishment, Report 211, ref 8.10.

8.0 REFERENCES

8.1 British Standards Institute: BS 5930 'Code of practice for site investigations', BSi 1999.

8.2 CIRIA Report C574, 'Engineering in Chalk' London 2002.

8.3 National House-Building Council, Standards, Chapter 4.2, 2003 'Building Near Trees'.

8.4 BRE Digest 240, 'Low-rise buildings on shrinkable clay soils: Part 1'. September 1993

8.5 Geotechnique, June 1983.

8.6 Transport and Road Research Laboratory, Report 1132, 'The Structural Design of Bituminous Roads'. 1984.

8.7 Building Research Establishment, Special Digest 1, 'Concrete in Aggressive Ground', 2005.

8.8 Wilson S A and Card G B, 'Reliability and Risk in Gas Protection Design', 2004.

8.9 National Radiological Protection Board, Report NRPB-R290, 1996, 'Radon Atlas of England'.

8.10 BRE Report 211, 'Radon, Guidance on the Protective Measures for New Buildings, 1999

8.11 Department of the Environment and the Welsh Office, 'The Building Regulations Approved Document C, Site Preparation and Resistance to Moisture', 1992.

8.12 CIRIA Reports 149 to 152, 'Methane and Associated Hazards to Construction', 1995.

8.13 Skennerton S, 'Landfill Gas: Rates vs Concentrations', Presentation notes from Remediation of Hazardous Gases: Workshop. Regional Group Meeting, Geological Society, 3 June 1997.

For and on behalf of Ian Farmer Associates (1998) Limited

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BSc (Hons) FGS
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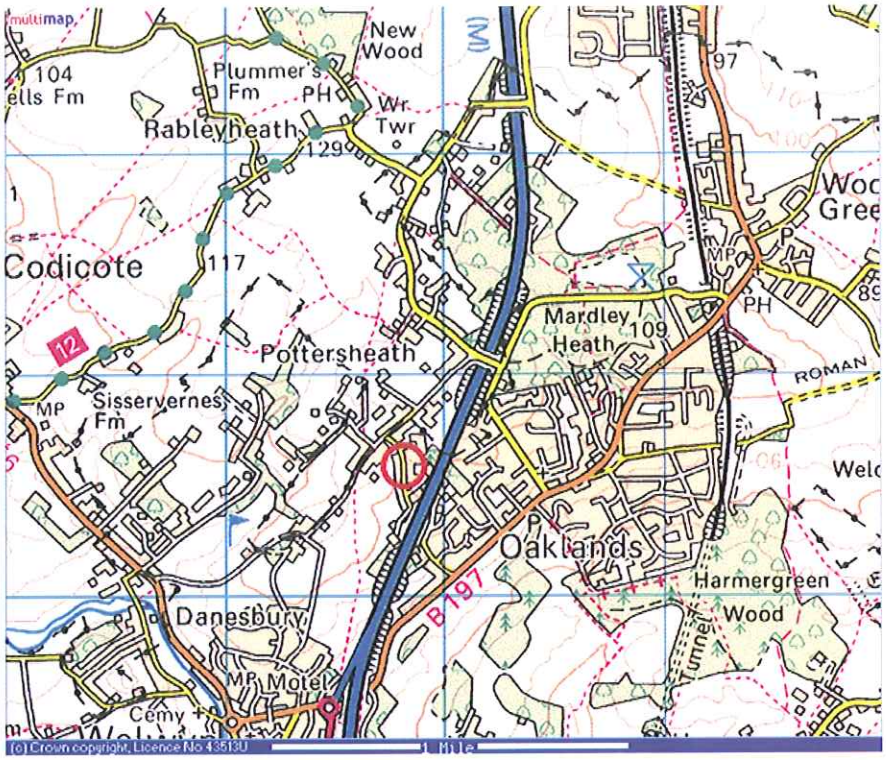
Director

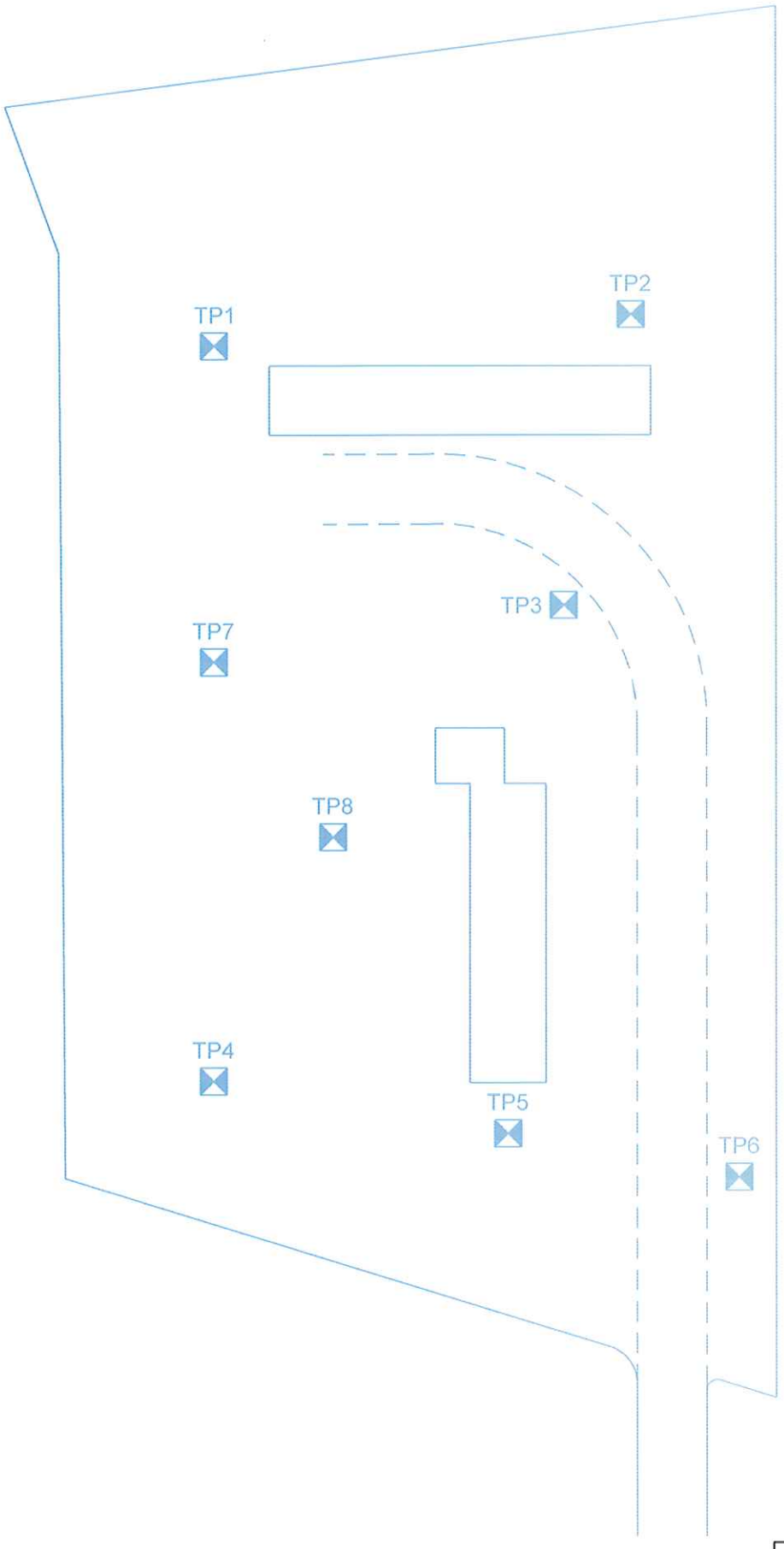
APPENDIX 1

DRAWINGS





IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	**Site Location Plan and Aerial Photograph**	Job no. 50411
	22 The Avenue, Welwyn, Hertfordshire, AL6 0PP	Fig. A1.1



A1(M)

N

Scale :	N.T.S.
Drawn By :	P.L.E.
Job No:	50411
Fig:	A1.2

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

SITE PLAN

22 The Avenue, Welwyn, Herts.

APPENDIX 2

SITE WORK

APPENDIX 2

GENERAL NOTES ON SITE WORKS

A2.1 SAMPLES

U(x) represents undisturbed 100mm diameter sample with (x) being the number of blows required to obtain sample.

U fail indicates undisturbed sample not recovered

HV represents Hand Vane test with equivalent undrained shear strength

PP represents Pocket Penetrometer test with equivalent undrained shear strength

CBR represents California Bearing Ratio test

B represents large bulk disturbed samples

D represents small disturbed sample

W represents water sample

$\underline{\nabla}$ respresents water strike

$\underline{\blacktriangledown}$ represents level to which water rose

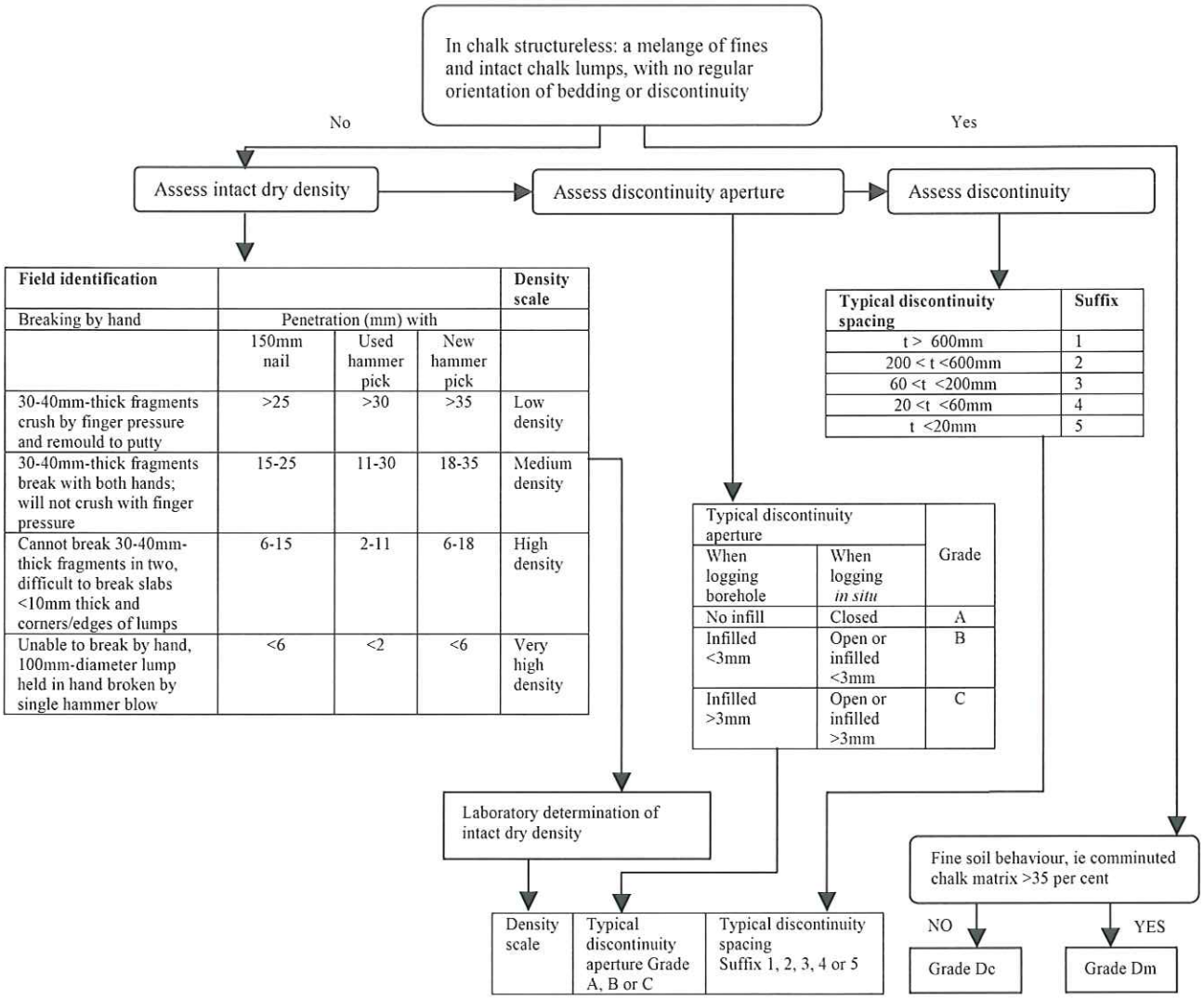
A2.2 DESCRIPTION OF SOILS

A2.2.1 General

The procedures and principles given in Section 6 of BS 5930, ref. 8.1 have been used in the soil descriptions contained within this report.

A2.2.2 Chalk

The descriptions and Grades of Chalk are based on guidelines given in CIRIA Report C574, ref. 8.2. The principal details are as follows.



Field identification				**Density scale**
Breaking by hand	Penetration (mm) with			
	150mm nail	Used hammer pick	New hammer pick	
30-40mm-thick fragments crush by finger pressure and remould to putty	>25	>30	>35	Low density
30-40mm-thick fragments break with both hands; will not crush with finger pressure	15-25	11-30	18-35	Medium density
Cannot break 30-40mm-thick fragments in two, difficult to break slabs <10mm thick and corners/edges of lumps	6-15	2-11	6-18	High density
Unable to break by hand, 100mm-diameter lump held in hand broken by single hammer blow	<6	<2	<6	Very high density

Typical discontinuity spacing	**Suffix**
t > 600mm	1
200 < t <600mm	2
60 <t <200mm	3
20 <t <60mm	4
t <20mm	5

Typical discontinuity aperture		Grade
When logging borehole	When logging *in situ*	
No infill	Closed	A
Infilled <3mm	Open or infilled <3mm	B
Infilled >3mm	Open or infilled >3mm	C

IAN FARMER ASSOCIATES

Site	Trial Pit Number
The Avenue, Welwyn, Hertfordshire.	TP1

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Mechanical Excavator			BMG Limited	50411
	Location TL 238 174	**Dates** 11/08/2005	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.25	D1				(0.40)	MADE GROUND: Dark greyish brown sandy gravelly clayey topsoil with occasional fine to coarse gravel sized brick, concrete and tile fragments, traces of metal pipe, roots and rootlets.		
0.50	D2				0.40	Orange brown clayey fine to coarse gravelly SAND with traces of dark grey clay pockets. Gravel is fine to coarse rounded to subangular flint.		
1.25	D3				(2.60)			
2.50	D4				3.00	Structureless CHALK composed of cream with occasional orange brown staining, slightly gravelly sandy silt. Gravel is weak, low density. Locally light brown. (Grade Dc) (Upper Chalk).		
					3.20	Complete at 3.20m		

Plan

Remarks

Pit remained open during excavation
Groundwater not encountered

Scale (approx)	Logged By	Figure No.
1:50	BMC	A2.1

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IAN FARMER ASSOCIATES

Site	Trial Pit Number
The Avenue, Welwyn, Hertfordshire.	TP2

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Mechanical Excavator			BMG Limited	50411
	Location TL 238 174	**Dates** 11/08/2005	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.40	D				(0.90)	MADE GROUND: Dark greyish brown sandy gravelly clayey topsoil with occasional fine to coarse gravel sized brick, concrete, and tile fragments, traces of wood and plastic. Sand is fine to coarse. Gravel is fine to coarse angular to subrounded flint.		
1.20	D				0.90	Orange brown very clayey fine to coarse SAND and fine to cobble size rounded to subangular flint GRAVEL with some stiff very sandy very gravelly clay pockets from 2.80m and occasional fine to medium gravel sized chalk fragments from 3.00m.		
2.00	D				(2.30)			
2.50	D							
3.00	D				3.20	Complete at 3.20m		

Plan

Remarks

Groundwater not encountered
Pit remained open during excavation

Scale (approx)	Logged By	Figure No.
1:50	BMC	A2.2

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IAN FARMER ASSOCIATES

Site	Trial Pit Number
The Avenue, Welwyn, Hertfordshire.	TP3

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Mechanical Excavator			BMG Limited	50411
	Location TL 238 174	**Dates** 11/08/2005	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.30	D1				(0.60)	MADE GROUND: Dark greyish brown sandy gravelly clayey topsoil with occasional fine to coarse gravel sized brick and concrete fragments, roots and rootlets. Sand is fine to coarse. Gravel is fine to coarse angular to subrounded flint.		
					0.60			
1.00	D2					Orange brown clayey to very clayey fine to coarse SAND and fine to cobble size rounded to subangular flint GRAVEL with occasional stiff orange brown with occasional black flecks sandy clay pockets from 3.00m		
1.50	D3				(2.60)			
2.50	D4							
3.00	D5				3.20			
						Complete at 3.20m		

Plan

Remarks

Groundwater not encountered
Pit remained open during excavation

Scale (approx)	Logged By	Figure No.
1:50	BMC	A2.3

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IAN FARMER ASSOCIATES

Site	Trial Pit Number
The Avenue, Welwyn, Hertfordshire.	TP4

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Mechanical Excavator			BMG Limited	50411
	Location TL 238 174	**Dates** 11/08/2005	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.10	D1				(0.25) 0.25	MADE GROUND: Dark greyish brown sandy gravelly clayey topsoil with occasional fine to coarse gravel sized brock, concrete and tile fragments, roots and rootlets. Sand is fine to coarse. Gravel is fine to coarse subangular to rounded flint.		
0.45	D2				(0.25) 0.50			
1.00	D3				(1.00)	MADE GROUND: Light brown sandy gravelly clayey topsoil with occasional fine to coarse gravel sized brick and concrete fragments, roots and rootlets. Sand is fine to coarse. Gravel is fine to coarse subangular to rounded flint.		
1.50	D4				1.50 (0.30) 1.80	Stiff orange brown very sandy gravelly CLAY. Sand is fine to coarse. Gravel is fine to cobble sized rounded to angular flint.		
						Structureless CHALK composed of a light brown matrix and gravel size clasts of medium to high density. (Grade Dc) (Upper Chalk).		
					(1.20)	Structured medium to high density white CHALK with occasional black specks. (Grade A4) (Upper Chalk).		
2.70	D5				3.00	Complete at 3.00m		

Plan

Remarks

Pit remained open during excavation
Groundwater not encountered

Scale (approx)	Logged By	Figure No.
1:50	BMC	A2.4

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IAN FARMER ASSOCIATES

Site	Trial Pit Number
The Avenue, Welwyn, Hertfordshire.	TP5

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Mechanical Excavator			BMG Limited	50411
	Location TL 238 174	**Dates** 11/08/2005	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.40) 0.40	MADE GROUND: Dark greyish brown sandy gravelly clayey topsoil with occasional fine to coarse gravel size brick and concrete fragments, roots and rootlets. Sand is fine to coarse. Gravel is fine to coarse angular to subrounded flint.		
0.40	D				(1.10)	Orange brown very clayey gravelly fine to coarse SAND with occasional brown stained cream gravel sized chalk fragments. Gravel is fine to coarse rounded to subangular flint.		
1.20	D				1.50	Structureless CHALK composed of a light brown matrix with some gravel sized clasts of medium density. (Grade Dm) (Upper Chalk).		
					(0.40) 1.90	Structured medium to high density white chalk with occasional black specks. (Grade A4) (Upper Chalk).		
2.50	D				(1.10)			
3.00	D				3.00	Complete at 3.20m		

