

APPENDIX G
COUNCIL SRFA & EMSWORTH FLOOD RISK STRATEGIES EXTRACTS

Havant Borough Council

Emsworth Flood Risk Strategy

October 2013

Cleaner, Safer,
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Executive Summary

Emsworth occupies a unique situation in the Borough due to its geology, the hydrology within its three drainage catchments, and its historic urban form, which affects the free operation of critical sections of watercourses within these catchments. In the past planning applications for individual developments have been permitted recognising the effects of large incremental changes on the operation of these watercourses, but it is now recognised that the cumulative effect of many smaller developments has had an equal if not greater bearing on the operation - both in terms of capacity and in terms of water quality - of the drainage system.

The primary role of the Local Plan (Allocations) is to allocate land to meet the Borough's development needs set out in the adopted Local Plan (Core Strategy), this includes the allocation of land for housing and employment in Emsworth. During consultation on the Local Plan (Allocations), the community and Councillors of Emsworth aired their concern that new development could exacerbate the existing flood risk in the area. The NPPF makes it clear that new development should not increase flood risk to an area. Therefore, all applications for new development need to show how this can be achieved in order to be permitted. In accordance with the requirements of the NPPF, development of sites within the Allocations Plan will not make the existing situation worse.

The Council has also taken the opportunity to explore how Emsworth's existing levels of flood risk could be reduced, through discussions with the Environment Agency (EA), Solent Coastal Partnership, Hampshire County Council and the Emsworth Flood Action Group, amongst others. The outcome of these discussions is collectively known as the 'Emsworth Flood Risk Strategy'.

This work has directly influenced the Local Plan (Allocations), in particular the drafting of Policy DM25 Managing Flood Risk in Emsworth. It has also helped in the selection of the allocated housing sites, with regard to their potential contribution to the Emsworth Flood Risk Strategy.

The purpose of this report is to explain the components of the Emsworth Flood Risk Strategy.

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1.0 Introduction

- 1.01 Havant Borough has 56km of coastal frontage and 32km of main river frontage. As a result, a significant proportion of the Borough, approximately 22%, is at risk from tidal and/or fluvial flooding and is therefore designated by the Environment Agency (EA) as being in Flood Zones 2 and 3.
- 1.02 Emsworth is one of the Borough's only urban areas, which suffers from flooding. The settlement is located on the coast and includes the Nore Farm Stream, the West Brook and the River Ems. Over recent years, extreme weather and high tides have resulted in a high frequency of flood events. These events have affected local residents and businesses and caused considerable damage to properties. These flood events were caused by a combination of fluvial and tidal influences and principally affected Selangor Avenue, Victoria Road, North Street and Bridge Road, Emsworth.
- 1.03 The frequency of recent flooding events has resulted in the EA, who have responsibilities for managing primary water courses, identifying Emsworth as being a priority area. This status means that one of the agency's priorities in Havant Borough is to review the current flood risk and investigate ways of reducing the flood risk in the area. This work has included the review of their maintenance and incident response procedures, installation of monitoring equipment and investigating the potential for fluvial and surface water flow attenuation.
- 1.04 The Local Plan (Allocations) is planning for new housing and employment in Emsworth up to 2026. It makes sense to coordinate this future growth with the EA's work. Havant Borough Council has therefore collaborated with the EA, and other partners including Hampshire County Council, Solent Coastal Partnership and Emsworth Flood Action Group, in the preparation of the Local Plan (Allocations) to ensure that new development makes the most of opportunities to contribution to the reduction of flood risk in Emsworth.
- 1.05 The purpose of this document is to support the policies in the Local Plan (Allocations) and to provide more detail on the 'Emsworth Flood Risk Strategy', which aims to reduce the levels of flood risk in Emsworth in the short, medium and long term. The EA, Havant Borough Council, Hampshire County Council, the Solent Coastal Partnership, Southern Water, local interest groups and other partners are working together ensure the timely and effective delivery of this strategy.

2.0 Background

- 2.01 The EA have explored the historic patterns of flooding in Emsworth. The main source of flooding has been from the overflow from the West Brook and the Nore Farm Stream. This was caused by heavy and/or prolong periods of rain, and often exacerbated by tidal events and in the past by debris blocking the flows through existing channels and culverts.
- 2.02 The flooding event in winter 2010/2011 affected 21 properties in Bridge Road and Selangor Avenue. The properties on Bridge Road were effected by water overflowing from the West Brook and the properties on Selangor Avenue were effected by the overflow from the Nore Farm Stream. More recent flood events in the summer and winter of 2012 have highlighted the very low standard of protection to the properties in Selangor Avenue.

The West Brook

- 2.03 The West Brook rises at Southleigh Farm and flows through agricultural land prior to reaching Emsworth. The stream becomes increasingly modified as it passes under the south coast mainline railway line, the A27 and then onto Emsworth's existing urban area. Here the river flows a delineated course through the existing urban area before reach Bridge Road.
- 2.04 From Southleigh Farm to Bridge Road, the stream flows through several culverts, which constrain its flow. It pass under a footpath on Washington Road, the A27 dual carriageway, the railway line and Victoria Road. At Bridge Road the water course flows through a highly modified, largely artificial channel before entering Bridge Road Culvert and discharging into Emsworth Mill Pond. The Mill Pond has an outflow to Chichester Harbour. Water levels in the pond can be controlled (lowered) through a sluice gate but are influenced by tidal conditions.
- 2.05 Historically, flood has occurred in the proximity of the final culvert at Bridge Road. The capacity of this culvert is 20% of that required for an urban area. Bridge Road is therefore prone to frequent flooding when the culvert capacity is exceeded. The flood water then becomes trapped and held back at Bridge Road by the A259 as the raised level of this road prevents the water draining out to the Mill Pond.

Nore Farm Stream

- 2.06 The Nore Farm Stream rises to the North of the A27. It is channelled through a series of drainage ditches across agricultural land southwards to a culvert and pipe under the A27 and a single culvert under the railway line. It then flows along a ditch beside the railway to a paddock upstream of Selangor Avenue. It enters two pipes immediately north of 87 and 89 Selangor Avenue, flowing underneath the properties and the road. It then flows into a single culvert beneath Nore Farm Avenue and the A259 until it opens into a ditch in a garden to the rear of Barn Close. The stream continues southwards at the boundary of the residential properties at Brook Gardens, where it is constrained by a variety of flood defences to Nore Barn Wood and finally via marsh land to Chichester Harbour.
- 2.07 The culvert system underneath Selangor Avenue and Nore Farm Avenue restricts the flow from its original condition of an open watercourse and as a result the properties in Selangor Avenue flooded in November 2010, June and December 2012. in extreme events more properties could be at risk in Nore Farm Avenue and the Brook Garden Area. Increasing de-culverting the watercourse is considered to be economically unviable, disruptive and technically limited due to tidal influence further downstream.