Plan

Remarks

Groundwater not encountered
Pit remained open during excavation

Scale (approx)	Logged By	Figure No.
1:50	BMC	A2.5

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IAN FARMER ASSOCIATES

Site	Trial Pit Number
The Avenue, Welwyn, Hertfordshire.	TP6

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Mechanical Excavator			BMG Limited	50411
	Location TL 238 174	**Dates** 11/08/2005	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.70)	MADE GROUND: Dark greyish brown sandy gravelly clayey topsoil with occasional fine to coarse gravel sized brick and concrete fragments, traces of roots and rootlets. Sand is fine to coarse. Gravel is fine to coarse angular to subrounded flint.		
0.60	D				0.70			
					(0.40)	Orange brown very clayey gravelly fine to coarse SAND. Gravel is fine to coarse subangular to rounded flint.		
1.20	D				1.10			
					(0.70)	Structureless CHALK composed of a light brown matrix and gravel size clasts of medium density. (Grade Dc) (Upper Chalk).		
					1.80			
					(0.60)	Structured medium to high density white CHALK with occasional light brown staining. (Grade A4) (Upper Chalk)		
					2.40			
						Complete at 2.40m		

Plan

Remarks

Groundwater not encountered
Pit remained open during excavation

Scale (approx)	Logged By	Figure No.
1:50	BMC	A2.6

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IAN FARMER ASSOCIATES

Site	Trial Pit Number
The Avenue, Welwyn, Hertfordshire.	TP7

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Mechanical Excavator			BMG Limited	50411
	Location TL 238 174	**Dates** 11/08/2005	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.30	D1				(0.40) 0.40	MADE GROUND: Dark to light greyish brown sandy gravelly clayey topsoil with occasional fine to coarse gravel size brick and concrete fragments, roots and rootlets. Sand is fine to coarse. Gravel is fine to coarse angular to subrounded flint.		
					(0.30) 0.70	Orange brown clayey gravelly fine to coarse SAND wih some firm to stiff brown sandy clay pockets. Gravel is fine to coarse subangular to rounded flint.		
1.50	D2				(0.90) 1.60	Structureless CHALK composed of a light brown matrix with clasts of medium density, some clayey gravelly fine to coarse sand. Gravel is fine to coarse subangular to rounded flint.		
2.10	D3				(1.40)	Structured medium to high density white CHALK with traces of iron staining and flint cobbles. (Grade A4) (Upper Chalk).		
2.90	D4				3.00	Complete at 3.00m		

Plan

Remarks

Pit remained open during excavation
Groundwater not encountered

Scale (approx)	Logged By	Figure No.
1:50	BMC	A2.7

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APPENDIX 3

LABORATORY TESTS

APPENDIX 3

GENERAL NOTES ON LABORATORY TESTS ON SOILS

A3.1 GENERAL

A3.1.1 Where applicable all tests are carried out in accordance with the relevant British Standard. The laboratory test procedures are as below:

Test Name	Procedures BS1377:1990 Part:Clause
Moisture Content	2:3
Liquid Limit	2:4
Plastic Limit and Plastic Index	2:5
Particle Size Distribution	2:9
Sulphate content	3:5
pH Value	3:9
Compaction Test	4:3*
California Bearing Ratio	4:7
Consolidation	5:3
Bulk Density	7:2*
Laboratory Vane Tests	7:3*
Triaxial Compression	
Total Stress Single-Stage	7:8
Total Stress Multi-Stage	7:9
Desiccation	Note 1*

Note 1 - BRE Information paper IP4 issued February 1993
* Tests are not included in UKAS accreditation

A3.1.2 Any discussion in this report is based on the values and results obtained from the appropriate tests. Due allowance should be made, when considering any result in isolation, of the possible inaccuracy of any such individual result. Details of the accuracy of results are included in this section, where applicable.

A3.2 MOISTURE CONTENT

A3.2.1 Unless stated to the contrary, the moisture content of a soil sample was determined by the standard oven drying method, BS 1377, Part 1, Test 3. The result is reported to an accuracy of ±0.5%

A3.3 ATTERBERG LIMITS

A3.3.1 The Liquid Limit, **LL**, is the moisture content at which the soil passes from the liquid to plastic state. Unless stated to the contrary, the Liquid Limit was determined using the four point, cone penetrometer method, Test 4. The value is reported to the nearest whole number, to an accuracy of ±0.5%.

A3.3.2 The Plastic Limit, **PL**, is the moisture content at which soil passes from the plastic to solid state and becomes too dry to remain in a plastic condition. The Plastic Limit was determined using the method described in Test 5. The value is reported to the nearest whole number, to an accuracy of ±0.5%.

A3.3.3 The Plasticity Index, **PI**, is the numerical difference between the liquid and plastic limits, corresponding to the range of moisture contents over which a soil is in a plastic state. The determination of the Plasticity Index is covered by Test 5.

A3.4 SOIL CLASSIFICATION

A3.4.1 Classification of soils is usually undertaken by means of the Plasticity Classification Chart, sometimes called the A-Line Chart. This is a graphical plot of PI against LL with the A-Line defined as PI = 0.73(LL - 20).

A3.4.2 This line is defined from experimental evidence and does not represent a well defined boundary between soil types, but forms a useful reference datum. When the values of LL and PI for inorganic clays are plotted on the chart they generally lie just above the A-Line in a narrow band parallel to it, while silts and organic clays plot below this line.

A3.4.3 Clays and silts are divided into five zones of plasticity:

Low Plasticity (L)	LL less than 35
Intermediate Plasticity (I)	LL between 35 and 50
High Plasticity (H)	LL between 50 and 70
Very High Plasticity (V)	LL between 70 and 90
Extremely High Plasticity (E)	LL greater than 90

A3.4.4 In general, clays of high plasticity are likely to have a lower permeability, are more compressible and consolidate over a longer period of time under load than clays of low plasticity. Clays of high plasticity are more difficult to compact as fill material.

A3.5 CHEMICAL TESTS

A3.5.1 The total sulphate content of soil was determined using the gravimetric method detailed in BS1377: Part 3:1990, Test 5. The results are recorded to an accuracy of ±0.1%.

A3.5.2 The water soluble sulphate content of soil was determined using the gravimetric method detailed in BS1377: Part 3: 1990, Test 5. The results are recorded to an accuracy of ±0.1g/l.

A3.5.3 The sulphate content of groundwater was determined the gravimetric method detailed in BS1377: Part 3: 1990, Test 5. The rests are record to an accuracy of ±0.1g/l.

A3.5.4 The pH value was determined electrometrically using the procedures given in BS 1377: Part 3: 1990, Test 9. The results are recorded to an accuracy of ±0.1 pH units.

Location		Sample		NMC (%)	Index properties				NMC / LL	Liquidity Index	Test Type	Chemical Tests				
Lab. Ref. (G)	TP/ BH	Depth (m)	Type		LL (%)	PL (%)	PI (%)	<425µm (%)				Total Sulphur (% S)	Sulphate as SO_4			pH
													GW (mg/l)	Total (%)	2:1 Extract (mg/l)	
189635	TP3	1.00	D												49	7.4
189641	TP4	1.00	D	15	72	36	36	51	0.41	-0.58	4 Pt				115	7.6

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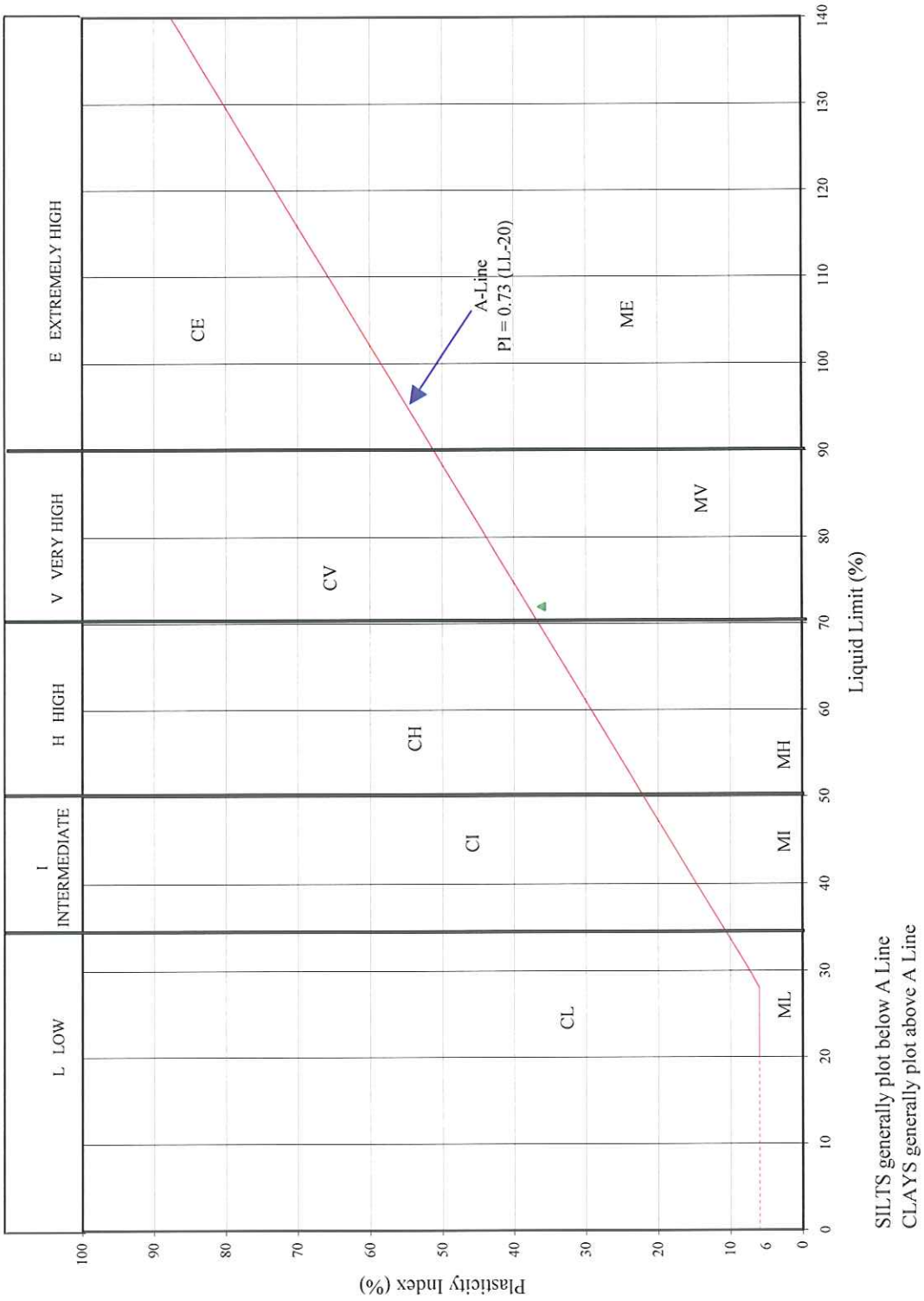
RESULTS OF LABORATORY TESTS

The Avenue, Welwyn, Hertfordshire

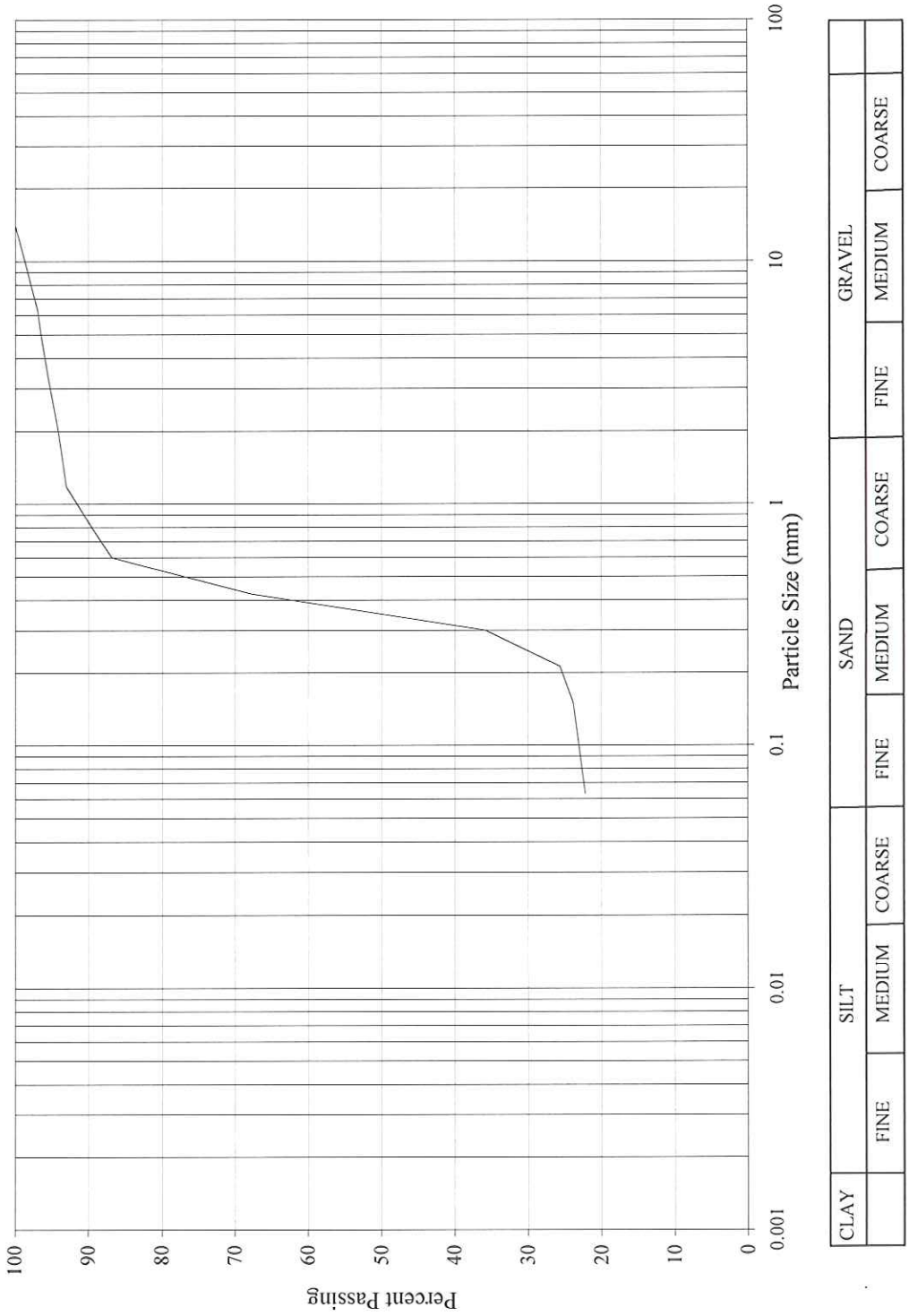
Job no. 50411

Fig. A3.1



IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	**PLASTICITY CLASSIFICATION CHART**	Job no. 50411
	The Avenue, Welwyn, Hertfordshire	Fig no. A3.2

TP1 @ 1.25 - G189627



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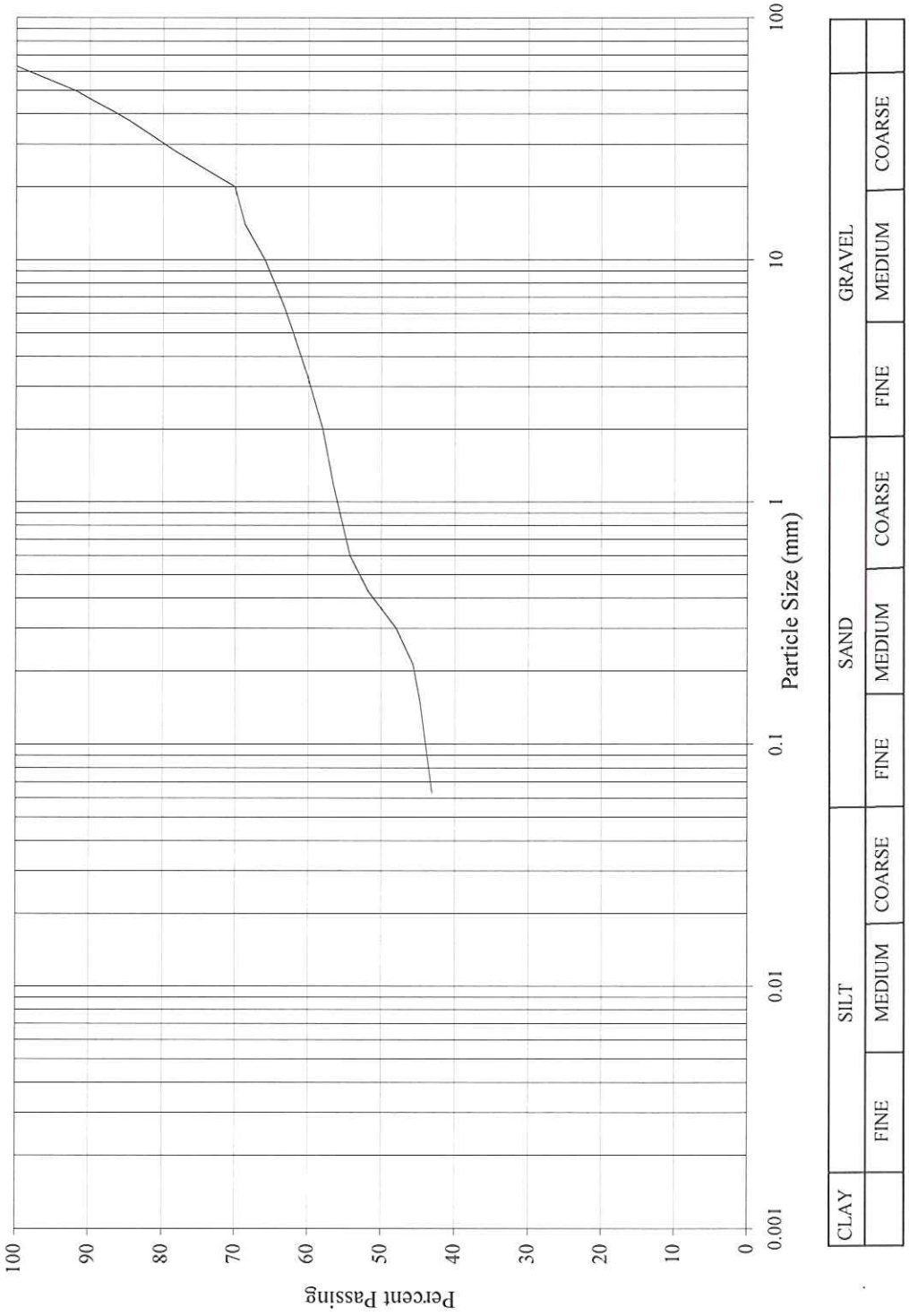
PARTICLE SIZE DISTRIBUTION

The Avenue, Welwyn, Hertfordshire

Job no. 50411

Fig no. A3.3

TP5 @ 1.20 - G189645



IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	**PARTICLE SIZE DISTRIBUTION**	Job no. 50411
	The Avenue, Welwyn, Hertfordshire	Fig no. A3.4

Site : The Avenue

Client :

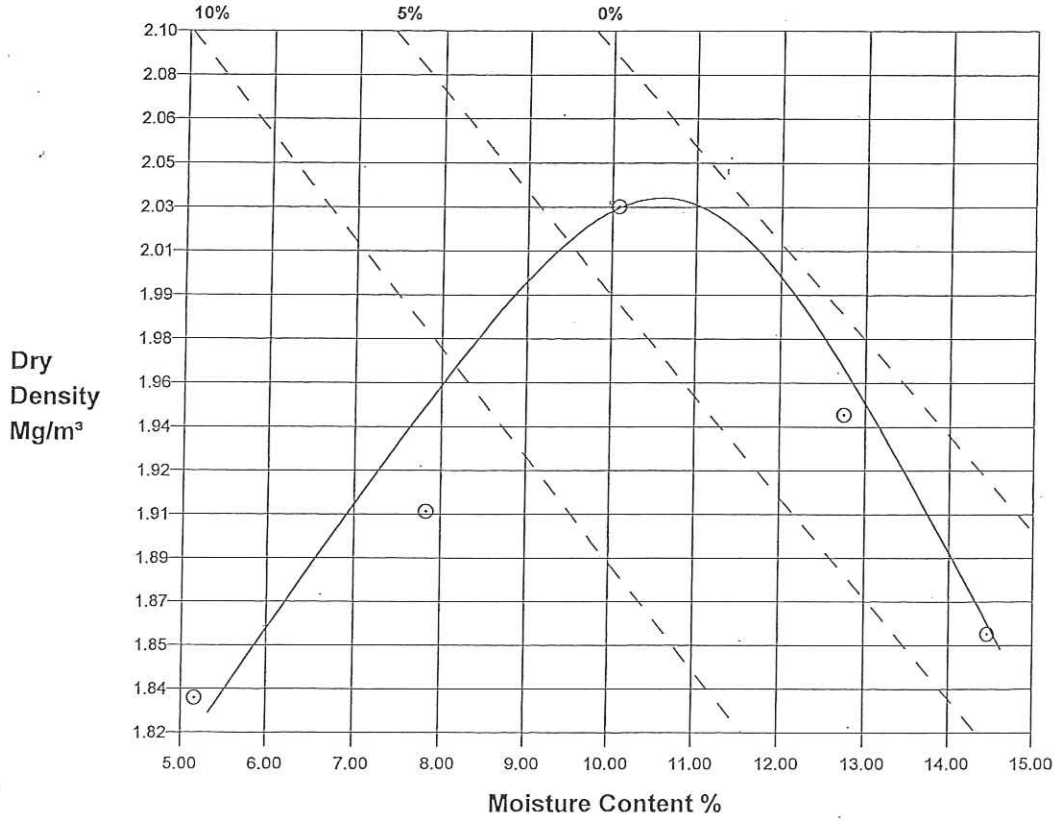
Job Number 50411

Sheet 1 / 2

DETERMINATION OF DRY DENSITY/MOISTURE CONTENT RELATIONSHIP

Borehole / Trial Pit	Depth (m)	Sample	Description
TP1	0.5	B1	Brown very sandy CLAY with fine to coarse gravel

Percentage retained 37.5 mm	2 %	Max size of cohesive lumps	20 mm
Percentage retained 20.0 mm	5 %	Single or separate samples	Single
Grading Zone	4	Particle density	2.65 Assumed
Mould Type	1 Litre/proctor	Method of compaction	2.5kg Rammer
MAX DRY DENSITY	2.03 Mg/m³	**OPTIMUM MOISTURE CONTENT**	11 %



Method of Preparation : BS 1377:PART 4:1990:3.2 Preparation of samples for compaction tests

Method of Test : BS 1377:PART 4:1990:3.4 Determination using 2.5 kg rammer,3.6 Determination using 4.5kg rammer: PART 2:1990:3 Determination of partical density

Remarks :

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Geotechnical & Environmental Specialists

COMPACTION TESTS

The Avenue, Welwyn, Hertfordshire

Job no. 50411

Fig. A3.5

Site : The Avenue

Client :

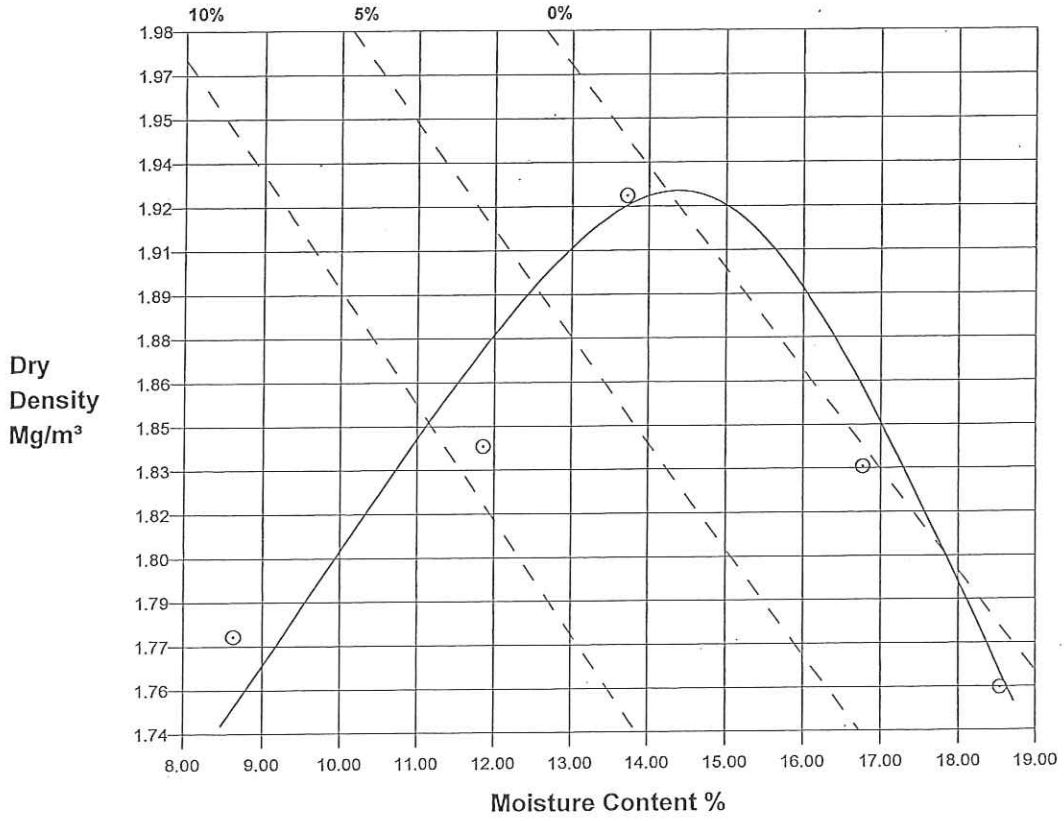
Job Number 50411

Sheet 2 / 2

DETERMINATION OF DRY DENSITY/MOISTURE CONTENT RELATIONSHIP

Borehole / Trial Pit	Depth (m)	Sample	Description
TP7	0.00	B1	Brown sandy silty CLAY with fine to coarse gravel and chalk fragments

Percentage retained 37.5 mm	4 %	Max size of cohesive lumps	20 mm
Percentage retained 20.0 mm	12 %	Single or separate samples	Single
Grading Zone	4	Particle density	2.65 Assumed
Mould Type	1 Litre/proctor	Method of compaction	2.5kg Rammer
MAX DRY DENSITY	1.93 Mg/m³	**OPTIMUM MOISTURE CONTENT**	14 %



Method of Preparation : BS 1377:PART 4:1990:3.2 Preparation of samples for compaction tests

Method of Test : BS 1377:PART 4:1990:3.4 Determination using 2.5 kg rammer,3.6 Determination using 4.5kg rammer: PART 2:1990:3 Determination of partical density

Remarks :

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Geotechnical & Environmental Specialists

COMPACTION TESTS

The Avenue, Welwyn, Hertfordshire

Job no. 50411

Fig. A3.6

APPENDIX 4

DESIGN CONSIDERATIONS

Broad leafed trees		
Water demand	Species	Mature height (m)
High	Elm	
	English	24
	Wheatley	22
	Wych	18
	Eucalyptus	18
	Hawthorn	10
	Oak	
	English	20
	Holm	16
	Red	24
	Turkey	24
	Poplar	
	Hybrid black	28
	Lombardy	25
	White	15
	Willow	
	Crack	24
	Weeping	16
	White	24
Moderate	Acacia False	18
	Alder	18
	Apple	10
	Ash	23
	Bay Laurel	10
	Beech	20
	Blackthorn	8
	Cherry	
	Japanese	9
	Laurel	8
	Orchard	12
	Wild	17
	Chestnut	
	Horse	20
	Sweet	24
	Lime	22
	Maple	
	Japanese	8
	Norway	18
	Mountain ash	11
	Pear	12
	Plane	26
	Plum	10
	Sycamore	22
	Tree of Heaven	20
	Walnut	18
	Whitebeam	12
Low	Birch	14
	Elder	10
	Fig	8
	Hazel	8
	Holly	12
	Honey Locust	14
	Hornbeam	17
	Laburnum	12
	Magnolia	9
	Mulberry	9
	Tulip tree	20

Coniferous trees		
Water demand	Species	Mature height (m)
High	Cypress	
	Lawson's	18
	Leyland	20
	Monterey	20
Moderate	Cedar	20
	Douglas fir	20
	Larch	20
	Monkey Puzzle	18
	Pine	20
	Spruce	18
	Wellingtonia	30
	Yew	12

Note

1. Where hedgerows contain trees, their effects should be assessed separately. In hedgerows, the height of species likely to have the greatest effect should be used

2. Within the classes of water demand, species are listed alphabetically; the order does not signify any graduation in water demand

3. When the species is known but the sub-species is not, the greatest height listed for the species should be assumed

4. Further information regarding trees may be obtained from the Arboricultural Association or the Arboricultural Advisory and Information Service

Reproduced from National House Building Council, Standards, 2003, Chapter 4.2, 'Building Near Trees'

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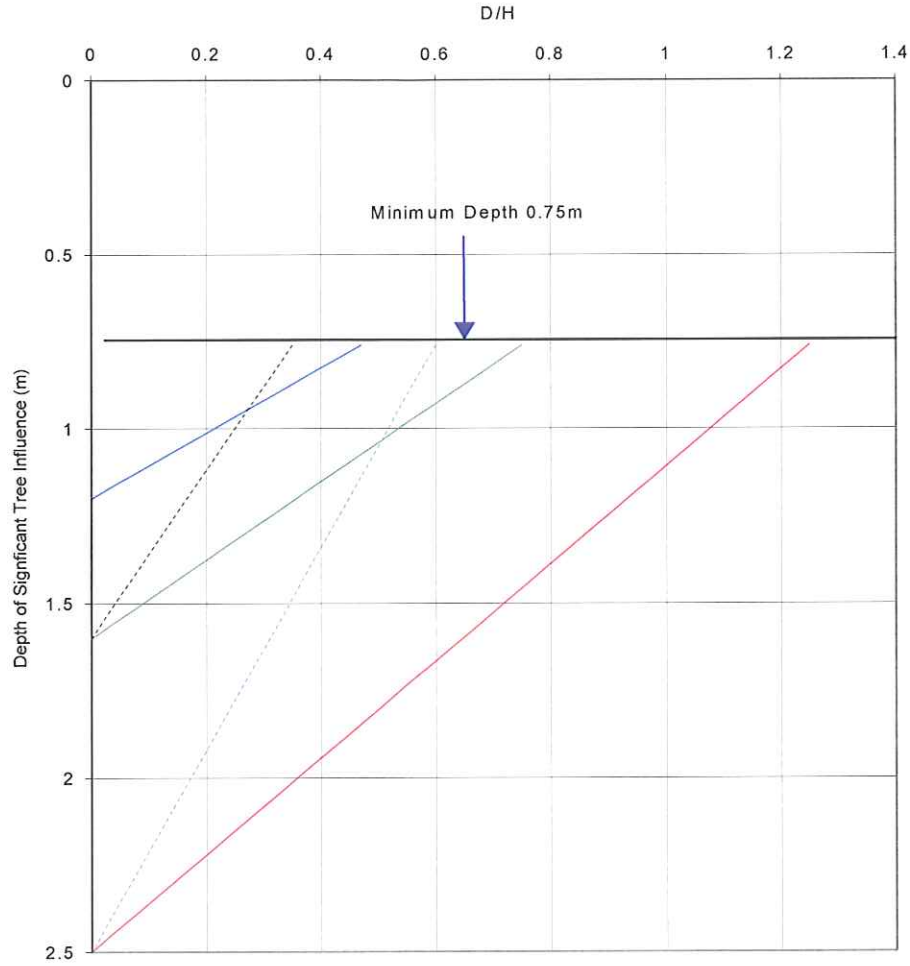
WATER DEMAND AND MATURE HEIGHT OF TREES

The Avenue, Welwyn, Hertfordshire

Job no. 50411

Fig. A4.1



Broad Leaf ——— D = Distance between tree and foundation

Conifers - - - - - - H = Height of Tree

Low water demand ---------- Moderate water demand ——— Moderate water demand

High water demand ——— High water demand

Reproduced from National House Building Council, Standards 2003, Chapter 4.2, 'Building Near Trees'

IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	DETERMINATION OF FOUNDATION DEPTH – LOW SHRINKAGE SOILS	Job no. 50411
	The Avenue, Welwyn, Hertfordshire	Fig. A4.2

Aggressive Chemical Environment for Concrete (ACEC) classification for natural ground locations

Sulphate				Groundwater		
Design Sulphate Class for location	2:1 water/soil extract[b]	Groundwater	Total potential sulphate[c]	Static water	Mobile water	ACEC class for location
	(SO_4 mg/l)	(SO_4mg/l	(SO_4 %)	(pH)	(pH)	
DS-1	<500	<400	0.24	≥2.5		AC-1s
					>5.5[d]	AC-1[d]
					2.5-5.5	AC-2z
DS-2	500-1500	400-1400	0.24-0.6	>3.5		AC-1s
					>5.5	AC-2
				2.5-3.5		AC-2s
					2.5-5.5	AC-3z
DS-3	1600-3000	1500-3000	0.7-1.2	>3.5		AC-2s
					>5.5	AC-3
				2.5-3.5		AC-3s
					2.5-5.5	AC-4
DS-4	3100-6000	3100-6000	1.3-2.4	>3.5		AC-3s
					>5.5	AC-4
				2.5-3.5		AC-4s
					2.5-5.5	AC-5
DC5	>6000	>6000	>2.4	>3.5		AC-4s
				2.5-3.5	≥2.5	AC-5

Notes

a Applies to locations on sites that comprise either undisturbed ground that is in its natural state (ie is not brownfield) or clean fill derived from such ground.

b The limits of Design Sulphate Classes based on 2:1 water/soil extracts have been lowered relative to previous Digests

c Applies only to locations where concrete will be exposed to sulphate ions (SO_4) which may result from the oxidation of sulfides (eg pyrite) following ground disturbance

d For flowing water that is potentially aggressive to concrete owing to high purity or an aggressive carbon dioxide level greater than 15 mg/l, increase the ACEC Class to AC-2z.

Explanation of suffix symbols to ACEC Class

- Suffix 's' indicates that the water has been classified as static
- Concrete placed in ACEC Classes that include the suffix 'z' primarily have to resist acid conditions and may be made with any of the cements or combinations listed in Digest

APPENDIX 5

GAS GENERATION

APPENDIX 5

GENERAL NOTES ON GAS GENERATION

A5.1 GENERAL

A5.1.1 Soft organic clays, peat, Made Ground and landfills are potentially subject to significant microbial degradation resulting in the formation of a mixture of gases and vapours.

A5.1.2 The chemical composition of landfill gas varies over time, a typical landfill gas can comprise up to 65% methane and 35% carbon dioxide. The properties of landfill gases are determined principally by the proportions of these two gases together with their mixture with air. Trace amounts of other gases such as hydrogen and hydrogen sulphide plus a range of organic vapours can also be present.

A5.1.3 Methane is colourless, odourless, non-toxic asphyxiant gas, which is flammable in air. However, the gas will only burn when mixed with air in certain proportions defined by the lower and upper limits of flammability (or explosibility). Any mixture of methane in air within these limits will burn if ignited. However, a mixture with a concentration of methane above the upper explosive limit (UEL) should not be considered safe since dilution with clean air will result in a composition within the flammable range. Thus mixtures above the UEL are a potential hazard and only mixtures below the lower explosive limit (LEL) can be considered safe. The LEL and UEL for methane are 5%v/v and 15%v/v respectively.

A5.1.4 Carbon dioxide is a non-flammable toxic gas with a long-term exposure limit of 0.5% by volume and a short-term limit of 1.5% by volume.

A5.1.5 On sites such as former docklands or reclaimed estuaries, gas is generated slowly and is characterised by low volumes of gas and low surface emissions. Development has taken place on such sites over many years without problems.

A5.1.6 In the case of recent landfills or mine workings, methane can be generated rapidly. This gives rise to large volumes of gas being produced with high surface emission rates. These conditions pose a risk to development.

A5.1.7 The Building Regulations Approved Document C (1992), ref. 8.11, gives guidance on the problems associated with the presence of landfill gas. This guidance suggests that where the level of methane is unlikely to exceed 1% by volume no further protection needs to be provided if the ground floor is suspended concrete and ventilated.

A5.1.8 Carbon dioxide should be considered independently of methane. Concentrations exceeding 1.5% by volume in the ground indicate a need to consider gas exclusion measures, while a level of 5% implies that specific design measures are required.

A5.1.9 Guidelines produced in Table 28 of CIRIA Report 149, ref. 8.12 are frequently used as a design tool with little regard to the nature of the gassing source or surface emission rates. However, this table was never intended as a definitive design tool.

A5.1.10 The most important aspect relating to the risk posed to a development by the gas regime below the site is, how quickly is the gas coming out of the ground. The lower the surface emission rate the lower the risk.

A5.1.11 For design purposes the gas flow rate and gas concentration provide a more reliable method for classifying a site and specifying the scope of gas protection.

A5.1.12 A rational method for classifying gassing sites in terms of the risks posed by the presence of gas should consider the following, ref. 8.8.

- the source of the gas
- the generation potential of the source
- the location of the source and the presence of any natural geological barriers to migration
- the borehole flow rate and surface emission rate
- measured gas concentrations
- the nature of proposed development
- the confidence in the knowledge of the gas regime and any likely variations in concentration and borehole flow rate

A5.1.13 A risk ranking, ref. 8.12 deemed natural soils with low organic content posed the lowest risk in terms of gas generation while recent landfills, post 1960's, the greatest risk.