3.0 Emsworth Flood Risk Strategy

Overview

- 3.01 The EA has considered ways of reducing the flood risk to the residents of Emsworth. Clearly it is not possible to prevent rain and stop the tides, and we cannot remove the risk of flooding entirely. However managing the flow of water in the West Brook and Nore Farm Streams and into the Mill Pond, can reduce the probability of flooding in Selangor Avenue, Victoria Road, North Street and Bridge Road.
- 3.02 The EA and Havant Borough Council consider that the best way to do that is through the Emsworth Flood Risk Strategy, which includes Policy DM25 Managing Flood Risk in Emsworth.

Emsworth Flood Risk Strategy

- 3.03 The Emsworth Flood Risk Strategy refers to a series of improvements to the existing flood maintenance regime and a series of new flood management and storage works in the Emsworth Area and Policy DM25 of the Publications Local Plan (Allocations).
- 3.04 The improvements to the existing flood maintenance regime and a series of new flood management and storage works in the Emsworth Area will help to control the flow of water and slow its discharge into Chichester Harbour. Collectively these measures will help to reduce the frequency of flooding events in Emsworth from 1 in 2 years, 50% probability to a desired return period of 1 in 75, a 1.33% probability.
- 3.05 The following projects fall under these works and many are in the process of being implemented:
- Replacement of the deteriorated sluice and fish pass at Constant Spring on the River Ems. This structure helps to control and manage the rate of water flow through to Chichester Harbour via the Clipper Pond. This improvement was started in 2012 and is expected to be complete by the end of 2013
 - More frequent and regular clearing of existing channels, culverts and their trash screens in the area. This was approved by the EA in spring 2013 and is now in operation
 - Replacement of the trash screen at Bridge Road to best practice standards. This will reduce the probability of the screen collecting debris and make it more accessible for maintenance. This will help to reduce the likelihood of total blockage
 - The replacement was fitted in summer 2013 and now operates to best practice standards
 - Installation of a telemetry at the Bridge Road Grill to monitor the rate of flow, any blockages and act as an early warning system of a localised flooding event at Bridge Road. This was put in place in summer 2013
 - New flood storage area to alleviate the water flows into Nore Farm Stream. This element of the strategy is called the Emsworth Flood Alleviation Scheme. The new flood storage area will be located in the arable land and ditches north of the A27 and the railway. This will hold water back at times of high rainfall and reduce the probability of flooding to the properties on Selangor Avenue. Securing the land for the works will be the subject of a legal agreement between the EA and landowners. The EA and the landowner are expected to formally agree this before the end of 2013. The works are expected to take place in the next 12 to 18 months and completed by 2015
 - New flood storage areas are being reviewed to alleviate the water flow into the West Brook. These new flood storage areas will be located north of the A27 adjacent to the West Brook, one such site has been identified in the arable land immediately to the west of allocated site UE13 West of Horndean Road. This will hold water back at times of high rainfall and alleviate the flooding of properties on Victoria Road, North Street and Bridge Road. The allocation and development of UE13 provides a unique

opportunity to relieve the flooding problems experienced in the north of Emsworth. The site's topography and location relative north of the railway line and A27 culverts makes it the ideal location for the West Brook's flood storage area. In addition, by working with the landowners and developers of UE13, the cost of the construction of the flood storage in this location are significantly reduced, by coordinating the timing of construction of the alleviation works to coincide with the development of the site. A planning application for the development of the site is expected in the winter of 2013/2014. The timing of this and the direct involvement of the landowner in negotiations ensures that its delivery is secured, through construction and phasing of development.

Policy DM25

- 3.06 The Local Plan (Allocations) not only allocates sites for new development, but it also includes policies that help to manage new development. Havant Borough Council in consultation with the EA and others have prepared Policy DM25 Managing Flood Risk in Emsworth, as a proactive method of managing the future flood risk in Emsworth in response to local circumstance.
- 3.07 Clearly, Emsworth is currently affected by high incidents of flooding. However, it is likely that this situation will worsen in coming years, as a result of climate change and the possibility of more extreme weather events. Therefore, it is appropriate make the most of opportunities to contribute to the reduction of flood risk in the future through the Local Plan (Allocations) where possible.
- 3.08 The purpose of DM25 is to reduce the speed of the flow of surface water from the development of new sites, which help to store water and hold it back from eventually entering the West Brook, Nore Farm Stream and the River Ems. This is possible through the use of 'sustainable urban drainage systems' (SUDS), which help to reduce pressure on the drainage system and alleviate flooding. The policy applies to new development in Emsworth, with the exception of residential extensions.

4.0 Delivery and Monitoring

- 4.01 On the approval of the Publication Local Plan (Allocations) by Council on 2 October, all the policies in the plan will become a material consideration in the determination of planning applications in the Borough. Therefore this policy may be applied by where it is considered appropriate. The Council anticipate that the Local Plan (Allocations) will be adopted in summer 2015 and will become part of Havant Borough's development Plan at this point.
- 4.02 The Council anticipate the work on the Emsworth Flood Alleviation Scheme, that is the Nore Farm Stream element of the strategy, will begin in 2014 and be completed by winter 2014/2015. The Council expect that works relating to the West Brook will be delivered alongside the development of the allocated sites adjacent to the West Brook and before the end of the plan period.
- 4.03 The Annual Monitoring Report (AMR) will monitor the delivery of these two important pieces of infrastructure. Should there be any delays this will be reported and the delivery dates updated. Should difficulties in delivering the works become apparent, whether through issues with viability or in the collaboration with landowners, the Council and the EA will review the Emsworth Flood Alleviation Scheme and identify the preferred alternative in the AMR.

Appendix 1: Policy DM25 Managing Flood Risk in Emsworth

Note: This version of Policy DM25 and its accompanying text is taken from the report to Havant Borough Cabinet and Council 2 October, published on 25 September 2013. This policy may be subject to changes as a result of recommendations from these meetings. The final version of the Policy will be published on 11 October 2013.

Policy DM25 Managing Flood Risk in Emsworth

Planning permission will be granted for developments within the Emsworth urban area boundary that can demonstrate how post development runoff has been reduced by the greatest percentage rates and volumes that are possible in the context of cost, technical feasibility and viability.

Planning permission will be granted for developments within the Emsworth urban area boundary of greater than 1 hectare that are supported by on-site sustainable drainage systems.

New developments that fall within the Emsworth urban area boundary; and/or has an impact on the flood risk of the areas within the Emsworth urban area boundary may be required to make a contribution towards the Emsworth Flood Alleviation Scheme (FAS)

- 9.25 Emsworth occupies a unique situation in the Borough due to its geology, the hydrology within its three drainage catchments, and its urban form. All of which affect critical sections of watercourses within these catchments. In the past, large developments were permitted and the potential effects on the operation of these watercourses were recognised and addressed, however it is now understood that the cumulative effect of many smaller developments has had an equal if not greater bearing on the operation, both in terms of capacity and of water quality of the drainage system.
- 9.26 Havant Borough Council, Hampshire County Council and the Environment Agency have therefore determined that it is now necessary to understand and take account of the drainage impact of any changes to impermeable areas within proposals for development. This policy forms part of an overall flood risk management strategy for Emsworth. Another critical element of this strategy is the delivery of the Emsworth Flood Alleviation Scheme, which is a series of physical interventions to the Emsworth watercourses that will help reduce the frequency of flooding events in the future. More information is set out in the Emsworth Flood Risk Management Strategy, which is an evidence base study that supports this plan.
- 9.27 All new development in Emsworth should follow the SUDS Management Train (prevention, source control, site control and regional control) to reduce pressure on the existing drainage regime and aim to improve the existing standard of protection. Planning applications for new development should therefore demonstrate how post development runoff has been reduced. This evidence should be set out in a flood risk statement, where the development is of less than 1 hectare. This statement should be proportionate in scale and detail of the planning application and should also demonstrate that any increase does not have a negative effect on the watercourse, groundwater and/or sewerage. Planning applications for development of 1 hectare or more should be supported by a flood risk assessment, which should in addition demonstrate how the sustainable drainage system will operate on-site and will reduce the existing greenfield and brownfield runoff rates and volumes. More information on the information required for a flood risk assessment is contained in the government publication called Technical Guidance to the National Planning Policy Framework (NPPF).

- 9.28 Contributions may also be required from developments that fall within or impact on the flood risk of the area within the Emsworth urban area boundary, where the Emsworth Flood Alleviation Scheme is expected to be in place or approved within five years of the date of the application. The use of independent third party valuation expertise, at the developer's cost, may be required to find a negotiated solution to developer requirements.
- 9.29 This policy relates to applications for developments within the Emsworth urban area boundary. However, it may also be necessary to apply this policy on a case by case basis to developments that are adjacent to the urban area boundary, which may have the potential to impact upon the level of flooding within the urban area boundary. Due to their scale, planning applications for extensions to existing houses are exempt from the policy. However, in some cases the Council may suspend permitted development rights where the Council considers there to be potential for a negative impact from the development, whether alone or in combination.

Appendix 2: Emsworth Flood Risk Strategy - Summary Table

Improvement to Existing Infrastructure or New Measure	Description	Benefit	Phasing
Improvement	Replacement of the deteriorated sluice and fish pass at Constant Spring on the River Ems	This structure helps to control and manage the rate the flow of water through the main river and into Chichester Harbour via the Clipper Pond	Completed
Improvement	More frequent and regular clearing of existing channels, culverts and their trash screens	Reduce the risk of blockages. To ensure it does not block significantly during a flood event	This was approved by the EA in spring 2013 and is now in operation in the area
Improvement	Replace the trash screen at Bridge Road to best practice standards	Reduce the risk of blockages. To ensure it does not block significantly during a flood event	The replacement was fitted in summer 2013 and now operates at best practice standards
Improvement	Installation of a telemetry at the Bridge Road Grill	Monitor the rate of flow, identifies blockages and acts as a warning system for early identification of a localised flooding event in the Bridge Road Area	The was put in place in summer 2013 and now operates at best practice standards
New	Emsworth Flood Alleviation Scheme: New flood storage area to alleviate the water flows into Nore Farm Stream located in the arable land and ditches north of the A27 and the railway	This would hold water back at times of high rainfall and alleviate the flooding of properties on Selangor Avenue	The works are expected to take place in the next 12 to 18 months, to be completed in 2015
New	New flood storage area to alleviate the water flow into the West Brook located in the arable land immediately adjacent to allocated site UE13 west of Horndean Road	This would hold water back at times of high rainfall and alleviate the flooding of properties on Victoria Road, North Street and Bridge Road.	The EA and the landowner are expected to formally agree this as part of the planning application for UE13. The Council expected to receive a planning application for the development of UE13 in winter 2013/2014. The works are expected to be delivered before the end of the plan period.

Havant Borough Council

Strategic Flood Risk Assessment Supplement:

Incorporating Sequential and Exception
Tests for the purpose of the Local Plan
(Allocations)

October 2013

Cleaner, Safer,
More Prosperous



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1.0 Introduction

- 1.01 This document has been prepared as a second stage and supplement to the Strategic Flood Risk Assessment (SFRA). The purpose of this document is to demonstrate that sites to be allocated for development in areas at flood risk are appropriate in the context of the Sequential and Exception Tests which are required as part of the National Planning Policy Framework (NPPF). It provides evidence in association with the sites allocated in the Local Plan (Allocations) where flood risk is a relevant issue.
- 1.02 This document firstly explains the context in terms of local flood risk and national planning policy. It then identifies those sites allocated in the emerging Local Plan (Allocations) where a Sequential or Sequential and Exception Test are required.
- 1.03 Further information relating to the explanation of Sequential/Exception Tests and when they are applicable in relation to the vulnerability of the proposed use is available in the NPPF and accompanying Technical Guidance.

2.0 Local Flood Risk Context

- 2.01 Havant Borough has 56km of coastal frontage and 32km of main river. As a result a significant proportion (approximately 22%) of the borough is at risk of coastal and/or fluvial flooding and is designated within Flood Zones 2 and 3 by the Environment Agency (EA).
- 2.02 The Partnership for Urban South Hampshire (PUSH) Strategic Flood Risk Assessment (SFRA) (2007) has shown that the primary source of flood risk in Havant is from the sea. The key parts of the borough which are currently at risk of flooding from the extreme tides include Brockhampton, Langstone and Emsworth on the mainland and Eastoke, Selsmore and Mengham on Hayling Island.
- 2.03 The secondary source of flood risk to Havant Borough is from river sources including the Lavant Stream, the Hermitage Stream and associated tributaries. These watercourses flow through the town centre of Havant and discharge into Langstone Harbour. Additionally, the upper reaches of the Wallington River rise near Waterlooville in Havant Borough. The key parts of the borough which are currently at risk of river flooding include Havant Town Centre, Leigh Park, West Leigh and Stockheath.
- 2.04 Historically, Havant has also been susceptible to flooding from other sources including groundwater, surface water and flooding caused by infrastructure failure. A number of previous groundwater flooding incidents have been observed in the upper parts of the Lavant Stream between Rowlands Castle and Havant in the north of the borough. The town of Havant has a drainage system which in many places dates back to before the mid 1960s. As such, flooding from surface water drainage systems and sewers has occurred at locations including The Florins, Petersfield Road, Park Lane and Hulbert Road.
- 2.05 The PUSH SFRA is the main evidence based study on flooding in the borough. It covers in detail the whole of the South Hampshire and is a critical tool which the council has used to predict flood risk in the year 2115 (i.e. taking into account climate change). The SFRA was a key tool in guiding the potential locations for development in the borough.

- 2.06 Further modelling work was undertaken in 2008 which in part superseded that of the 2007 SFRA. The updated flood modelling is reflected on the Environment Agency's flood risk mapping and has been used in formulating this document and the constraints applicable to the sites in the Local Plan (Allocations).

3.0 Planning Context

- 3.01 The National Planning Policy Framework (NPPF) (2012) provides the policy guidance in relation to development, and the allocation of development sites, in areas at risk of flooding. This is expanded further in the accompanying Technical Guidance to the NPPF.
- 3.02 The stance of national policy on flood risk is that inappropriate development should be avoided in areas at risk of flooding by directing development away from areas at highest risk. Where development is necessary, it should be made safe without increasing flood risk elsewhere.
- 3.03 At the local level Havant Borough have an adopted Local Plan (Core Strategy). This includes Policy CS15 which deals with flood and coastal erosion risk. The second stage of the Local Plan, the Local Plan (Allocations) is progressing well toward submission. It includes the allocation of specific sites for different types of development. The sites included within this plan have been derived from various pieces and stages of evidence base.