Source	Gas generation potential
Natural soils, low peat/lowest organic content	Low generation potential from small amounts of degradable material
Carbonate deposits e.g. Chalk	
Dock silt, Made Ground, low organic content	
Natural soil, Made Ground, high peat/organic content	Moderate generation due to increased levels of degradable material
Landfill – pre 1960	
Mineworking – susceptible to flooding	Potential for high generation if working (and pumping and ventilation) ceases and groundwater levels rise
Mineworking unflooded inactive	Potential for high generation if groundwater levels rise
Mineworking flooded	Potential for high generation if water levels vary
Landfill site, post 1960	High potential for gas generation due to high organic content

A5.1.14 The importance of surface emission rates together with gas concentrations lead to the following ranking system, ref. 8.13.

Scenario	Gas concentration	Borehole flow rate	Risk ranking
1	High	High	1
2	High	Low	3
3	Low	High	2
4	Low	Low	4

A5.1.15 A new method for characterising gassing sites is proposed, taking into account flow rates as well as gas concentrations, ref. 8.8.

Characteristic Situation	Limiting volume flow of CH_4 or CO_2 (l/hr)[1] from borehole	Additional limiting factors	Typical source of generation
1	<0.07	Methane not to exceed 1% volume and carbon dioxide not to exceed 5% by volume	Natural soils with low organic content
2	<0.7	Borehole air flow rate not to exceed 70l/hr otherwise increase to content Characteristic Situation 4	Natural soil, high peat/organic
3	<3.5	Borehole air flow rate not to exceed 701/hr otherwise increase to Characteristic Situation 4	Old landfill, inert waste, mineworking flooded
4	<15	Quantitative risk assessment required to evaluation scope of protection measures	Mineworking – susceptible to flooding, completed landfill, inert waste
5	<70		Mineworking unflooded inactive
6	>70		Recent landfill site

1. Limiting volume flow rate of gas = gas concentration x measured borehole flow rate

2. Site characterisation should be based on gas monitoring of concentrations and borehole flow rates for a minimum of one year and covering a range of atmospheric conditions. For readings covering less than one year but over six months, increase Characteristic Situation by 1. For reading covering less than 6 months but over three months, increase Characteristic Situation by 2.

3. Source of gas and generation potential/performance must be identified

A5.1.16 On the basis of the Characteristic Situation the scope of protection measures may be determined as below.

Characteristic Situation	Typical scope of protection measures	
	Residential Building	Office/commercial/industrial development
1	No special precautions	No special precautions
2	Well constructed ground or suspended floor slab. Waterproofing membrane sealed around penetrations, passively ventilated underfloor sub-space and wall cavities	Reinforced concrete cast in-situ ground slab. All joints and penetrations sealed. Possibly waterproofing membrane. Granular layer below slab passively vented to atmosphere with interleaved geocomposite strips or pipes

3	Wall constructed suspended or ground slab. Gas resistant membrane and passively ventilated underfloor sub-space	Reinforced concrete cast in-situ ground slab. All joints and penetrations sealed. Waterproof/gas resistant membrane and passively ventilated underfloor sub-space
4	Well constructed suspended or ground slab. Gas resistant membrane and passively ventilated underfloor subspace, oversite capping and in ground venting layer	Reinforced concrete cast in-situ ground slab. All joints and penetrations sealed. Gas resistant membrane and passively ventilated underfloor sub-space
5	Specific gas resistant membrane and ventilated underfloor void, oversite capping and in ground venting layer and in ground venting wells	Reinforced concrete cast in-situ slab. All joints and penetrations sealed. Gas resistant membrane and passively ventilated underfloor sub-space. In ground venting wells
6	Not suitable unless gas regime is reduced first and quantitative risk assessment carried out to assess design of protection measures in conjunction with foundation design	Reinforced concrete cast in-situ ground slab. All joints and penetrations sealed. Gas resistant membrane and actively ventilated underfloor sub-space, with monitoring. In ground venting wells

1. Typical scope of protection measures may be rationalised for specific developments on the basis of quantitative risk assessments based on CIRIA Report 152.

2. Note the type of protection is given for illustration purposes only. Individual site specific designs should provide the same number of separate protection methods for any given Characteristic Situation.

3. In all cases there should be minimum penetration of ground slabs by services and minimum number of confined spaces such as cupboards above the ground slab. Any confined spaces should be ventilated.

4. Foundation design must minimise differential settlement particularly between structural elements and ground bearing slabs.

5. Buildings with basement car parks, provided with ventilation in accordance with the Building Regulations, may not require gas resistant membranes for Characteristic Situations 3 and 4.

Appendix 2 – Site Geology and Flood Risk Maps

- *Site Investigation Report*
- *EA Groundwater Maps*

DRAFT

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BMG LIMITED

22 THE AVENUE,
WELWYN, HERTFORDSHIRE AL6 0PP

REPORT ON
SITE INVESTIGATION

Contract: 50411

Date: September 2005

Ian Farmer Associates (1998) Limited
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REPORT ON

SITE INVESTIGATION

carried out at

22 THE AVENUE,

WELWYN, HERTFORDSHIRE AL6 0PP

Prepared for

BMG Limited
Unit 5
Tewin Road Business Centre,
Welwyn Garden City
Hertfordshire
AL6 0PP

Contract No: 50411

Date: September 2005

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CONTENTS

1.0	INTRODUCTION		3
2.0	SITE SETTING		3
	2.1	Site Location	3
	2.2	Site Description	3
	2.3	Geological Setting	4
3.0	SITE WORK		4
4.0	LABORATORY TESTS		4
	4.1	Geotechnical Testing	4
5.0	GROUND CONDITIONS ENCOUNTERED		5
	5.1	Sequence	5
	5.2	Made Ground	5
	5.3	Glacial Gravel	5
	5.4	Upper Chalk	5
	5.5	Groundwater	6
6.0	GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS IN RELATION TO PROPOSED DEVELOPMENT		6
	6.1	Structural Details	6
	6.2	Foundation Design	6
	6.3	Ground Floor Slabs	6
	6.4	Excavations	7
	6.5	Road and Hard Standing Design	7
	6.6	Earth Bund	7
	6.7	Chemical Attack on Buried Concrete	8
7.0	RECOMMENDATIONS IN RELATION TO GAS GENERATION		8
	7.1	Assessment of Gas Emission	8
8.0	REFERENCES		8

APPENDIX 1	-	DRAWINGS	
Figure A1.1	-	Site Location and Aerial Photograph	
Figure A1.2	-	Site Plan	
APPENDIX 2	-	SITE WORK	
		General Notes on Site Work	ii/i-ii/ii
Figures A2.1-A2.7	-	Trial Pit Records	

APPENDIX 3	-	LABORATORY TESTS **General Notes on** **Laboratory Tests on Soils**	iii/i-iii/ii
Figure A3.1	-	Results of Laboratory Tests	
Figure A3.2	-	Plasticity Classification Chart	
Figures A3.3-A3.4	-	Particle Size Distribution	
Figures A3.5-A3.6	-	Compaction Tests	
APPENDIX 4	-	DESIGN CONSIDERATIONS	
Figure A4.1	-	Determination of Water Demand and Mature Height of Trees	
Figure A4.2	-	Determination of Foundation Depth - Low Shrinkage Soils	
Figure A4.3	-	Aggressive Chemical Environment for Concrete (ACEC)	
APPENDIX 5	-	GAS GENERATION **General Notes on Gas Generation**	v/i-v/iv

1.0 INTRODUCTION

1.1 It is understood that it is proposed to develop the site for three detached residential properties with gardens and access road, together with an earth sound barrier.

1.2 On the instructions of BMG Limited, a site investigation was undertaken to determine ground conditions to enable foundation and road/hard standing design to be carried out, together with compaction testing on the surface soil.

1.3 This report has been prepared for the sole use of the Client for the purpose described and no extended duty of care to any third party is implied or offered. Third parties using any information contained within this report do so at their own risk.

1.4 The comments given in this report and the opinions expressed herein are based on the information received, the conditions encountered during site works, and on the results of tests made in the field and laboratory. However, there may be conditions prevailing at the site which have not been disclosed by the investigation and which have not been taken into account in the report.

1.5 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 or other effects.

2.0 SITE SETTING

2.1 Site Location

2.1.1 The site is situated on the eastern side of The Avenue adjacent to the Al(M), in Welwyn, Hertfordshire, and may be located by National Grid reference TL 239 175. A site location plan and aerial photograph are included in Appendix 1, Figure A1.1.

2.2 Site Description

2.2.1 The site which slopes gently up in a broadly northerly direction is predominantly open landscaping with a few trees. A residential property with outbuildings is situated at the southern end and an access track leading to a rectangular building is situated at the northern end of the site. The majority of the site boundaries are substantially wooded with the A1(M) running adjacent to the eastern boundary.

2.2.2 A site plan is included in Appendix 1, Figure A1.2.

2.3 Geological Setting

2.3.1 Details of the geology underlying the site have been obtained from the British Geological Survey map, Sheet No.239, 'Hertford', drift edition, 1:50,000 scale, published 1978.

2.3.2 The geological map indicates the site to be directly underlain by solid deposits of Upper Chalk, described as soft white chalk with many flints. However, to the south and north, the site is indicated as being close to the boundaries with areas of Glacial Gravel.

2.3.3 The site is within an urban area and, although not indicated as present upon the site, the possibility that Made Ground is present cannot be discounted.

3.0 SITE WORK

3.1 The site work was carried out on the 11 August 2005. The site works were carried out on the basis of the practices set out in BS 5930:1999 ref. 8.1.

3.2 Seven trial pits were dug by mechanical excavator at the positions shown on the site plan, Appendix 1, Figure A1.2. The depths of trial pits, descriptions of strata encountered and comments on groundwater conditions are given in the trial pit records, Appendix 2, Figures A2.1 to A2.7. Trial pit 8 comprised a single bulk surface sample only.

3.3 Representative disturbed samples were taken at the depths shown on the trial pit records and despatched to the laboratory.

3.4 The ground levels at the trial pit locations were not determined.

4.0 LABORATORY TESTS

4.1 Geotechnical Testing

4.1.1 The natural moisture content was determined of a single sample and liquid and plastic limit tests were carried out on a single sample and the results included in Appendix 3, Figure A3.1 and on the plasticity classification chart, Figure A3.2.

4.1.2 The particle size distributions of two samples were determined by wet sieving method and the results included in Figures A3.3 to A3.4.

4.1.3 Chemical tests were carried out on two soil samples to determine the sulphate concentrations as a 2:1 water/soil extract and the pH values. The results of these tests are included in Figure A3.1.

5.0 GROUND CONDITIONS ENCOUNTERED

5.1 Sequence

5.1.1 The sequence of the strata encountered during the investigation generally confirms the anticipated geology as interpreted from the geological map.

5.1.2 The sequence and indicative thicknesses of strata are provided below:

Strata Encountered	Depth Encountered (m)		Strata Thickness (m)
	From	To	
Made Ground	0.00	0.40 to 0.90	0.40 to 0.90
Glacial Gravel	0.40 to 0.90	0.70 to >3.20	0.30 to >2.60
Upper Chalk	0.70 to 3.00	>3.20	>2.30

5.2 Made Ground

5.2.1 Made Ground was found in all locations across the site to a depth of between 0.40m and 0.90m as dark greyish brown sandy gravelly clayey topsoil with occasional brick, concrete and tile, with traces of wood, metal and plastic. Roots and rootlets were noted.

5.3 Glacial Gravel

5.3.1 These were encountered below the Made Ground in all locations to a thickness ranging from 0.30m in trial pit 7 to greater than 2.60m in trial pit 3. The stratum consisted of orange brown clayey to very clayey sand or sand and gravel, and occasionally gravelly clay.

5.3.2 Trial pits 2 and 3 were terminated in this stratum.

5.4 Upper Chalk

5.4.1 Upper Chalk was found to underlie the Glacial Gravel in trial pits 1, and 4 to 7, the stratum appeared to dip away in the eastern half of the site, and was not encountered in trial pits 2 and 3 which terminated at 3.20m.

5.4.2 Generally the Upper Chalk was found to comprise weathered structureless chalk of Grade Dc or Dm, overlying structured medium to high-density white chalk of Grade A4.

5.4.3 Trial pit 1 only penetrated the Upper Chalk to a depth of 0.20m, and thus only encountered structureless chalk, grade Dc.

5.4.4 The description of chalk and references to Chalk Grade under the heading 'Description' in the records are based on the guidelines given in CIRIA Report C574 ref 8.2. Details of the Grades are included in Appendix 2.

5.5 Groundwater

5.5.1 Groundwater was not encountered in any of the exploratory holes.

6.0 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS IN RELATION TO PROPOSED DEVELOPMENT

6.1 Structural Details

6.1.1 It is understood that the proposed development is to consist of a residential development consisting of three properties and an earth sound barrier.

6.2 Foundation Design

6.2.1 The results of laboratory tests indicate the Glacial Gravel when encountered as gravelly clay is of very high plasticity and of low swell potential as defined by the National House Building Council, ref 8.3 and other published data, refs 8.4 and 8.5. Changes in moisture content will result in small changes in volume, seasonal changes being exacerbated by the presence of trees.

6.2.2 On the basis of observations made on site together with results of in-situ and laboratory tests, it is recommended that consideration could be given to the adoption of strip or trench fill foundations to support the proposed structures.

6.2.3 It is recommended that conventional shallow spread footings should be taken through any Made Ground and placed in the underlying Glacial Gravel or Structureless Upper Chalk at a minimum depth of 0.75m. Due to the depth of Made Ground encountered in the trial pits, it is likely that foundations would have to be placed at depths up to 0.90m.

6.2.4 Such foundations may be designed to an allowable bearing pressure of 150kN/m^2, which would provide an adequate factor of safety against shear failure and limit settlements to the order of 10mm.

6.2.5 It is recommended that the Building Control Officer at the local council is contacted as to whether they have any special design requirements in this area.

6.3 Ground Floor Slabs

6.3.1 On the basis of observation on site together with the results of laboratory tests it is recommended that consideration is given to constructing the ground floor slab on formation prepared in the natural strata. Any soft or deleterious material should be removed and replaced with properly compacted granular fill.

6.3.2 Where the final levels dictate that the depth of sub floor fill exceeds 600mm, ground floor slabs should be suspended in accordance with NHBC requirements.

6.4 Excavations

6.4.1 On the basis of observations on site, together with the results of in-situ and laboratory tests, it is considered that excavations to less than 0.90m should stand unsupported in the short term. Side support for safety purposes should of course be provided to all excavations in excess of 0.90m deep in accordance with Health and Safety Regulations.

6.4.2 Groundwater should not be expected in shallow excavations for foundations or services.

6.5 Road and Hard Standing Design

6.5.1 The structural design of a road or hard standing is based on the strength of the subgrade, which is assessed on the California Bearing Ratio, **CBR**, scale. Experience has indicated that the measurement of the in-situ CBR value tends to give unreliable results because of the influence of the moisture content of the materials. In practice, the correlation given in Transport and Road Research Laboratory, Report 1132, ref. 8.6, is usually more appropriate than direct determination of the CBR.

6.5.2 On the basis of laboratory classification tests it is recommended that for formation prepared in the Made Ground or Glacial Gravel, a subgrade CBR value of 6% be adopted for design purposes. Any areas of soft or deleterious material in the Made Ground should be excavated and replaced with a properly compacted granular fill.

6.5.3 All chalks are highly frost-susceptible; therefore, in the unlikely event of the Upper Chalk being encountered within the access road a minimum of 450mm of road construction should be provided.

6.6 Earth Bund

6.6.1 It is understood that soil excavated during levelling operations in the northwestern section of the site is to be used for an earth sound barrier, which is to be constructed adjacent to the A1(M).

6.6.2 Bulk samples were collected from the uppermost natural soil in trial pit locations 1 and 7 to enable the determination of optimum moisture content and maximum dry density to be carried out.

6.6.3 The optimum moisture content was in the range of 11% to 14% and the maximum dry density in the range of 1.93Mg/m^3 to 2.03Mg/m^3. It is considered that this material would be suitable to be placed in the earth bund.

6.7 Chemical Attack on Buried Concrete

6.7.1 The results of chemical tests indicate a sulphate concentration in the soil of between 49mg/l and 115mg/l as a 2:1 water/soil extract with pH values in the range of 7.4 to 7.6. It is recommended that the guidelines given in BRE Special Digest 1, ref. 8.7, be adopted. Relevant details of this digest are included in Appendix 4, Figure A4.3.

6.7.2 It is recommended that for conventional shallow foundations, the groundwater should be regarded as mobile.

6.7.3 On the basis of the laboratory test results it is considered that a Design Sulphate Class for the site may by taken as DS-1. The site conditions would suggest that an ACEC class for the site of AC-1 would be appropriate.

7.0 RECOMMENDATIONS IN RELATION TO GAS GENERATION

7.1 Assessment of Gas Emission

7.1.1 Although no gas monitoring was undertaken, based upon the ground conditions encountered on site, it is considered that no special precautions need be adopted within the proposed structures to prevent the ingress of toxic gases.

7.1.2 The National Radiological Protection Board, ref. 8.9, indicates the site to lie within an area where there is a probability of <1% of present or future homes being above the action level of 200Bq/m^3. As such, the site is not classified as a Radon Affected Area. This is confirmed by the Building Research Establishment, Report 211, ref 8.10.

8.0 REFERENCES

8.1 British Standards Institute: BS 5930 'Code of practice for site investigations', BSi 1999.

8.2 CIRIA Report C574, 'Engineering in Chalk' London 2002.

8.3 National House-Building Council, Standards, Chapter 4.2, 2003 'Building Near Trees'.

8.4 BRE Digest 240, 'Low-rise buildings on shrinkable clay soils: Part 1'. September 1993

8.5 Geotechnique, June 1983.

8.6 Transport and Road Research Laboratory, Report 1132, 'The Structural Design of Bituminous Roads'. 1984.

8.7 Building Research Establishment, Special Digest 1, 'Concrete in Aggressive Ground', 2005.

8.8 Wilson S A and Card G B, 'Reliability and Risk in Gas Protection Design', 2004.

8.9 National Radiological Protection Board, Report NRPB-R290, 1996, 'Radon Atlas of England'.

8.10 BRE Report 211, 'Radon, Guidance on the Protective Measures for New Buildings, 1999

8.11 Department of the Environment and the Welsh Office, 'The Building Regulations Approved Document C, Site Preparation and Resistance to Moisture', 1992.

8.12 CIRIA Reports 149 to 152, 'Methane and Associated Hazards to Construction', 1995.

8.13 Skennerton S, 'Landfill Gas: Rates vs Concentrations', Presentation notes from Remediation of Hazardous Gases: Workshop. Regional Group Meeting, Geological Society, 3 June 1997.

For and on behalf of Ian Farmer Associates (1998) Limited

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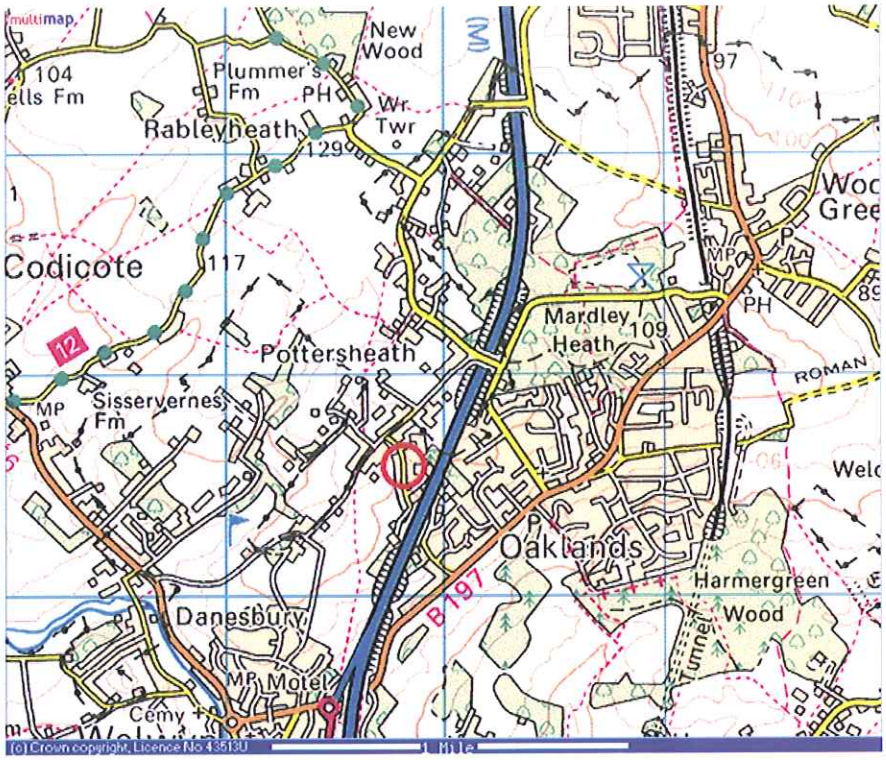
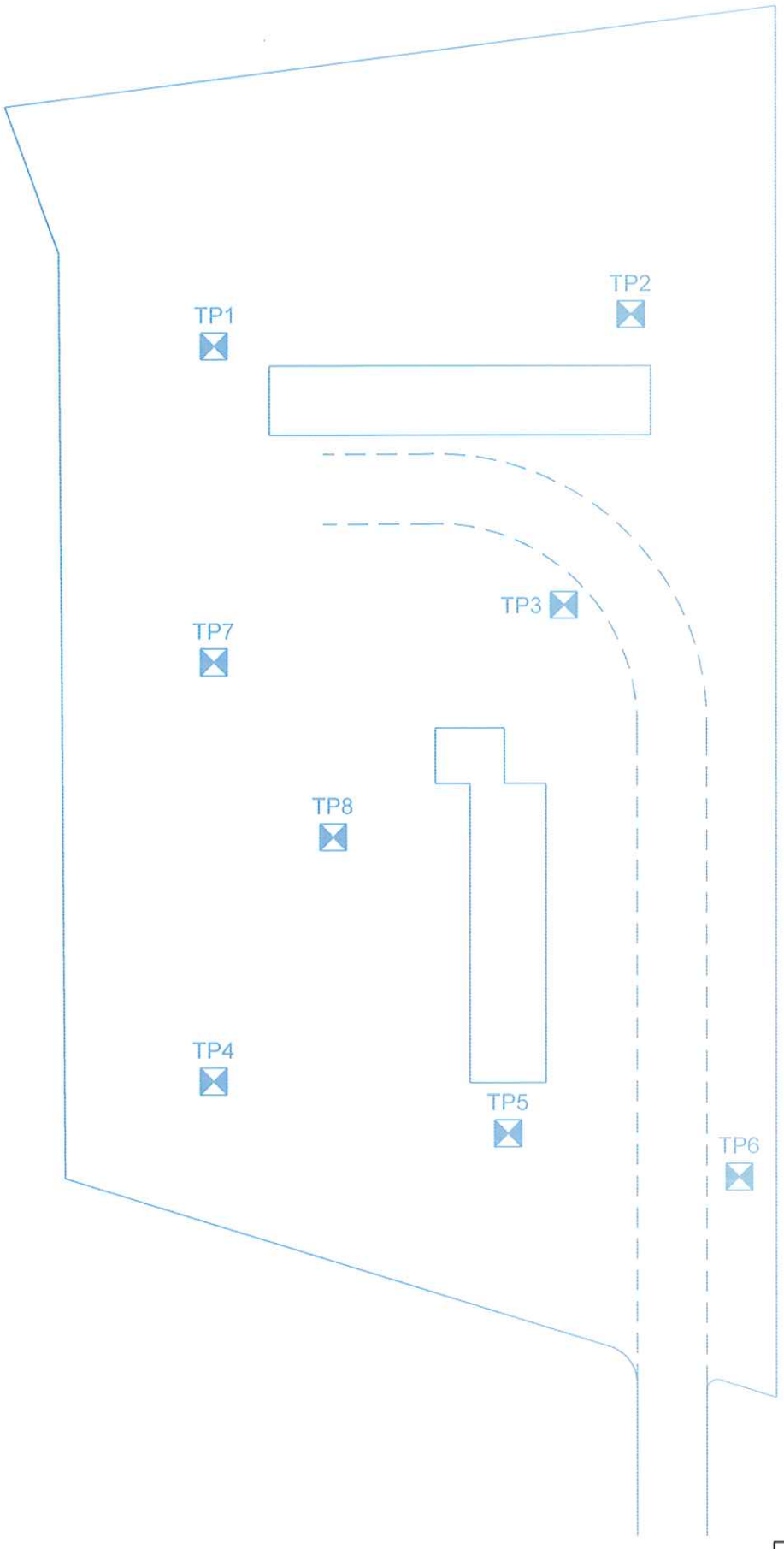
APPENDIX 1

DRAWINGS





IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	**Site Location Plan and Aerial Photograph**	Job no. 50411
	22 The Avenue, Welwyn, Hertfordshire, AL6 0PP	Fig. A1.1



A1(M)

N

Scale :	N.T.S.
Drawn By :	P.L.E.
Job No:	50411
Fig:	A1.2

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

SITE PLAN

22 The Avenue, Welwyn, Herts.

APPENDIX 2

SITE WORK

APPENDIX 2

GENERAL NOTES ON SITE WORKS

A2.1 SAMPLES

U(x) represents undisturbed 100mm diameter sample with (x) being the number of blows required to obtain sample.

U fail indicates undisturbed sample not recovered

HV represents Hand Vane test with equivalent undrained shear strength

PP represents Pocket Penetrometer test with equivalent undrained shear strength

CBR represents California Bearing Ratio test

B represents large bulk disturbed samples

D represents small disturbed sample

W represents water sample

$\underline{\nabla}$ respresents water strike

$\underline{\blacktriangledown}$ represents level to which water rose

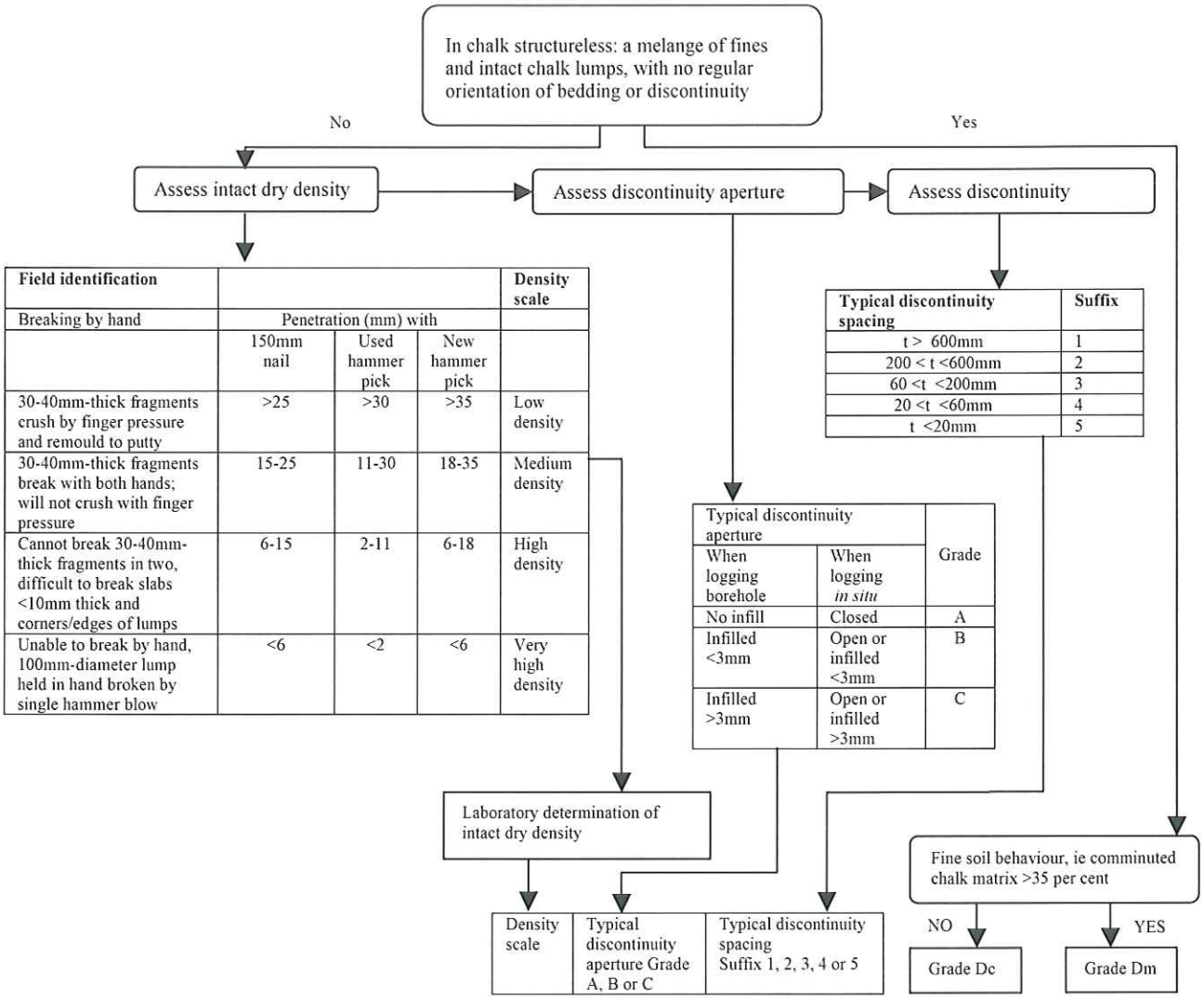
A2.2 DESCRIPTION OF SOILS

A2.2.1 General

The procedures and principles given in Section 6 of BS 5930, ref. 8.1 have been used in the soil descriptions contained within this report.

A2.2.2 Chalk

The descriptions and Grades of Chalk are based on guidelines given in CIRIA Report C574, ref. 8.2. The principal details are as follows.



Field identification				**Density scale**
Breaking by hand	Penetration (mm) with			
	150mm nail	Used hammer pick	New hammer pick	
30-40mm-thick fragments crush by finger pressure and remould to putty	>25	>30	>35	Low density
30-40mm-thick fragments break with both hands; will not crush with finger pressure	15-25	11-30	18-35	Medium density
Cannot break 30-40mm-thick fragments in two, difficult to break slabs <10mm thick and corners/edges of lumps	6-15	2-11	6-18	High density
Unable to break by hand, 100mm-diameter lump held in hand broken by single hammer blow	<6	<2	<6	Very high density

Typical discontinuity spacing	**Suffix**
t > 600mm	1
200 < t <600mm	2
60 <t <200mm	3
20 <t <60mm	4
t <20mm	5

Typical discontinuity aperture		Grade
When logging borehole	When logging *in situ*	
No infill	Closed	A
Infilled <3mm	Open or infilled <3mm	B
Infilled >3mm	Open or infilled >3mm	C

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Site	Trial Pit Number
The Avenue, Welwyn, Hertfordshire.	TP1

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Mechanical Excavator			BMG Limited	50411
	Location TL 238 174	**Dates** 11/08/2005	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.25	D1				(0.40)	MADE GROUND: Dark greyish brown sandy gravelly clayey topsoil with occasional fine to coarse gravel sized brick, concrete and tile fragments, traces of metal pipe, roots and rootlets.		
0.50	D2				0.40	Orange brown clayey fine to coarse gravelly SAND with traces of dark grey clay pockets. Gravel is fine to coarse rounded to subangular flint.		
1.25	D3				(2.60)			
2.50	D4				3.00	Structureless CHALK composed of cream with occasional orange brown staining, slightly gravelly sandy silt. Gravel is weak, low density. Locally light brown. (Grade Dc) (Upper Chalk).		
					3.20	Complete at 3.20m		

Plan

Remarks

Pit remained open during excavation
Groundwater not encountered

Scale (approx)	Logged By	Figure No.
1:50	BMC	A2.1

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Site	Trial Pit Number
The Avenue, Welwyn, Hertfordshire.	TP2

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Mechanical Excavator			BMG Limited	50411
	Location TL 238 174	**Dates** 11/08/2005	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.40	D				(0.90)	MADE GROUND: Dark greyish brown sandy gravelly clayey topsoil with occasional fine to coarse gravel sized brick, concrete, and tile fragments, traces of wood and plastic. Sand is fine to coarse. Gravel is fine to coarse angular to subrounded flint.		
1.20	D				0.90	Orange brown very clayey fine to coarse SAND and fine to cobble size rounded to subangular flint GRAVEL with some stiff very sandy very gravelly clay pockets from 2.80m and occasional fine to medium gravel sized chalk fragments from 3.00m.		
2.00	D				(2.30)			
2.50	D							
3.00	D				3.20	Complete at 3.20m		

Plan

Remarks

Groundwater not encountered
Pit remained open during excavation

Scale (approx)	Logged By	Figure No.
1:50	BMC	A2.2

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Site	Trial Pit Number
The Avenue, Welwyn, Hertfordshire.	TP3

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Mechanical Excavator			BMG Limited	50411
	Location TL 238 174	**Dates** 11/08/2005	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.30	D1				(0.60)	MADE GROUND: Dark greyish brown sandy gravelly clayey topsoil with occasional fine to coarse gravel sized brick and concrete fragments, roots and rootlets. Sand is fine to coarse. Gravel is fine to coarse angular to subrounded flint.		
					0.60			
1.00	D2					Orange brown clayey to very clayey fine to coarse SAND and fine to cobble size rounded to subangular flint GRAVEL with occasional stiff orange brown with occasional black flecks sandy clay pockets from 3.00m		
1.50	D3				(2.60)			
2.50	D4							
3.00	D5				3.20			
						Complete at 3.20m		

Plan

Remarks

Groundwater not encountered
Pit remained open during excavation

Scale (approx)	Logged By	Figure No.
1:50	BMC	A2.3

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Site	Trial Pit Number
The Avenue, Welwyn, Hertfordshire.	TP4

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Mechanical Excavator			BMG Limited	50411
	Location TL 238 174	**Dates** 11/08/2005	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.10	D1				(0.25) 0.25	MADE GROUND: Dark greyish brown sandy gravelly clayey topsoil with occasional fine to coarse gravel sized brock, concrete and tile fragments, roots and rootlets. Sand is fine to coarse. Gravel is fine to coarse subangular to rounded flint.		
0.45	D2				(0.25) 0.50			
1.00	D3				(1.00)	MADE GROUND: Light brown sandy gravelly clayey topsoil with occasional fine to coarse gravel sized brick and concrete fragments, roots and rootlets. Sand is fine to coarse. Gravel is fine to coarse subangular to rounded flint.		
1.50	D4				1.50 (0.30) 1.80	Stiff orange brown very sandy gravelly CLAY. Sand is fine to coarse. Gravel is fine to cobble sized rounded to angular flint.		
						Structureless CHALK composed of a light brown matrix and gravel size clasts of medium to high density. (Grade Dc) (Upper Chalk).		
					(1.20)	Structured medium to high density white CHALK with occasional black specks. (Grade A4) (Upper Chalk).		
2.70	D5				3.00	Complete at 3.00m		

Plan

Remarks

Pit remained open during excavation
Groundwater not encountered

Scale (approx)	Logged By	Figure No.
1:50	BMC	A2.4

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Site	Trial Pit Number
The Avenue, Welwyn, Hertfordshire.	TP5

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Mechanical Excavator			BMG Limited	50411
	Location TL 238 174	**Dates** 11/08/2005	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.40) 0.40	MADE GROUND: Dark greyish brown sandy gravelly clayey topsoil with occasional fine to coarse gravel size brick and concrete fragments, roots and rootlets. Sand is fine to coarse. Gravel is fine to coarse angular to subrounded flint.		
0.40	D				(1.10)	Orange brown very clayey gravelly fine to coarse SAND with occasional brown stained cream gravel sized chalk fragments. Gravel is fine to coarse rounded to subangular flint.		
1.20	D				1.50	Structureless CHALK composed of a light brown matrix with some gravel sized clasts of medium density. (Grade Dm) (Upper Chalk).		
					(0.40) 1.90	Structured medium to high density white chalk with occasional black specks. (Grade A4) (Upper Chalk).		
2.50	D				(1.10)			
3.00	D				3.00	Complete at 3.20m		

Plan

Remarks

Groundwater not encountered
Pit remained open during excavation

Scale (approx)	Logged By	Figure No.
1:50	BMC	A2.5

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Site	Trial Pit Number
The Avenue, Welwyn, Hertfordshire.	TP6

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Mechanical Excavator			BMG Limited	50411
	Location TL 238 174	**Dates** 11/08/2005	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.70)	MADE GROUND: Dark greyish brown sandy gravelly clayey topsoil with occasional fine to coarse gravel sized brick and concrete fragments, traces of roots and rootlets. Sand is fine to coarse. Gravel is fine to coarse angular to subrounded flint.		
0.60	D				0.70			
					(0.40)	Orange brown very clayey gravelly fine to coarse SAND. Gravel is fine to coarse subangular to rounded flint.		
1.20	D				1.10			
					(0.70)	Structureless CHALK composed of a light brown matrix and gravel size clasts of medium density. (Grade Dc) (Upper Chalk).		
					1.80			
					(0.60)	Structured medium to high density white CHALK with occasional light brown staining. (Grade A4) (Upper Chalk)		
					2.40			
						Complete at 2.40m		

Plan

Remarks

Groundwater not encountered
Pit remained open during excavation

Scale (approx)	Logged By	Figure No.
1:50	BMC	A2.6

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Site	Trial Pit Number
The Avenue, Welwyn, Hertfordshire.	TP7

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Mechanical Excavator			BMG Limited	50411
	Location TL 238 174	**Dates** 11/08/2005	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.30	D1				(0.40) 0.40	MADE GROUND: Dark to light greyish brown sandy gravelly clayey topsoil with occasional fine to coarse gravel size brick and concrete fragments, roots and rootlets. Sand is fine to coarse. Gravel is fine to coarse angular to subrounded flint.		
					(0.30) 0.70	Orange brown clayey gravelly fine to coarse SAND wih some firm to stiff brown sandy clay pockets. Gravel is fine to coarse subangular to rounded flint.		
1.50	D2				(0.90) 1.60	Structureless CHALK composed of a light brown matrix with clasts of medium density, some clayey gravelly fine to coarse sand. Gravel is fine to coarse subangular to rounded flint.		
2.10	D3				(1.40)	Structured medium to high density white CHALK with traces of iron staining and flint cobbles. (Grade A4) (Upper Chalk).		
2.90	D4				3.00	Complete at 3.00m		

Plan

Remarks

Pit remained open during excavation
Groundwater not encountered

Scale (approx)	Logged By	Figure No.
1:50	BMC	A2.7

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APPENDIX 3

LABORATORY TESTS

APPENDIX 3

GENERAL NOTES ON LABORATORY TESTS ON SOILS

A3.1 GENERAL

A3.1.1 Where applicable all tests are carried out in accordance with the relevant British Standard. The laboratory test procedures are as below:

Test Name	Procedures BS1377:1990 Part:Clause
Moisture Content	2:3
Liquid Limit	2:4
Plastic Limit and Plastic Index	2:5
Particle Size Distribution	2:9
Sulphate content	3:5
pH Value	3:9
Compaction Test	4:3*
California Bearing Ratio	4:7
Consolidation	5:3
Bulk Density	7:2*
Laboratory Vane Tests	7:3*
Triaxial Compression	
Total Stress Single-Stage	7:8
Total Stress Multi-Stage	7:9
Desiccation	Note 1*

Note 1 - BRE Information paper IP4 issued February 1993
* Tests are not included in UKAS accreditation

A3.1.2 Any discussion in this report is based on the values and results obtained from the appropriate tests. Due allowance should be made, when considering any result in isolation, of the possible inaccuracy of any such individual result. Details of the accuracy of results are included in this section, where applicable.