Strategic Housing Land Availability Assessment (SHLAA)

- 3.04 The SHLAA is a piece of evidence base that identifies land available for housing development. In line with the Sequential Test approach, flood risk was part of the initial sift of available sites and those greenfield sites in Flood Zones 2 and 3 were largely considered unsuitable on the basis that other more suitable sites were available at a lesser risk of flooding.
- 3.05 Sites within the urban area at risk of flooding, particularly those on brownfield land, were still considered to offer potential subject to further assessment.

Employment Land Review (ELR)

- 3.06 The ELR acts as the evidence base for employment land. Employment sites identified in the ELR do, in some cases, include sites which are in Flood Zones 2 and 3, although the council has tried to exclude sites in these areas wherever possible. Those sites in Flood Zones 2 and 3 which have been included are, in the most part, land last used for employment purposes.

4.0 Sites Requiring Sequential/Exception Test

- 4.01 Table 1 identifies those sites which are proposed to be allocated for development where the developable area will include areas wholly or partly affected by flood risk (i.e. Flood Zones 2 or 3). This has been established through the use of up-to-date flood modelling which includes the 2007 SFRA and the 2008 modelling updates reflected on the Environment Agency flood risk maps. The table indicates the flood zone type, the vulnerability of the use proposed and the subsequent requirement for the Sequential and/or Exception Test to be applied. The requirement for a Sequential and/or Exception Test has been informed by the Technical Guidance to the National Planning Policy Framework (2012).

Site Ref	Site Name	Flood Zone/type	Whole or part of site affected	Proposed use	Vulnerability of use	Sequential Test	Exception Test	Flood Risk Assessment
BD9	Harts Farm Way North	2 & 3 (tidal) – based on climate change layer	Whole/Majority	Employment	Less Vulnerable	✓	x	✓
BD14	Solent Road North	2 & 3 (fluvial)	Whole/Majority	Employment	Less Vulnerable	✓	x	✓
BD16	Solent Road South	2 (and part 3 based on climate change) (fluvial)	Part	Employment	Less Vulnerable	✓	x	✓
BD19	Kingscroft Farm	2 (tidal)	Majority	Employment	Less Vulnerable	✓	x	✓
HY45	Beachlands	2 & 3 (tidal) – based on climate change	Part	Mixed use: Residential/leisure/tourism	More Vulnerable	✓	✓	✓
L16	Garage Court off Sunwood	3 (fluvial)	Whole	Residential	More Vulnerable	✓	✓	✓

	Rd							
L147	Garage Court off Rownhams Rd	3 (fluvial)	Whole	Residential	More Vulnerable	✓	✓	✓

Table 1

4.02 Based on Table 1 the allocation of the following sites requires the Sequential Test to be applied:

BD9 Harts Farm Way
 BD14 Solent Road North
 BD16 Solent Road South
 BD19 Kingscroft Farm

4.03 Based on Table 1 the allocation of the following sites require both the Sequential and Exception Tests to be applied:

HY45 Beachlands
 L16 Garage Court off Sunwood Rd
 L147 Garage Court off Rownhams Rd

4.04 The following are those sites allocated that include a small portion of land in Flood Zones 2 and/or 3 but where the areas affected by flood risk can easily be excluded from the developable area. It is therefore considered that no Sequential or Exception Test is required for these sites as they are developable in compliance with the NPPF (i.e. by not including development in Flood Zone 2 or 3).

Site Ref	Site Name	Flood Zone/type	Whole or part of site affected	Proposed use	Vulnerability of use
UE13	West of Horndean Road	2 and 3 (fluvial)	Part (southern end of site)	Residential	More Vulnerable
UE37	West of Coldharbour Farm	2 (fluvial)	Part (small section on eastern boundary)	Residential	More Vulnerable
BD39	Interbridges East	2 and 3 (fluvial)	Part (section along northern boundary)	Employment	Less Vulnerable

BD10	Land North of the Regional Business Centre	2 & 3 (tidal) – based on climate change	Part	Employment	Less Vulnerable
H14	Portsmouth Water HQ	3 (fluvial) on far east boundary	Part (small section on eastern boundary)	Residential	More Vulnerable
H69	Former Oak Park School	2 & 3 (fluvial)	Part (section on eastern boundary)	Mixed use: Health campus/ Residential etc.	More Vulnerable
BD65	Land South of Fulflood Rd	3 (fluvial)	Part (on southern boundary)	Employment	Less Vulnerable

Table 2

- 4.05 Sites over 1 hectare in size will still require an individual Flood Risk Assessment as part of the planning application process as this is a requirement of the NPPF.
- 4.06 Those sites that have already secured planning permission have been excluded from this assessment on the basis that matters relating to flood risk have been thoroughly investigated and found acceptable.
- 4.07 The Publication (Regulation 19) version of the Local Plan (Allocations) includes 'constraints' and 'development requirements' for individual sites. These details are not intended to provide a exhaustive list but specific constraints and requirements associated with flood risk have been referred to as relevant.

5.0 Sequential Test

5.01 A Sequential Test for the four allocated sites for business development (less vulnerable use) are outlined below.

Sequential Test	
BD9	Harts Farm Way
Flood Risk: A small part of the site along the eastern boundary is at risk of flooding at the present day. Based on the 2085 layer for climate change, as applied to the SFRA, the proposed allocation falls within Flood Zones 2 and 3 (tidal flooding) when sea level rise is taken into account. This flooding will originate from the south and east. Indicative site levels suggest that this flooding could be up to 0.5m in depth by the end of the development lifetime (75 years for commercial development). Site Characteristics: • 4.19 hectares in size • Will provide approximately 16,300 sq metres of employment floorspace • Brownfield site previously used for employment • Planning permission issued in past for 16,275 sq metres of employment floorspace Overview: This is a brownfield site historically used as employment land in the heart of an employment area of Havant Borough. It is an important regeneration opportunity. It is largely at a low probability of flooding at the present day. Based on the availability of land identified in the Employment Land Review there are no suitable alternative sites where this type/scale of development could be delivered. Options for addressing flood risk and their feasibility: It is considered that the site specific sequential approach could be applied to avoid locating development in areas at risk of fluvial flooding. Flood resistant and resilient measures could be incorporated into any final design for the less vulnerable use proposed at the site in areas at future risk of tidal flooding, and any planning application would have to be accompanied by a detailed Flood Risk Assessment. There is a significant opportunity to improve the watercourse that dissects the site, which must be kept in an open channel and a buffer kept free of development on either side of the channel. Conclusion: Flood risk becomes a significant factor when taking climate change into account. This is a redundant brownfield site in the heart of an employment area. It is considered that the measures outlined above are feasible and would enable the development to be delivered. There are no alternative available sites at lesser risk of flooding in the borough. Based on this the proposed allocation passes the Sequential Test.	