A3.2 MOISTURE CONTENT

A3.2.1 Unless stated to the contrary, the moisture content of a soil sample was determined by the standard oven drying method, BS 1377, Part 1, Test 3. The result is reported to an accuracy of ±0.5%

A3.3 ATTERBERG LIMITS

A3.3.1 The Liquid Limit, **LL**, is the moisture content at which the soil passes from the liquid to plastic state. Unless stated to the contrary, the Liquid Limit was determined using the four point, cone penetrometer method, Test 4. The value is reported to the nearest whole number, to an accuracy of ±0.5%.

A3.3.2 The Plastic Limit, **PL**, is the moisture content at which soil passes from the plastic to solid state and becomes too dry to remain in a plastic condition. The Plastic Limit was determined using the method described in Test 5. The value is reported to the nearest whole number, to an accuracy of ±0.5%.

A3.3.3 The Plasticity Index, **PI**, is the numerical difference between the liquid and plastic limits, corresponding to the range of moisture contents over which a soil is in a plastic state. The determination of the Plasticity Index is covered by Test 5.

A3.4 SOIL CLASSIFICATION

A3.4.1 Classification of soils is usually undertaken by means of the Plasticity Classification Chart, sometimes called the A-Line Chart. This is a graphical plot of PI against LL with the A-Line defined as PI = 0.73(LL - 20).

A3.4.2 This line is defined from experimental evidence and does not represent a well defined boundary between soil types, but forms a useful reference datum. When the values of LL and PI for inorganic clays are plotted on the chart they generally lie just above the A-Line in a narrow band parallel to it, while silts and organic clays plot below this line.

A3.4.3 Clays and silts are divided into five zones of plasticity:

Low Plasticity (L)	LL less than 35
Intermediate Plasticity (I)	LL between 35 and 50
High Plasticity (H)	LL between 50 and 70
Very High Plasticity (V)	LL between 70 and 90
Extremely High Plasticity (E)	LL greater than 90

A3.4.4 In general, clays of high plasticity are likely to have a lower permeability, are more compressible and consolidate over a longer period of time under load than clays of low plasticity. Clays of high plasticity are more difficult to compact as fill material.

A3.5 CHEMICAL TESTS

A3.5.1 The total sulphate content of soil was determined using the gravimetric method detailed in BS1377: Part 3:1990, Test 5. The results are recorded to an accuracy of ±0.1%.

A3.5.2 The water soluble sulphate content of soil was determined using the gravimetric method detailed in BS1377: Part 3: 1990, Test 5. The results are recorded to an accuracy of ±0.1g/l.

A3.5.3 The sulphate content of groundwater was determined the gravimetric method detailed in BS1377: Part 3: 1990, Test 5. The rests are record to an accuracy of ±0.1g/l.

A3.5.4 The pH value was determined electrometrically using the procedures given in BS 1377: Part 3: 1990, Test 9. The results are recorded to an accuracy of ±0.1 pH units.

Location		Sample		NMC (%)	Index properties				NMC / LL	Liquidity Index	Test Type	Chemical Tests				
Lab. Ref. (G)	TP/ BH	Depth (m)	Type		LL (%)	PL (%)	PI (%)	<425µm (%)				Total Sulphur (% S)	Sulphate as SO_4			pH
													GW (mg/l)	Total (%)	2:1 Extract (mg/l)	
189635	TP3	1.00	D												49	7.4
189641	TP4	1.00	D	15	72	36	36	51	0.41	-0.58	4 Pt				115	7.6

IAN FARMER ASSOCIATES
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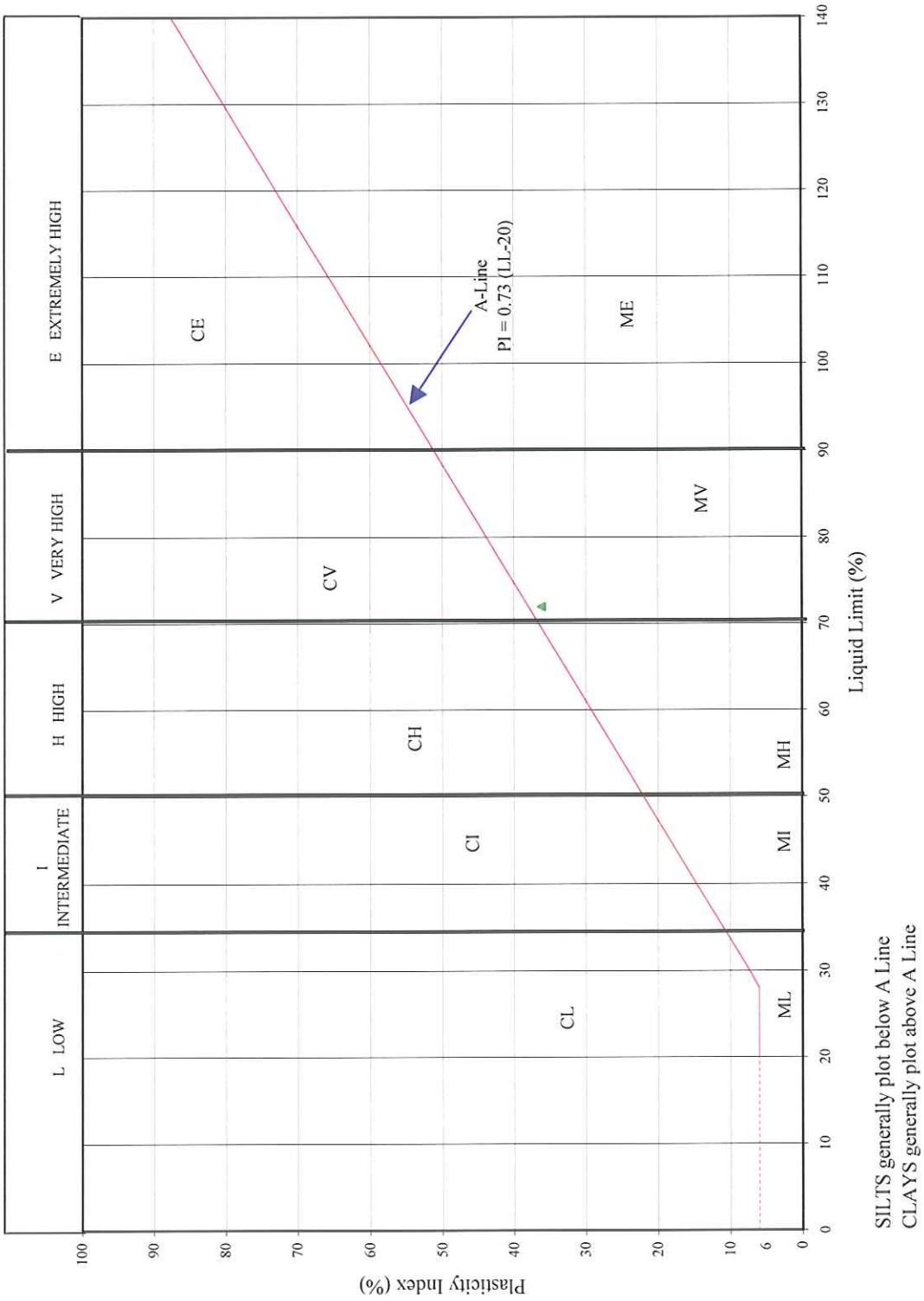
RESULTS OF LABORATORY TESTS

The Avenue, Welwyn, Hertfordshire

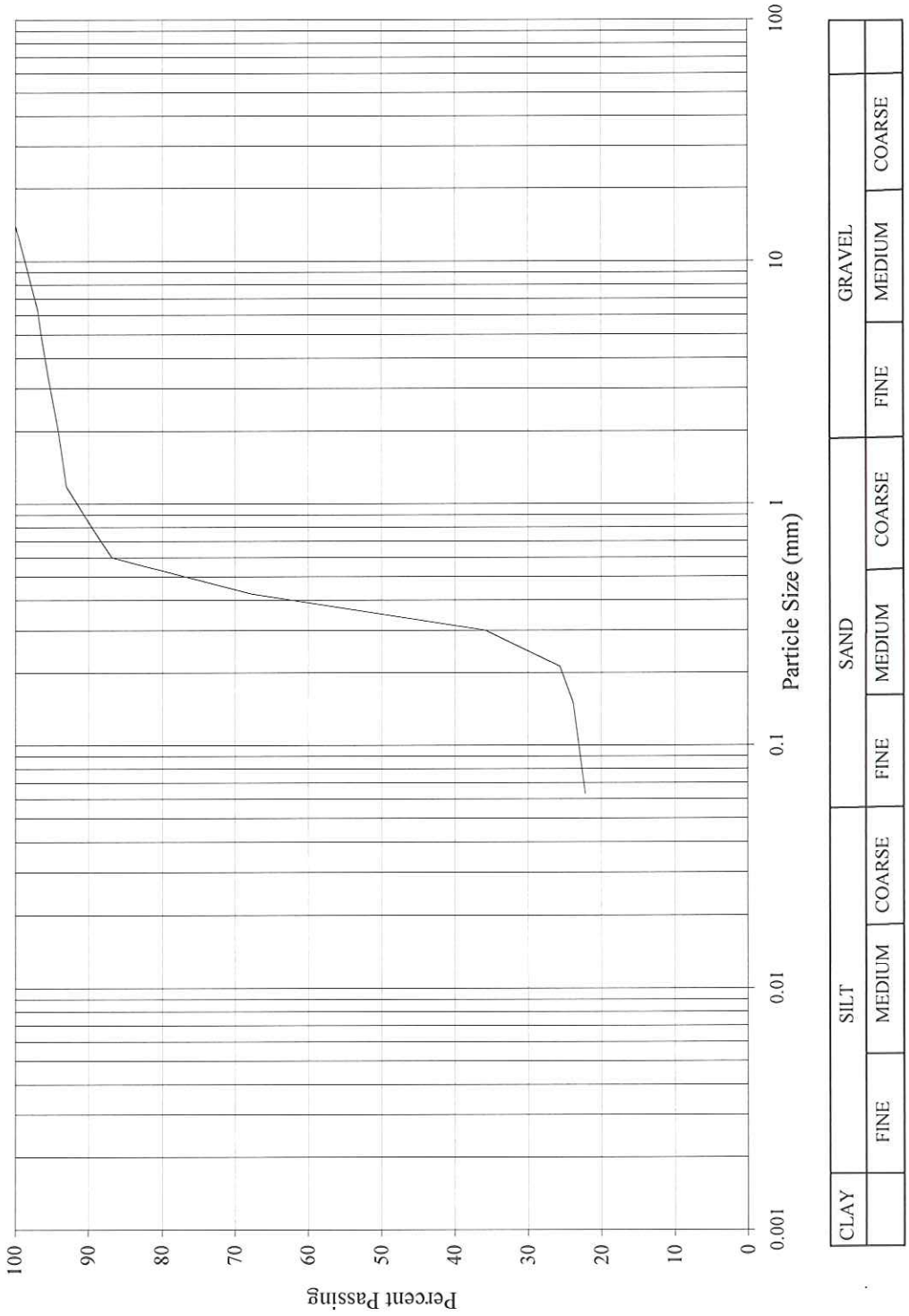
Job no. 50411

Fig. A3.1



IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	**PLASTICITY CLASSIFICATION CHART**	Job no. 50411
	The Avenue, Welwyn, Hertfordshire	Fig no. A3.2

TP1 @ 1.25 - G189627



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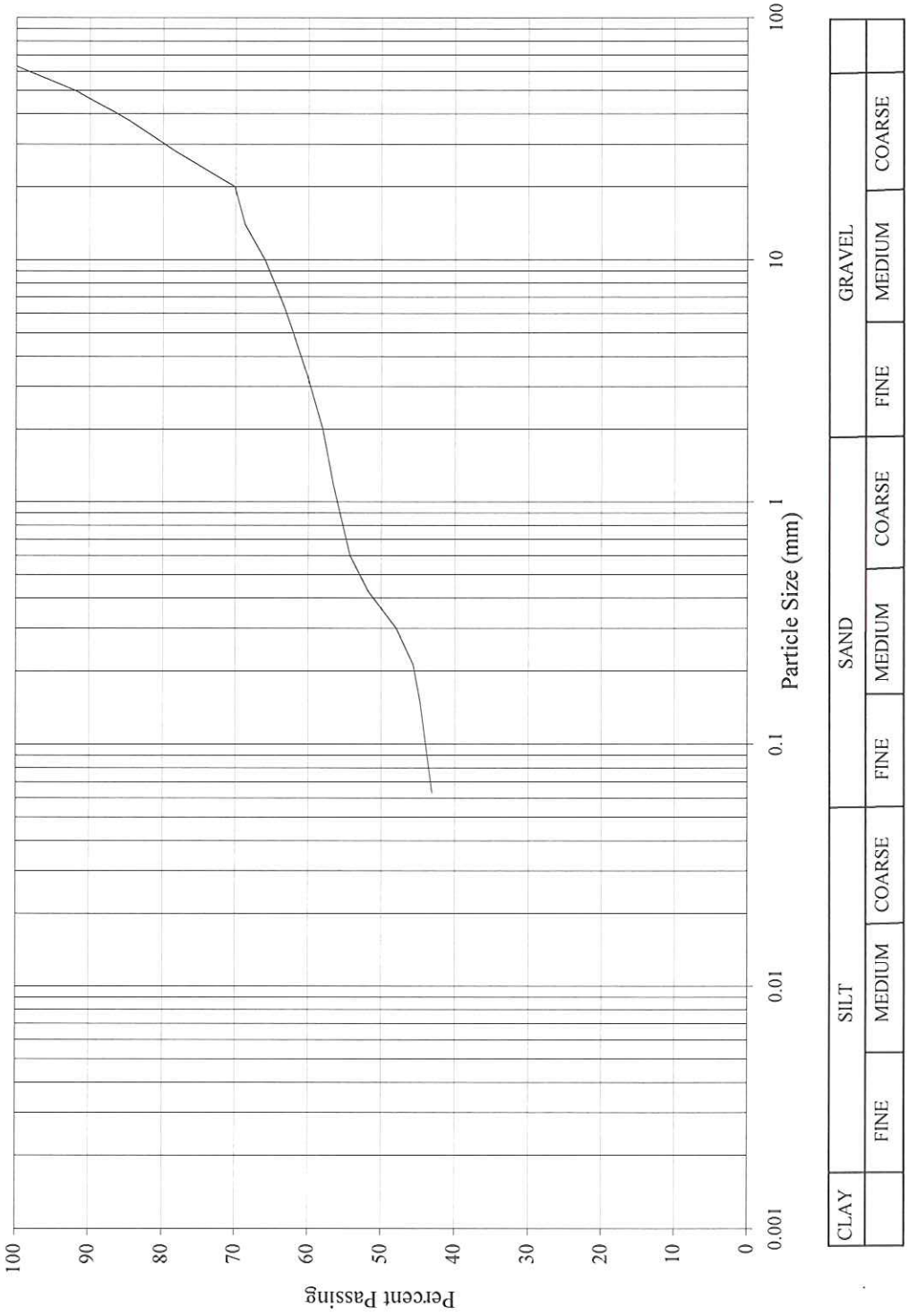
PARTICLE SIZE DISTRIBUTION

The Avenue, Welwyn, Hertfordshire

Job no. 50411

Fig no. A3.3

TP5 @ 1.20 - G189645



IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	**PARTICLE SIZE DISTRIBUTION**	Job no. 50411
	The Avenue, Welwyn, Hertfordshire	Fig no. A3.4

Site : The Avenue

Client :

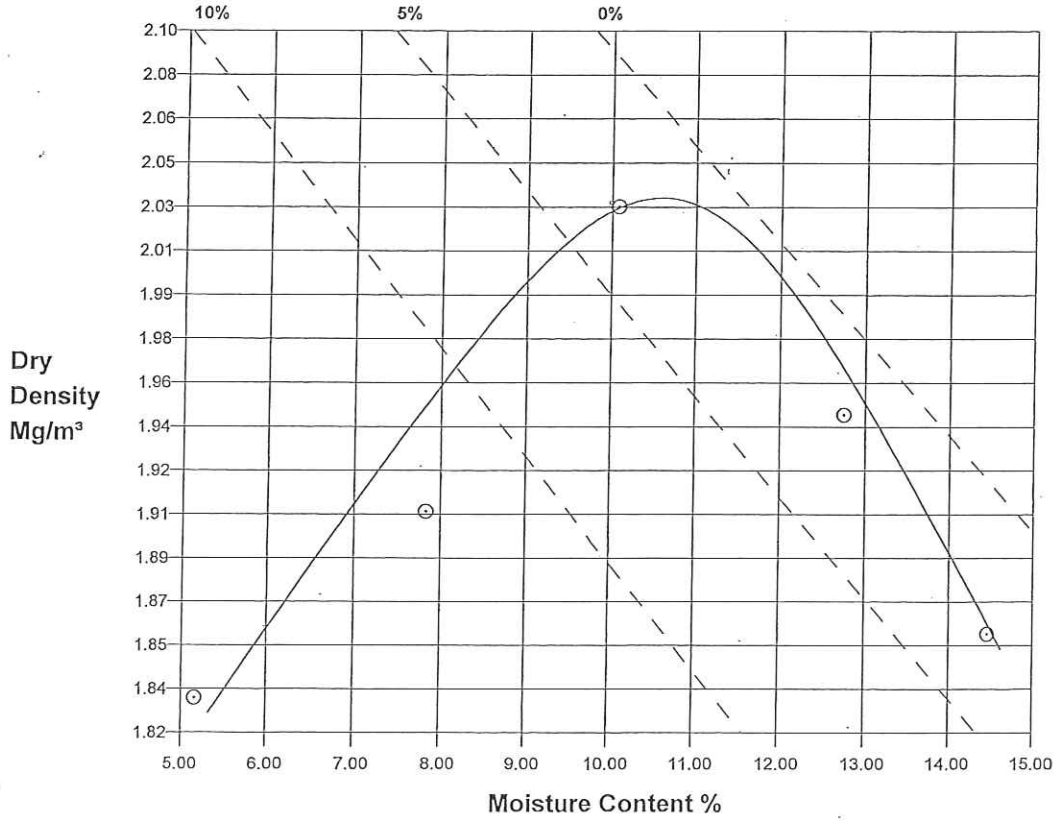
Job Number 50411

Sheet 1 / 2

DETERMINATION OF DRY DENSITY/MOISTURE CONTENT RELATIONSHIP

Borehole / Trial Pit	Depth (m)	Sample	Description
TP1	0.5	B1	Brown very sandy CLAY with fine to coarse gravel

Percentage retained 37.5 mm	2 %	Max size of cohesive lumps	20 mm
Percentage retained 20.0 mm	5 %	Single or separate samples	Single
Grading Zone	4	Particle density	2.65 Assumed
Mould Type	1 Litre/proctor	Method of compaction	2.5kg Rammer
MAX DRY DENSITY	2.03 Mg/m³	**OPTIMUM MOISTURE CONTENT**	11 %



Method of Preparation : BS 1377:PART 4:1990:3.2 Preparation of samples for compaction tests

Method of Test : BS 1377:PART 4:1990:3.4 Determination using 2.5 kg rammer,3.6 Determination using 4.5kg rammer: PART 2:1990:3 Determination of partical density

Remarks :

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COMPACTION TESTS

The Avenue, Welwyn, Hertfordshire

Job no. 50411

Fig. A3.5

Site : The Avenue

Client :

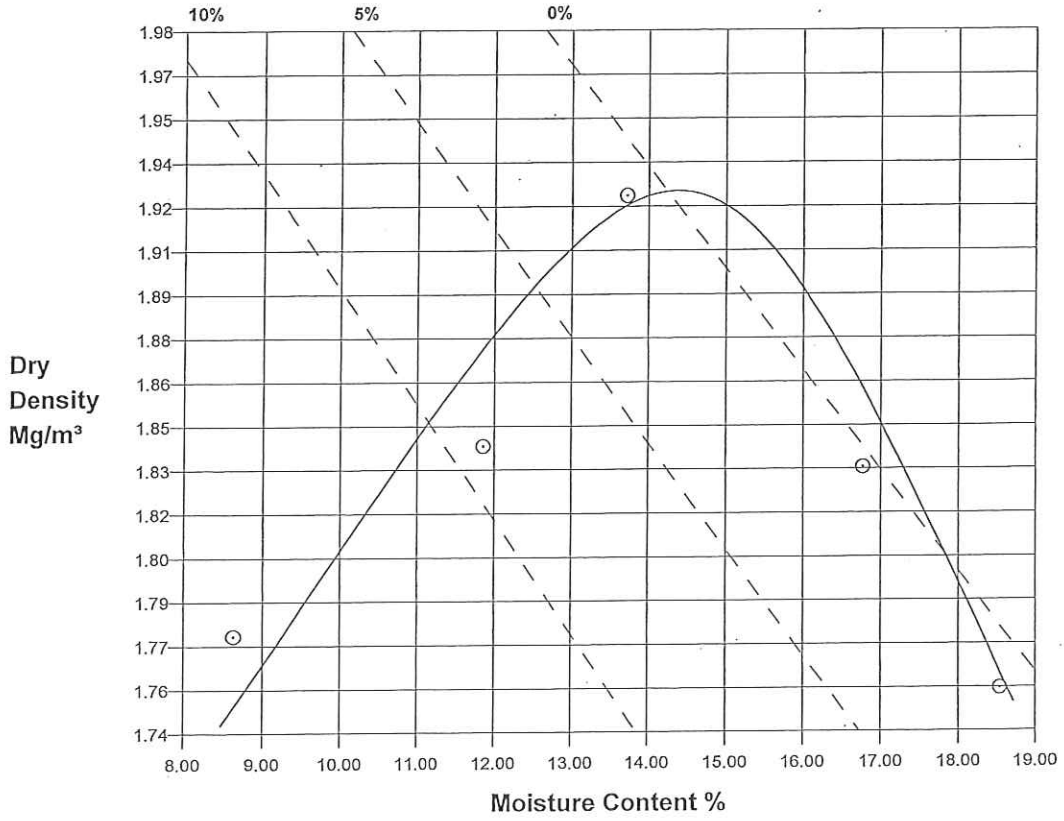
Job Number 50411

Sheet 2 / 2

DETERMINATION OF DRY DENSITY/MOISTURE CONTENT RELATIONSHIP

Borehole / Trial Pit	Depth (m)	Sample	Description
TP7	0.00	B1	Brown sandy silty CLAY with fine to coarse gravel and chalk fragments

Percentage retained 37.5 mm	4 %	Max size of cohesive lumps	20 mm
Percentage retained 20.0 mm	12 %	Single or separate samples	Single
Grading Zone	4	Particle density	2.65 Assumed
Mould Type	1 Litre/proctor	Method of compaction	2.5kg Rammer
MAX DRY DENSITY	1.93 Mg/m³	**OPTIMUM MOISTURE CONTENT**	14 %



Method of Preparation : BS 1377:PART 4:1990:3.2 Preparation of samples for compaction tests

Method of Test : BS 1377:PART 4:1990:3.4 Determination using 2.5 kg rammer,3.6 Determination using 4.5kg rammer: PART 2:1990:3 Determination of partical density

Remarks :

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COMPACTION TESTS

The Avenue, Welwyn, Hertfordshire

Job no. 50411

Fig. A3.6

APPENDIX 4

DESIGN CONSIDERATIONS

Broad leafed trees		
Water demand	Species	Mature height (m)
High	Elm	
	English	24
	Wheatley	22
	Wych	18
	Eucalyptus	18
	Hawthorn	10
	Oak	
	English	20
	Holm	16
	Red	24
	Turkey	24
	Poplar	
	Hybrid black	28
	Lombardy	25
	White	15
	Willow	
	Crack	24
	Weeping	16
	White	24
Moderate	Acacia False	18
	Alder	18
	Apple	10
	Ash	23
	Bay Laurel	10
	Beech	20
	Blackthorn	8
	Cherry	
	Japanese	9
	Laurel	8
	Orchard	12
	Wild	17
	Chestnut	
	Horse	20
	Sweet	24
	Lime	22
	Maple	
	Japanese	8
	Norway	18
	Mountain ash	11
	Pear	12
	Plane	26
	Plum	10
	Sycamore	22
	Tree of Heaven	20
	Walnut	18
	Whitebeam	12
Low	Birch	14
	Elder	10
	Fig	8
	Hazel	8
	Holly	12
	Honey Locust	14
	Hornbeam	17
	Laburnum	12
	Magnolia	9
	Mulberry	9
	Tulip tree	20

Coniferous trees		
Water demand	Species	Mature height (m)
High	Cypress	
	Lawson's	18
	Leyland	20
	Monterey	20
Moderate	Cedar	20
	Douglas fir	20
	Larch	20
	Monkey Puzzle	18
	Pine	20
	Spruce	18
	Wellingtonia	30
	Yew	12

Note

1. Where hedgerows contain trees, their effects should be assessed separately. In hedgerows, the height of species likely to have the greatest effect should be used

2. Within the classes of water demand, species are listed alphabetically; the order does not signify any graduation in water demand

3. When the species is known but the sub-species is not, the greatest height listed for the species should be assumed

4. Further information regarding trees may be obtained from the Arboricultural Association or the Arboricultural Advisory and Information Service

Reproduced from National House Building Council, Standards, 2003, Chapter 4.2, 'Building Near Trees'

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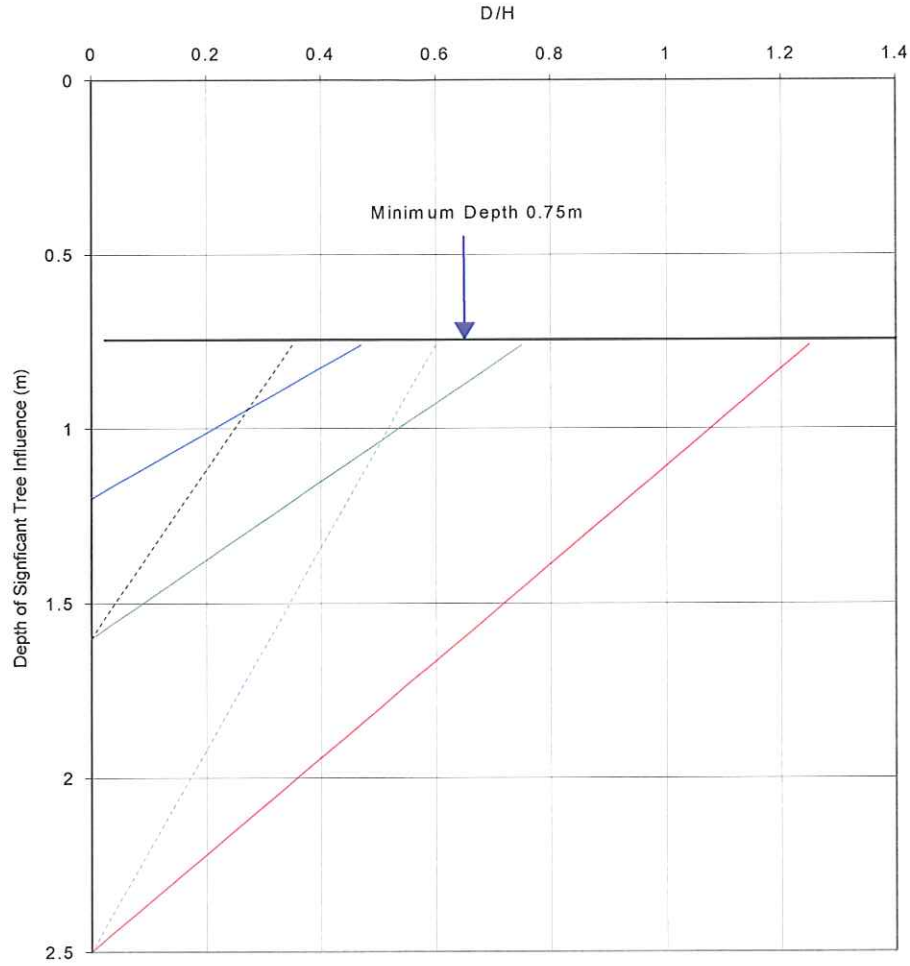
WATER DEMAND AND MATURE HEIGHT OF TREES

The Avenue, Welwyn, Hertfordshire

Job no. 50411

Fig. A4.1



Broad Leaf ——— D = Distance between tree and foundation

Conifers - - - - - - H = Height of Tree

Low water demand ---------- Moderate water demand ——— Moderate water demand

High water demand ——— High water demand

Reproduced from National House Building Council, Standards 2003, Chapter 4.2, 'Building Near Trees'

IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	DETERMINATION OF FOUNDATION DEPTH – LOW SHRINKAGE SOILS	Job no. 50411
	The Avenue, Welwyn, Hertfordshire	Fig. A4.2

Aggressive Chemical Environment for Concrete (ACEC) classification for natural ground locations

Sulphate				Groundwater		
Design Sulphate Class for location	2:1 water/soil extract[b]	Groundwater	Total potential sulphate[c]	Static water	Mobile water	ACEC class for location
	(SO_4 mg/l)	(SO_4mg/l	(SO_4 %)	(pH)	(pH)	
DS-1	<500	<400	0.24	≥2.5		AC-1s
					>5.5[d]	AC-1[d]
					2.5-5.5	AC-2z
DS-2	500-1500	400-1400	0.24-0.6	>3.5		AC-1s
					>5.5	AC-2
				2.5-3.5		AC-2s
					2.5-5.5	AC-3z
DS-3	1600-3000	1500-3000	0.7-1.2	>3.5		AC-2s
					>5.5	AC-3
				2.5-3.5		AC-3s
					2.5-5.5	AC-4
DS-4	3100-6000	3100-6000	1.3-2.4	>3.5		AC-3s
					>5.5	AC-4
				2.5-3.5		AC-4s
					2.5-5.5	AC-5
DC5	>6000	>6000	>2.4	>3.5		AC-4s
				2.5-3.5	≥2.5	AC-5

Notes

a Applies to locations on sites that comprise either undisturbed ground that is in its natural state (ie is not brownfield) or clean fill derived from such ground.

b The limits of Design Sulphate Classes based on 2:1 water/soil extracts have been lowered relative to previous Digests

c Applies only to locations where concrete will be exposed to sulphate ions (SO_4) which may result from the oxidation of sulfides (eg pyrite) following ground disturbance

d For flowing water that is potentially aggressive to concrete owing to high purity or an aggressive carbon dioxide level greater than 15 mg/l, increase the ACEC Class to AC-2z.

Explanation of suffix symbols to ACEC Class

- Suffix 's' indicates that the water has been classified as static
- Concrete placed in ACEC Classes that include the suffix 'z' primarily have to resist acid conditions and may be made with any of the cements or combinations listed in Digest

APPENDIX 5

GAS GENERATION

APPENDIX 5

GENERAL NOTES ON GAS GENERATION

A5.1 GENERAL

A5.1.1 Soft organic clays, peat, Made Ground and landfills are potentially subject to significant microbial degradation resulting in the formation of a mixture of gases and vapours.

A5.1.2 The chemical composition of landfill gas varies over time, a typical landfill gas can comprise up to 65% methane and 35% carbon dioxide. The properties of landfill gases are determined principally by the proportions of these two gases together with their mixture with air. Trace amounts of other gases such as hydrogen and hydrogen sulphide plus a range of organic vapours can also be present.

A5.1.3 Methane is colourless, odourless, non-toxic asphyxiant gas, which is flammable in air. However, the gas will only burn when mixed with air in certain proportions defined by the lower and upper limits of flammability (or explosibility). Any mixture of methane in air within these limits will burn if ignited. However, a mixture with a concentration of methane above the upper explosive limit (UEL) should not be considered safe since dilution with clean air will result in a composition within the flammable range. Thus mixtures above the UEL are a potential hazard and only mixtures below the lower explosive limit (LEL) can be considered safe. The LEL and UEL for methane are 5%v/v and 15%v/v respectively.

A5.1.4 Carbon dioxide is a non-flammable toxic gas with a long-term exposure limit of 0.5% by volume and a short-term limit of 1.5% by volume.

A5.1.5 On sites such as former docklands or reclaimed estuaries, gas is generated slowly and is characterised by low volumes of gas and low surface emissions. Development has taken place on such sites over many years without problems.

A5.1.6 In the case of recent landfills or mine workings, methane can be generated rapidly. This gives rise to large volumes of gas being produced with high surface emission rates. These conditions pose a risk to development.

A5.1.7 The Building Regulations Approved Document C (1992), ref. 8.11, gives guidance on the problems associated with the presence of landfill gas. This guidance suggests that where the level of methane is unlikely to exceed 1% by volume no further protection needs to be provided if the ground floor is suspended concrete and ventilated.

A5.1.8 Carbon dioxide should be considered independently of methane. Concentrations exceeding 1.5% by volume in the ground indicate a need to consider gas exclusion measures, while a level of 5% implies that specific design measures are required.

A5.1.9 Guidelines produced in Table 28 of CIRIA Report 149, ref. 8.12 are frequently used as a design tool with little regard to the nature of the gassing source or surface emission rates. However, this table was never intended as a definitive design tool.

A5.1.10 The most important aspect relating to the risk posed to a development by the gas regime below the site is, how quickly is the gas coming out of the ground. The lower the surface emission rate the lower the risk.

A5.1.11 For design purposes the gas flow rate and gas concentration provide a more reliable method for classifying a site and specifying the scope of gas protection.

A5.1.12 A rational method for classifying gassing sites in terms of the risks posed by the presence of gas should consider the following, ref. 8.8.

- the source of the gas
- the generation potential of the source
- the location of the source and the presence of any natural geological barriers to migration
- the borehole flow rate and surface emission rate
- measured gas concentrations
- the nature of proposed development
- the confidence in the knowledge of the gas regime and any likely variations in concentration and borehole flow rate

A5.1.13 A risk ranking, ref. 8.12 deemed natural soils with low organic content posed the lowest risk in terms of gas generation while recent landfills, post 1960's, the greatest risk.

Source	Gas generation potential
Natural soils, low peat/lowest organic content	Low generation potential from small amounts of degradable material
Carbonate deposits e.g. Chalk	
Dock silt, Made Ground, low organic content	
Natural soil, Made Ground, high peat/organic content	Moderate generation due to increased levels of degradable material
Landfill – pre 1960	
Mineworking – susceptible to flooding	Potential for high generation if working (and pumping and ventilation) ceases and groundwater levels rise
Mineworking unflooded inactive	Potential for high generation if groundwater levels rise
Mineworking flooded	Potential for high generation if water levels vary
Landfill site, post 1960	High potential for gas generation due to high organic content

A5.1.14 The importance of surface emission rates together with gas concentrations lead to the following ranking system, ref. 8.13.

Scenario	Gas concentration	Borehole flow rate	Risk ranking
1	High	High	1
2	High	Low	3
3	Low	High	2
4	Low	Low	4

A5.1.15 A new method for characterising gassing sites is proposed, taking into account flow rates as well as gas concentrations, ref. 8.8.

Characteristic Situation	Limiting volume flow of CH_4 or CO_2 (l/hr)[1] from borehole	Additional limiting factors	Typical source of generation
1	<0.07	Methane not to exceed 1% volume and carbon dioxide not to exceed 5% by volume	Natural soils with low organic content
2	<0.7	Borehole air flow rate not to exceed 70l/hr otherwise increase to content Characteristic Situation 4	Natural soil, high peat/organic
3	<3.5	Borehole air flow rate not to exceed 701/hr otherwise increase to Characteristic Situation 4	Old landfill, inert waste, mineworking flooded
4	<15	Quantitative risk assessment required to evaluation scope of protection measures	Mineworking – susceptible to flooding, completed landfill, inert waste
5	<70		Mineworking unflooded inactive
6	>70		Recent landfill site

1. Limiting volume flow rate of gas = gas concentration x measured borehole flow rate

2. Site characterisation should be based on gas monitoring of concentrations and borehole flow rates for a minimum of one year and covering a range of atmospheric conditions. For readings covering less than one year but over six months, increase Characteristic Situation by 1. For reading covering less than 6 months but over three months, increase Characteristic Situation by 2.

3. Source of gas and generation potential/performance must be identified

A5.1.16 On the basis of the Characteristic Situation the scope of protection measures may be determined as below.