Sequential Test	
BD14	Solent Road North
Flood Risk: The site is in Flood Zones 2 and 3 (fluvial flooding from the adjacent Brockhampton Stream). Taking into account climate change predictions for 2085 the flood risk area at the site will increase slightly. With offices proposed the development type is 'Less Vulnerable'. Site Characteristics: • 1.68 hectares in size • Will provide approximately 6,600 sq metres of employment floorspace Overview: This is a greenfield site is an area of predominately employment uses. The land to the immediate south east of the site is occupied by Bosmere Medical Centre. Portsmouth Water Company are a local and important infrastructure provider and employer. They are seeking to relocate and replace their head office function with appropriate modern premises in the vicinity of their existing operations. Feasibility work has indicated that this site with a new build office will provide the most feasible option. Based on the availability of land identified in the Employment Land Review there are no suitable alternative sites where this type/scale of development could be delivered whilst meeting the particular needs of this important infrastructure provider/employer. Options for addressing flood risk and their feasibility: The actual extent of the site to be developed for the main building could largely avoid the functional flood plain. Any displacement of floodwater storage from the development would need to be compensated through a reduction of the ground level elsewhere on the site, which could provide additional and effective flood storage. It appears that the flood risk issues on this site can be addressed in principle. However, further work will need to be undertaken to provide confidence that the measures to address flood risk can be implemented taking into account the constraints and topography at the site. Flood resistant and resilient measures could be incorporated into any final design and a detailed Flood Risk Assessment would have to accompany any planning application submitted. Conclusion: In principle there are potential measures that will allow this site to be deliverable taking into account flood risk and ensuring compliance with the NPPF. Further investigative work will need to be undertaken to understand that the flood risk measures can be feasibly delivered (with no further adverse effect to flood risk) to the acceptance of Havant Borough Council. There are no alternative available sites at lesser risk of flooding in the borough that could accommodate this development in a feasible and deliverable manner for the proposed end user. Based on this the proposed allocation passes the Sequential Test.	

Sequential Test	
BD16	Solent Road South
Flood Risk: The western section of the site currently lies within Flood Zone 2 and is therefore at a medium probability of flooding at the present day. This area is confined to the western-most building currently located on the site. With offices proposed the development type is 'Less Vulnerable'. Site Characteristics: • 1.88 hectares in size • Will provide approximately 6,000 sq metres of employment floorspace Overview: This is a brownfield site historically used as employment land in the heart of an employment area of Havant Borough. It is an important regeneration opportunity. The majority of the site is in Flood Zone 1. Based on the availability of land identified in the Employment Land Review there are no suitable alternative sites where this type/scale of development could be delivered. Options for addressing flood risk and their feasibility: It is considered that flood risk can be managed on this site through flood resistant/resilient design. New development should be located preferentially in Flood Zone 1, and new proposals should not increase, and should ideally decrease, the development footprint within the area of the site at risk of flooding. Any planning application would have to be accompanied by a detailed Flood Risk Assessment. Conclusion: This is a redundant brownfield site in the heart of an employment area. It is considered that the measures outlined above are feasible and would enable the development to be delivered. There are no alternative available sites at lesser risk of flooding in the borough. Based on this the proposed allocation passes the Sequential Test.	

Sequential Test	
BD19	Kingscroft Farm
Flood Risk: The majority of the site is in Flood Zone 1 with the north west boundary in Flood Zone 3 (fluvial flooding). With offices proposed the development type is 'Less Vulnerable'. Site Characteristics: • 2.71 hectares in size • Will provide approximately 12,000 sq metres of employment floorspace Overview: The majority of the site lies within Flood Zone 1 with a small area in the north-western corner of the site at risk of fluvial flooding from the Hermitage stream. As sea levels rise, there may be a risk of tidal flooding in the future to an area in the south-eastern corner of the site. There is a culverted main river that flows through the site from north east to south east. Options for addressing flood risk and their feasibility It is considered that flood risk can be managed by applying on site measures i.e. The site specific sequential approach. Areas at risk of current and future flooding should be kept free of any development to maintain flood conveyance and storage, and ensure that development is safe from flooding. The course of the main river culvert must be accurately identified to inform the site layout and at least an 8 metre buffer must be kept free of any obstructions that could hinder access to the culvert. The potential to de-culvert the watercourse should be considered. Details of a full surface water drainage system incorporating sustainable drainage must be provided within the required Flood Risk Assessment that would accompany any planning application submitted for the site. Conclusion: It is considered that the sequential approach is a feasible option for managing flood risk and there is therefore a reasonable prospect of delivering the development.	

6.0 Sequential and Exception Test

- 6.01 A Sequential and Exception Test for the three allocated sites for mixed/residential use development (more vulnerable use) are outlined below.

Sequential and Exception Test	
HY45	Beachlands
Flood Risk: The site is located in current Flood Zone 1 but elements of the site could be in Tidal Flood Zones 2 & 3 within the development lifetime. This could be due to wave overtopping and issues associated with sea level rise. As the allocated use incorporates residential it is 'More Vulnerable' Site Characteristics: • 2.38 hectares in size • Will provide a mixed use development including leisure, tourism and housing Overview: The dominant source of flooding to this site will be tidal flooding via overtopping of the frontage to the south of the development. There could be issues with surface water flooding, and rising groundwater levels as average sea levels rise. The site currently lies within Flood Zone 1. However with climate change and associated sea level rise some of the site will be within Tidal Flood Zones 2 & 3 within the development lifetime. Also tidal flooding during a flood event will make safe access and exit impossible. Ground levels on the access road into the site are around 3.7-4.0m AOD. This could result in a depth of flooding between 0.5 and 1 metre, which could increase if waves are particularly large. Sequential Test Conclusion: The site provides an opportunity to realise the regeneration of Hayling Seafront, in accordance with CS6 of the Local Plan (Core Strategy). The development of the site will improve the economy of Hayling Island through regeneration and job creation; and the social needs of Hayling Island by providing much needed housing, leisure and recreation. The environment of Hayling Island will not be detrimentally affected and there is potential to improve the management of access to more sensitive areas of the coast. This is therefore considered an important sustainable development for the borough and there are no suitable alternatives to the allocation. Based on this the proposed allocation passes the Sequential Test. Exception Test: Options for addressing Flood Risk & their feasibility: 1. Off-site strategic measures: The North Solent Shoreline Management Plan (2010) identifies a policy of Hold the Line for the entire Hayling Island open coast. The Eastoke Point Sectoral Strategy Study identifies Beach Management as the preferred option for delivering flood and erosion protection to a 1 in 200 year standard of protection, in line with this Hold the Line policy. The South Hayling BMP will identify a strategy for delivering the beach management approach along the open coast over the next five years (2013 – 2017).	

2. On-site strategic measures: A raised defence could be constructed around the site however it would be easily outflanked if wave overtopping is significant and would be difficult to secure safe access and egress through this method.

3. On site measures: A developer could implement land raising on site to reduce reliance upon continued funding and implementation of the beach management scheme, and reduce the residual risk of flooding from breach or overtopping of the shingle beach. Locating non-residential uses at ground floor would ensure that the sequential approach is taken across the site, and that residential dwellings would be located above the predicted future tide level and could provide a refuge should flooding occur. It should be ensured that key services can still continue to function during the design flood event. A flood response plan would also need to be prepared & accepted by the LPA taking advice from the Emergency Planner and Emergency Services which would need to look at conditions experienced in a design and extreme flood event.

4. Adjacent off site measures: A developer could undertake some raising of the access roads, if acceptable in planning terms, to tie into higher land to the north of the site. This would reduce reliance upon continued funding and implementation of the beach management scheme, and reduce the residual risk of flooding from breach or overtopping of the shingle beach.

Preferred Option(s):

It would be preferred that a combination of options 1, 3 & 4 are employed to ensure that the development is safe. These measures would be provided by the Operating Authority and the developer.

If there is a risk (actual or residual) of flooding to the access and egress route remaining after the implementation of a set of agreed measures, there will need to be a robust Flood Response Plan which will show how flood risk will be managed i.e. Through evacuation or safe refuge. This must be acceptable to the LPA once it has consulted with the Emergency Planner and Emergency Services. Any residual risk will need to be properly assessed and appropriate mitigation measures identified.

Overall Conclusion:

A combination of feasible measures should ensure that the site can be made safe. Therefore the Local Planning Authority believe that the measures have a reasonable prospect of delivery. It should be noted that this assessment or conclusion does not remove the need for a full site level flood risk assessment when a planning application is made.

Sequential and Exception Test	
L16	Garage Court off Sunwood Road
Flood Risk: The site is located within Flood Zone 3 (fluvial flooding) and the residential use proposed is 'more vulnerable' Site Characteristics: • 0.09 hectares in size • Will provide fewer than five residential dwellings Overview: The site is an underused garage/parking court set within the built up urban area of Leigh Park. Sites of this nature can be vulnerable to crime and/or fly tipping and those proposed for development are underused. Cumulatively the garage/parking court development opportunities in Leigh Park will provide approximately 60 new dwellings. Sequential Test Conclusion: The development of underused garage/parking areas in Leigh Park will provide much needed housing in sustainable locations that form part of the existing urban area. They will also contribute to the objectives to regenerate Leigh Park and making best use of brownfield land. The availability of suitable potential housing sites in Leigh Park is limited and other available sites will not meet the wider objectives of regeneration and the general desire to make better use of these underused areas that can be vulnerable to crime and/or fly tipping. The scale of development proposed is very small and the objectives it will deliver will not be achieved at other available sites at lesser risk of flooding. Based on this the proposed allocation is considered to pass the Sequential Test. Exception Test: The need to regenerate Leigh Park and make a better use of the underused parking/garage courts is such that with appropriate design and flood resistance and resilience methods planned into a development the Exception Test can be met. This could include sleeping accommodation at first floor level and flood resilient construction. With such methods incorporated and identified in any detailed Flood Risk Assessment (which would have to accompany a planning application) an appropriate deliverable and safe development can be achieved on this site. Overall Conclusion: The small scale of development proposed on this redundant brownfield site is such that it should be considered appropriate for residential development when balanced with the wider objectives of the NPPF and the Local Plan.	

Sequential and Exception Test	
L147	Garage Court off Rownhams Road
Flood Risk: The site is located within Flood Zone 3 (fluvial flooding) and the residential use proposed is 'more vulnerable' Site Characteristics: • 0.11 hectares in size • Will provide fewer than five residential dwellings Overview: The site is an underused garage/parking court set within the built up urban area of Leigh Park. Sites of this nature can be vulnerable to crime and/or fly tipping and those proposed for development are underused. Cumulatively the garage/parking court development opportunities in Leigh Park will provide approximately 60 new dwellings. Sequential Test Conclusion: The development of underused garage/parking areas in Leigh Park will provide much needed housing in sustainable locations that form part of the existing urban area. They will also contribute to the objectives to regenerate Leigh Park and making best use of brownfield land. The availability of suitable potential housing sites in Leigh Park is limited and other available sites will not meet the wider objectives of regeneration and the general desire to make better use of these underused areas that can be vulnerable to crime and/or fly tipping. The scale of development proposed is very small and the objectives it will deliver will not be achieved at other available sites at lesser risk of flooding. Based on this the proposed allocation is considered to pass the Sequential Test. Exception Test: The need to regenerate Leigh Park and make a better use of the underused parking/garage courts is such that with appropriate design and flood resistance and resilience methods planned into a development the Exception Test can be met. This could include sleeping accommodation at first floor level and flood resilient construction. With such methods incorporated and identified in any detailed Flood Risk Assessment (which would have to accompany a planning application) an appropriate deliverable and safe development can be achieved on this site. Overall Conclusion: The small scale of development proposed on this redundant brownfield site is such that it should be considered appropriate for residential development when balanced with the wider objectives of the NPPF and the Local Plan.	

7.0 Conclusion

- 7.01 With the exception of a very small number of sites the council have been able to allocate the vast majority of development in Flood Zone 1. This is despite the fact that such a high proportion of the overall land in Havant Borough is within Flood Zones 2 and 3.
- 7.02 Of those sites allocated for development on land in Flood Zones 2 and 3 this document has demonstrated that the Sequential and Exception Test approach outlined in the NPPF has been undertaken and met. It has shown that the development type/scale to be allocated can, in principle, be delivered appropriately in relation to flood risk. Detailed Flood Risk Assessments will remain a necessary and important part of the planning application process for all these sites. Further work will also be undertaken in relation to site BD14 (Solent Road North) to provide additional confidence that the flood risk measures can be feasibly delivered.

**Partnership for Urban South
Hampshire
Strategic Flood Risk
Assessment
Final Report**

December 2007

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Glossary of Terms

Term	Meaning / Definition
AONB	Area of Outstanding Natural Beauty
CFMP	Catchment Flood Management Plan
Defra	Department for Environment, Food and Rural Affairs
DTM	Digital Terrain Model
EA	Environment Agency
EFO	Extreme Flood Outline
EiP	Examination in Public
ESL	Extreme Sea Level
Fluvial	River
FRA	Flood Risk Assessment
GIS	Geographical Information System
GLF	Greenfield Land in Flood Zone 1
HCC	Hampshire County Council
LDD	Local Development Document
LDF	Local Development Framework
LiDAR	Light Detection and Ranging
LNR	Local Nature Reserve
LP	Local Plan
LPA	Local Planning Authority
m AOD	Meters Above Ordnance Datum
NFCDD	National Flood and Coastal Defence Database
NNR	National Nature Reserve
PMF	Probably Maximum Flood
PPG	Planning Policy Guidance Note
PPS	Planning Policy Statement
PUSH	Partnership for Urban South Hampshire
RPB	Regional Planning Body
RPGn	Regional Planning Guidance note
RSS	Regional Spatial Strategy
SAC	Special Area of Conservation
SAPF	Small Area Population Forecasts
SEERA	South East England Regional Assembly
SEP	South East Plan
SFRA	Strategic Flood Risk Assessment
SINC	Site of Importance for Nature Conservation
SMP	Shoreline Management Plan
SoP	Standard of Protection
SPA	Special Protected Area
SRSS	Sub-Regional Spatial Strategy
SSSI	Site of Special Scientific Interest
UDP	Unitary Development Plan

Executive Summary

Introduction

Urban South Hampshire is a strategic growth area as identified in the draft South East Plan (SEP) prepared by the South East England Regional Assembly (SEERA). The draft SEP has initially allocated Urban South Hampshire with a growth target of 80,000 new homes and 59,000 new jobs by 2026.