Characteristic Situation	Typical scope of protection measures	
	Residential Building	Office/commercial/industrial development
1	No special precautions	No special precautions
2	Well constructed ground or suspended floor slab. Waterproofing membrane sealed around penetrations, passively ventilated underfloor sub-space and wall cavities	Reinforced concrete cast in-situ ground slab. All joints and penetrations sealed. Possibly waterproofing membrane. Granular layer below slab passively vented to atmosphere with interleaved geocomposite strips or pipes

3	Wall constructed suspended or ground slab. Gas resistant membrane and passively ventilated underfloor sub-space	Reinforced concrete cast in-situ ground slab. All joints and penetrations sealed. Waterproof/gas resistant membrane and passively ventilated underfloor sub-space
4	Well constructed suspended or ground slab. Gas resistant membrane and passively ventilated underfloor subspace, oversite capping and in ground venting layer	Reinforced concrete cast in-situ ground slab. All joints and penetrations sealed. Gas resistant membrane and passively ventilated underfloor sub-space
5	Specific gas resistant membrane and ventilated underfloor void, oversite capping and in ground venting layer and in ground venting wells	Reinforced concrete cast in-situ slab. All joints and penetrations sealed. Gas resistant membrane and passively ventilated underfloor sub-space. In ground venting wells
6	Not suitable unless gas regime is reduced first and quantitative risk assessment carried out to assess design of protection measures in conjunction with foundation design	Reinforced concrete cast in-situ ground slab. All joints and penetrations sealed. Gas resistant membrane and actively ventilated underfloor sub-space, with monitoring. In ground venting wells

1. Typical scope of protection measures may be rationalised for specific developments on the basis of quantitative risk assessments based on CIRIA Report 152.

2. Note the type of protection is given for illustration purposes only. Individual site specific designs should provide the same number of separate protection methods for any given Characteristic Situation.

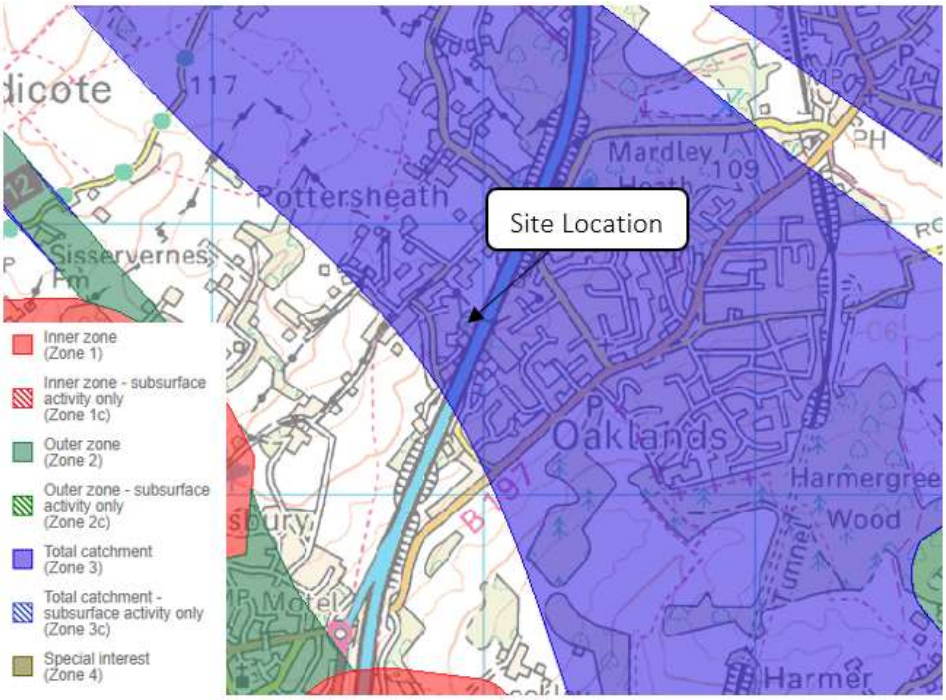
3. In all cases there should be minimum penetration of ground slabs by services and minimum number of confined spaces such as cupboards above the ground slab. Any confined spaces should be ventilated.

4. Foundation design must minimise differential settlement particularly between structural elements and ground bearing slabs.

5. Buildings with basement car parks, provided with ventilation in accordance with the Building Regulations, may not require gas resistant membranes for Characteristic Situations 3 and 4.



Groundwater Vulnerability Zones Map (Source: EA)



Groundwater Source Protection Zones Map (Source: EA)

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Appendix 3 – Calculations

- *Greenfield Runoff Rates*
- *Pre-Development Runoff Rates*
- *Proposed Calculations – 1 in 100 year Rainfall Event + 40% Climate Change*

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ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.150
Area (ha)	0.087	Urban	0.000
SAAR (mm)	667	Region Number	Region 6

Results l/s

QBAR Rural	0.0
QBAR Urban	0.0
Q100 years	0.1
Q1 year	0.0
Q30 years	0.1
Q100 years	0.1

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	20.000	Add Flow / Climate Change (%)	0
Ratio R	0.419	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	10.000	0.125	80.0	0.200	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	10.000	0.125	80.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	4.11	109.500	0.200	0.0	0.0	0.0	1.46	58.2	27.1
1.001	50.00	4.23	109.375	0.200	0.0	0.0	0.0	1.46	58.2	27.1

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Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.200	0.200	0.200
1.001	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.200	0.200	0.200

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.001		110.000	109.250	0.000	0	0

Simulation Criteria for Storm

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	30
Ratio R	0.419		

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.420
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.000	Cv (Winter)	0.840

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

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	1	15 Winter	1	+0%	30/15 Summer	100/15 Summer		
1.001	2	15 Winter	1	+0%	30/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	109.629	-0.096	0.000	0.62		30.0	OK	3
1.001	2	109.504	-0.096	0.000	0.61		29.7	OK	

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.420
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.000	Cv (Winter)	0.840

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

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	1	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
1.001	2	15 Winter	30	+0%	30/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	109.903	0.178	0.000	1.32		64.2	FLOOD RISK	3
1.001	2	109.682	0.082	0.000	1.32		63.9	SURCHARGED	

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.420
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.000	Cv (Winter)	0.840

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

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	1	15 Winter	100	+0%	30/15 Summer	100/15 Summer		
1.001	2	15 Winter	100	+0%	30/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	110.002	0.277	2.285	1.47		71.1	FLOOD	3
1.001	2	109.733	0.133	0.000	1.47		71.1	FLOOD RISK	

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Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 283 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	111.580	0.130	1.3	19.6	O K
30 min Summer	111.622	0.172	1.3	25.8	O K
60 min Summer	111.659	0.209	1.3	31.4	O K
120 min Summer	111.686	0.236	1.3	35.5	O K
180 min Summer	111.693	0.243	1.3	36.5	O K
240 min Summer	111.692	0.242	1.3	36.3	O K
360 min Summer	111.685	0.235	1.3	35.3	O K
480 min Summer	111.678	0.228	1.3	34.2	O K
600 min Summer	111.669	0.219	1.3	32.9	O K
720 min Summer	111.660	0.210	1.3	31.5	O K
960 min Summer	111.641	0.191	1.3	28.7	O K
1440 min Summer	111.606	0.156	1.3	23.4	O K
2160 min Summer	111.562	0.112	1.3	16.9	O K
2880 min Summer	111.531	0.081	1.3	12.1	O K
4320 min Summer	111.499	0.049	1.2	7.3	O K
5760 min Summer	111.490	0.040	1.0	5.9	O K
7200 min Summer	111.484	0.034	0.8	5.0	O K
8640 min Summer	111.479	0.029	0.7	4.4	O K
10080 min Summer	111.476	0.026	0.6	3.9	O K
15 min Winter	111.599	0.149	1.3	22.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	140.528	0.0	18
30 min Summer	91.498	0.0	33
60 min Summer	56.713	0.0	62
120 min Summer	33.971	0.0	122
180 min Summer	24.848	0.0	180
240 min Summer	19.793	0.0	226
360 min Summer	14.308	0.0	282
480 min Summer	11.369	0.0	344
600 min Summer	9.505	0.0	410
720 min Summer	8.207	0.0	478
960 min Summer	6.506	0.0	616
1440 min Summer	4.684	0.0	878
2160 min Summer	3.366	0.0	1252
2880 min Summer	2.661	0.0	1584
4320 min Summer	1.908	0.0	2244
5760 min Summer	1.505	0.0	2944
7200 min Summer	1.252	0.0	3672
8640 min Summer	1.076	0.0	4408
10080 min Summer	0.947	0.0	5144
15 min Winter	140.528	0.0	18

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Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	111.645	0.195	1.3	29.3	O K
60 min Winter	111.688	0.238	1.3	35.7	O K
120 min Winter	111.721	0.271	1.3	40.6	O K
180 min Winter	111.731	0.281	1.3	42.1	O K
240 min Winter	111.731	0.281	1.3	42.2	O K
360 min Winter	111.721	0.271	1.3	40.7	O K
480 min Winter	111.711	0.261	1.3	39.1	O K
600 min Winter	111.699	0.249	1.3	37.3	O K
720 min Winter	111.685	0.235	1.3	35.3	O K
960 min Winter	111.658	0.208	1.3	31.1	O K
1440 min Winter	111.605	0.155	1.3	23.2	O K
2160 min Winter	111.541	0.091	1.3	13.6	O K
2880 min Winter	111.503	0.053	1.3	7.9	O K
4320 min Winter	111.488	0.038	0.9	5.6	O K
5760 min Winter	111.480	0.030	0.7	4.5	O K
7200 min Winter	111.475	0.025	0.6	3.7	O K
8640 min Winter	111.471	0.021	0.5	3.2	O K
10080 min Winter	111.469	0.019	0.5	2.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	91.498	0.0	33
60 min Winter	56.713	0.0	62
120 min Winter	33.971	0.0	120
180 min Winter	24.848	0.0	176
240 min Winter	19.793	0.0	232
360 min Winter	14.308	0.0	328
480 min Winter	11.369	0.0	372
600 min Winter	9.505	0.0	448
720 min Winter	8.207	0.0	522
960 min Winter	6.506	0.0	666
1440 min Winter	4.684	0.0	938
2160 min Winter	3.366	0.0	1296
2880 min Winter	2.661	0.0	1560
4320 min Winter	1.908	0.0	2248
5760 min Winter	1.505	0.0	2992
7200 min Winter	1.252	0.0	3680
8640 min Winter	1.076	0.0	4408
10080 min Winter	0.947	0.0	5152

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.420	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.087

Time (mins) From:	To:	Area (ha)
0	4	0.087

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Model Details

Storage is Online Cover Level (m) 112.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.01800	Width (m)	20.0
Membrane Percolation (mm/hr)	1000	Length (m)	25.0
Max Percolation (l/s)	138.9	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	111.450	Membrane Depth (m)	150

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Appendix 4 – Proposed Drainage Strategy Layout

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THE PROPOSED DRAINAGE STRATEGY TO BE REVIEWED AND PROGRESSED AT THE DETAILED DESIGN PHASE

INDICATIVE OVERLAND FLOW ROUTES TO CONVEY FLOWS OFF-SITE TOWARD THE ACCESS ROAD ENTRANCE AND AWAY FROM NEIGHBORING PRIVATE PROPERTIES

No. 2 The Crest

Woodland

1

2

3

4

150 mm SLOTTED CARRIER PIPES TO BE LAID AT FORMATION LEVEL

No. 24

CHECK DAMS TO BE PROVIDED IN ORDER TO MAXIMISE THE STORAGE CAPACITY OF THE PERMEABLE PAVEMENT SUB-BASE

New road to adoptable standards

SuDS PERMEABLE PAVEMENT (TYPE A) - SUDS DEVICE TO INTERCEPT, TREAT AND CONVEY RUNOFF

PROPOSED SUB-BASE DEPTH - 400mm

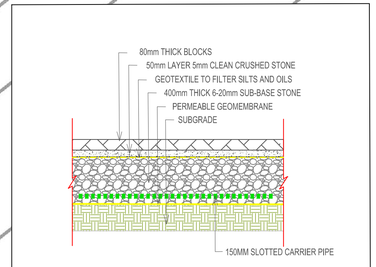
sting access road

A1(m) Northbound carriageway

SUDS GEOCELLULAR CRATE SYSTEM - MAIN DRAINAGE COMPONENT TO PROVIDE ATTENUATION AND INFILTRATION

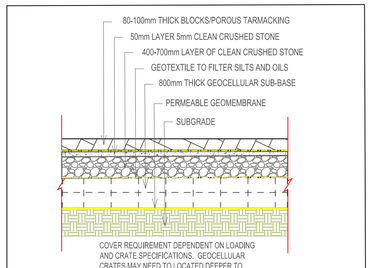
SUB-BASE AREA - 75m^2
SUB-BASE HEIGHT - 0.8m
STORAGE REQUIRED FOR THE 1 IN 100 YEAR EVENT + 40% CLIMATE CHANGE ALLOWANCE - 54.8m^3
TOTAL STORAGE PROVIDED - 57m^3 (95% CRATE VOID RATIO)

SURFACING DEPTH DEPENDS UPON TYPE OF CRATES (STRUCTURAL CAPACITY) AND UNDERLYING CBR VALUES



TYPICAL SuDS PERMEABLE PAVEMENT DETAIL

NOT TO SCALE



EXTENDED GEOCELLULAR SUB-BASE DETAIL

NOT TO SCALE

1. GENERAL
(i) THIS DRAWING IS NOT TO BE SCALED, WORK TO FIGURED DIMENSIONS ONLY, CONFIRMED ON SITE.
(ii) THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTURAL DRAWINGS, DETAILED SPECIFICATIONS WHERE APPLICABLE AND ALL ASSOCIATED DRAWINGS IN THIS SERIES.
(iii) ANY DISCREPANCY ON THIS DRAWING IS TO BE REPORTED IMMEDIATELY TO THE PARTNERSHIP FOR CLARIFICATION.
(iv) THE CONTRACTOR IS RESPONSIBLE FOR ALL TEMPORARY WORKS AND FOR THE STABILITY OF THE WORKS IN PROGRESS.

2. BELOW GROUND DRAINAGE - GENERAL INFORMATION
(i) PIPEWORK TO BE UPVC-U PIPES TO BS 4660 : 2000 AND INSPECTION CHAMBERS TO BS 7158 : 2001.
(ii) ALL ADOPTABLE DRAINAGE TO BE CONSTRUCTED IN ACCORDANCE WITH 'SEWERS FOR ADOPTION' 7TH EDITION AND THE RELEVANT COUNCIL DESIGN GUIDE.
(iii) ALL PRIVATE SURFACE WATER SEWERS TO BE LAID AT 1 IN 80 UNLESS OTHERWISE STATED ON THE DRAWING.
(iv) ALL PRIVATE FOUL WATER SEWERS TO BE LAID AT 1 IN 40 AT THE HEAD OF PIPE RUNS AND 1 IN 80 ELSEWHERE UNLESS OTHERWISE STATED.
(v) ALL PRIVATE FOUL SEWER PIPES TO BE 100MM DIAMETER UNLESS OTHERWISE STATED ON THE DRAWING. ALL PRIVATE SURFACE WATER SEWER PIPES TO BE 100MM DIAMETER FROM DOWNPIPES AND 150MM DIAMETER ELSEWHERE UNLESS OTHERWISE STATED ON THE DRAWING.
(w) ALLOW FOR RODDING ACCESS ABOVE GROUND WHERE RAINWATER DOWNPIPES DO NOT HAVE A DIRECT CONNECTION TO AN INSPECTION CHAMBER.
(vii) EXISTING SEWER PIPE TO BE RE-USED TO BE SURVEYED AND LEVELLED PRIOR TO COMMENCEMENT OF THE DRAINAGE WORKS AND REFURBISHED IF NECESSARY.
(viii) CONNECTIONS TO AN ADOPTED SEWER ONLY TO BE MADE FOLLOWING APPROVAL FROM THE RELEVANT ADOPTING AUTHORITY.
(ix) ALL DRAINS, SEWER PIPES AND MANHOLES TO BE CLEANED AND TESTED FOR WATER TIGHTNESS ON COMPLETION OF CONSTRUCTION.

3. DESIGN PHILOSOPHY
i) PRE-DEVELOPMENT SITE RUNOFF RATES:
1IN1YR: 30 l/s
1IN30YR: 64.2 l/s
1IN100YR: 71.1 l/s
ii) GREENFIELD RUNOFF RATES:
SAAR: 667mm
SPR: 0.15
Q_{BAR}: 0.0 l/s
1IN1YR: 0.0 l/s
1IN30YR: 0.1 l/s
1IN100YR: 0.1 l/s
ij) INFILTRATION SOLUTIONS HAVE BEEN CONSIDERED AS PART OF THE PROPOSED DEVELOPMENT AT THIS STAGE DUE TO FAVOURABLE SOIL TEXTURE FOR INFILTRATION. FURTHER TESTING TO BRE365 IS NECESSARY TO CONFIRM THE RATES.

ik) FROM MICRODRAINAGE:
- TOTAL STORAGE REQUIRED FOR THE 1in100+40%CC RAINFALL EVENT (CRITICAL STORM DURATION): 54.8m^3

FROM TREATMENT INDICES IN CIRIA SuDS MANUAL PERMEABLE PAVEMENT OFFERS SUFFICIENT WATER QUALITY TREATMENT TO WATER RUNOFF FROM PRIVATE DRIVES AND ROOFS THEREFORE NO FURTHER TREATMENT REQUIRED.

LEGEND

SURFACE WATER	
	PRIVATE DRAIN (NOT ADOPTABLE)
	150MM SLOTTED PIPE
	CHECK DAM
ACO	ACO DRAIN
RWP	RAIN WATER PIPE
	TYPE 4 CATCHPIT MANHOLE
	TYPE 3 CATCHPIT MANHOLE
	EXTENT OF PERMEABLE PAVEMENT
	EXTENT OF PERMEABLE PAVEMENT WITH EXTENDED GEOCELLULAR SUB-BASE
	OVERLAND FLOW ROUTE

PRELIMINARY DRAWING

DRAWING FOR INFORMATION ONLY. NOT FOR CONSTRUCTION.

Rev	Date	By	Description
-	-	-	-

Client

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Project

22 THE AVENUE, WELWYN
CONTRACT NO. 3656

Drawing

PRELIMINARY SURFACE WATER DRAINAGE STRATEGY

Drawn by: SD	Date: 01/2018
Checked by: RH	Date: 01/2018
Approved by: RH	Date: 01/2018

Drawing No. 3656/01

Revision

Drawing Scale: 1:200@A1

Appendix 5 – Information

Surface Water Runoff Calculation Method

Rainfall data has been extracted from the FEH CD-ROM for several storm duration events for a number of return periods, including 1: 1 year, 1:10 year and 1:100 year storm events. These return periods are industry standard, however it is important to be aware that return periods less than 1:2 years are not considered reliable and should not be used in detailed design calculations.

The 1:100 year with an allowance for climate change has been based on a 30% increase to the 1:100 year rainfall intensity and not the rainfall depth. This is to provide the most conservative runoff rates for the site possible.

Greenfield runoff rates have been calculated using The Institute of Hydrology Report 124 Marshall and Bayliss, 1994 method, as recommended in the SuDs Manual CIRIA (C753). In keeping with standard practice, the calculations are based on calculating the Greenfield runoff rates for a 50 Ha site and then factored to account for the actual site size.

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