The submission of the draft SEP in 2006 has highlighted the need for a Sub-Regional Spatial Strategy (SRSS) to support the projected growth figures. To support the SRSS and inform the Examination in Public (EiP) of the SEP, a number of sub-regional assessments were required.

In November 2006, the 10 Local Planning Authorities (LPAs) and Hampshire County Council (see Figure 1), which make up the Partnership for Urban South Hampshire (PUSH) commissioned Atkins to undertake the sub-regional Strategic Flood Risk Assessment (SFRA). The timing of the EiP in late January meant that the programme for the SFRA was divided into two stages.



Figure 1: PUSH sub-region

Stage 1 of the SFRA was comprised of a data collection and scoping stage, as well as a high-level statistical analysis of flood risk in the sub-region. The objective of the statistical analysis was to assess the feasibility of the PUSH housing allocation at both the sub-regional and LPA level, and to provide comment on the flood risk implications of the initial PUSH housing allocation for discussion at the EiP. The methodology and findings of the statistical analysis are fully documented in the separate Statistics Report (Ref. 1).

Stage 2 of the SFRA involved the production and delivery of a full SFRA which includes key mapping outputs and guidance to assist Planners and Flood Risk Managers meet their housing and development targets set out in the draft SEP whilst avoiding flood risk and demonstrating compliance with PPS25.

This document is the final SFRA report, which summarises the background and policy for the development of SFRAs, the guiding principles for undertaking a SFRA, the outputs of the SFRA and strategic flood risk management guidance for the LPA. Appendix C to this report contains individual Guidance Documents for each of the LPA which have been developed to assist local authority planners and the Environment Agency when allocating future development sites in line with PPS25 and when specifying the requirements for and assessing the compliance of site specific FRAs. The content of the Guidance Documents for each LPA is bespoke to the types of flood risks present within each administrative boundary.

The Guidance Documents aim to promote the use of the SFRA and its deliverables by:

- Summarising the key findings of the SFRA, tailored for the specific flood risks found in each Local Planning Authority area.
- Relating planning policy (PPS25) to specific SFRA information and data.
- Providing guidance on the requirements of site-specific FRAs.

SFRA Mapping Outputs

The SFRA has collated and analysed a considerable volume of flood risk information for the PUSH sub-region. The mapping outputs have been delivered in three groups, each of which are designed to be used by all or some of the key LPA and Environment Agency end users. These are designed to contain a manageable amount of information that fits together as a coherent 'package'. They have been termed 'Output Packages' and are described in the table below.

In order to facilitate the dissemination of the Output Packages described above, an online web-mapping system was set up at the following web address:

http://tfmapguide.atkinsglobal.com/mapguide/PUSH_SFRA/

The website is currently security protected. Full access details have been provided to the PUSH Steering Group. At the time of writing, options for permanent hosting of the data are being assessed in consultation with the Steering Group.

No.	'Theme' of Package	Key Users	Purpose	Mapping Information Provided
1	PPS25 Sequential Test and Relevant Supporting Information	LPA Planners LPA/EA Flood Risk Managers EA Development Control	Inform application of the Sequential Test and Exception Test. Help to identify relative flood hazards / dangers to existing development. Help guide development to areas with lowest probability of flooding and lowest flood hazard / danger.	Flood Zones Flood Hazard/Danger Areas Benefiting from Defences Other forms of flooding Impact of climate change on Flood Zones
2	Social Vulnerability of and Flood Hazard / Danger to Existing Development	LPA Planners LPA/EA Flood Risk Managers EA Development Control	Identify critical areas where vulnerability and hazard / danger are high. Help inform assessments of the sustainability of existing development. Help identify and prioritise asset management and improvements.	Social Vulnerability Maps Maps combining Social Vulnerability and Flood Hazard / Danger
3	Appropriate Defence Standards and Levels of Investment	LPA/EA Flood Risk Managers	Help identify shortfalls in existing defences in providing appropriate standards of defence, now and in the future. Help identify indicative levels of investment required to provide the appropriate standards, now and in the future.	Defence Standards Shortfall Maps Investment Level Indices Maps Impact of climate change on these maps

SFRA Output Packages

Important Note on Outputs

The report contains a detailed description of the proposed SFRA outputs and presents the methodologies used to estimate the key flooding indices that are displayed on the mapping outputs. These indices include flood hazard, flood danger, social vulnerability to flooding, and some outputs combine these indices together.

The report contains technical descriptions of the analyses required to calculate these indices. To understand what these indices represent and fully appreciate their usefulness, technical experience and understanding of flood processes is required.

It is recognised that this understanding will not be held by all users of the SFRA outputs. In order to assist readers of the document who are less familiar with the terminologies and analyses described, the following simplified definitions of the key indices are provided:

- **Flood Hazard:** For the purpose of the PUSH SFRA, this is defined as a numerical value that indicates whether the hazard to people during a flood event is low or high. It is a function of the speed and depth of the flood water, where speed is assumed based on the distance from the source of the flooding.

- **Flood Danger:** For the purpose of the PUSH SFRA, this is defined as a numerical value that indicates whether the danger to people during a flood event is low or high. It differs from flood hazard in that it refers to the danger to people from flooding due to failure of flood defences. It is therefore a function of the depth of the flood water and the distance from the flood defence line.
- **Social Vulnerability to Flooding:** This index identifies the degree of vulnerability of people experiencing the flooding. It identifies elderly people, ill or infirm people, lone parents and financially deprived households as having high social vulnerability to flooding.

The purpose of mapping the indices described above is not to identify the numerical value of the indices, but to identify where the indices are highest and lowest throughout a flood risk area. The numerical values and method of calculation are not as important as the variability of the hazard/danger/vulnerability throughout the flood risk area.

Conclusions

The following key conclusions were drawn from the study:

- The PUSH sub-region is exposed to flood risk from a number of sources. Flooding from the sea, due to extreme tides, is the predominant source of flood risk to the sub-region's most populated areas on low lying coastlines in Portsmouth, Southampton, Gosport, Havant, Fareham, Eastleigh and the New Forest. All of the PUSH LPAs contain areas at risk of flooding from rivers and watercourses, with the Rivers Test, Itchen, Hamble, Meon, Wallington, Hermitage Stream and Lavant Stream passing through existing developed areas. In addition, the coastal frontages of Portsea and Hayling Island have experienced flooding caused by wave overtopping; a number of areas in Winchester, Test Valley and East Hampshire have been affected by groundwater flooding; and flooding due to excessive overland flow has caused significant problems in East Hampshire in the past.
- The sub-region is protected from flooding from the sea by defences along the majority of its coastal frontages. The level of protection afforded by the defences along each frontage varies considerably, with areas such as Portsea Island, parts of Gosport and Southampton, and Hayling Island generally defended to a higher level than other frontages in the sub-region. There are no significant flood defences on rivers in the sub-region, although localised flood protection measures such as bank protection and maintenance of structures provide benefits in terms of flood risk in a number of locations.
- Climate change poses a significant risk to the sub-region. Predicted sea-level rise over the coming century will reduce the level of protection provided by most of the sub-region's flood defences and result in the inundation of larger areas by extreme tidal floods. In addition, increasing severity of storm events is predicted to result in an increase in river flood flows, which will subsequently increase the risk of flooding from rivers.
- The statistical analysis undertaken during Stage 1 of the SFRA concluded that the draft SEP housing target of 80,000 new dwellings in the PUSH sub-region by 2026 is feasible, with regard to flood risk, when assessed at the sub-regional level. However, when assessed at the LPA area scale, some of the housing targets may not be feasible due to the extent of the Flood Zones 2 and 3 within some LPA areas. In particular, the administrative areas of Portsmouth, Southampton and Gosport are significantly constrained by the extent of Flood Zones 2 and 3. Consideration may need to be given to revising the distribution

of dwellings across the LPA areas to ensure that the individual LPA housing targets are feasible in terms of flood risk constraints.

Recommendations

The following recommendations are made with respect to the use of the SFRA outputs and improving and maintaining the knowledge base:

- It is recommended that the Environment Agency and LPAs give due consideration to the implications of climate change for flood risk across the sub-region. The SFRA outputs should be used to assess the sustainability of raising existing defences to contend with rising sea levels in a number of areas, particularly where the residual risks of flooding may remain unacceptably high.
- The SFRA outputs should be used to inform a review of existing defence standards and to assist in identifying potentially higher standards that may be more appropriate in light of climate change forecasts. However, the SFRA outputs alone cannot inform such an assessment, as it should include consideration of wider social and economic factors.
- The SFRA has assessed flood risk across the sub-region at a strategic level. The outputs and findings of the SFRA are therefore sufficiently detailed to inform strategic decision making in relation to spatial planning. The outputs and findings of the SFRA should therefore not preclude the need for detailed site specific flood risk assessments to accompany planning applications for proposed developments.
- The flood hazard data produced for the SFRA have been generated using technical methods appropriate to a strategic level study. This data may be suitable for assessing flood risk at the site specific scale for sites with a low risk of flooding; however this should be agreed in consultation with the Environment Agency. The data may not be sufficiently accurate or detailed for site specific assessments in higher risk areas where techniques such as hydrodynamic modelling may be required to refine the understanding of flood risk.
- The assessment of indicative defence standards is based on a simple comparison of defence crest level against extreme sea levels. Site specific or more detailed assessments that are required to consider the function of defences should obtain and consider further data on defence type, condition, residual life and appropriate failure scenarios, in consultation with the Environment Agency.
- Where gaps in coastal defence asset information have been identified, local ground levels have been used to represent the crest level of the defence. Improvements to the defence database should be made to standardise the data entries and categories and to make the information consistent across the sub-region.
- Modelling information to define the fluvial functional floodplain (Flood Zone 3b) is currently only available for the Wallington Stream and the Tadburn Lake Stream. For the remainder of the main rivers, the SFRA has assumed that the functional floodplain is the whole of the high probability flood area (Flood Zone 3). This is a conservative approach that should be updated in the future when modelling information becomes available.
- There are no consistent estimates across the sub-region for how climate change may increase the areas at risk of fluvial flooding. The SFRA has assumed that by 2025, increases in flows in the river will mean that Flood Zone 3 will extend to cover the area defined by Flood Zone 2. Again, this is a conservative approach

that should be updated in the future when more detailed information becomes available.

- This SFRA has provided a snapshot of flood risk issues throughout the PUSH sub-region using flood risk, climate change and flood defence asset information available in 2007. The datasets used in this assessment are likely to be updated, expanded or revised in the future. We therefore recommend that the SFRA is considered to be a live study that is reviewed and updated at appropriate intervals to account for new information, so that it can continue to provide a sound basis for future spatial planning decisions. Currently, there is no guidance on the appropriate frequency of updates to SFRAs. We would therefore recommend that updates are undertaken following significant revisions to key flood risk datasets and policy guidance or, as a minimum, every 3 to 5 years.
- The SFRA has highlighted the range and extent of information held by the LPA, the Environment Agency and the Water Companies. It recommended that a partnering approach between these Stakeholders should be adopted for the future development and improvement of flood risk and flood defence asset information. Furthermore, a partnering approach to strategic flood risk management can help to ensure that sustainable development is delivered across the sub-region.

APPENDIX H
EXTRACT GEOTECHNICAL REPORT

PHASE I GEO-ENVIRONMENTAL SITE ASSESSMENT & PRELIMINARY PHASE II GEOTECHNICAL SITE INVESTIGATION

**Field at the junction of:
Southleigh Road
&
Horndean Road,
Emsworth,
Hampshire,
PO10 7PU**

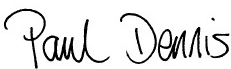
**REC Report: 20568
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Prepared for:

**C & A Consulting Engineers Ltd
Office 19
Hart House
Priestly Road
Basingstoke
Hampshire
RG24 9PU**



QUALITY ASSURANCE

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Date	November 2013		
Prepared by	Hannah Carr		
Qualifications	BSc MSc IEMA		
Signature			
Checked by	P Dennis		
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Signature			
Authorised by	L McDonald		
Qualifications	Director		
Signature			
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Doc. Ref – QR5A-1 Issued – August 2013 By – A Edgar			

REC Offices

Manchester

Osprey House
 Pacific Quay
 Broadway
 Manchester
 M50 2UE
 Tel: 0161 868 1300

London Stansted

Environment House
 Bullock Lane
 Takeley
 Bishop's Stortford
 Hertfordshire
 CM22 6TA
 Tel: 01279 879 416

Birmingham

Unit 19 Bordesley Trading Estate
 Bordesley Green Road
 Birmingham
 B8 1BZ
 Tel: 0121 326 7007

Northern Ireland

69A Killyman Street
 Moy
 County Tyrone
 BT71 7EA
 Tel: 02887 789 180

Plymouth

Unit 13, Barn Close, Langage
 Business Park
 Plymouth
 Devon
 PL7 5HQ
 Tel: 0844 561 6735

Swindon

Unit 58, Shrivensham Hundred
 Business Park
 Majors Road
 Watchfield
 Swindon
 SN6 8TY
 Tel: 01793 784 935

Glasgow

16 Langlands Place
 Kelvin South Business Park
 East Kilbride
 Glasgow
 G75 0YF
 Tel: 01355 573 350

Dublin

Unit 79
 Cherry Orchard Industrial Estate
 Cherry Orchard
 Dublin 10
 Tel: +353 1 623 8883

Southampton

Environment House
 Segensworth Business Centre
 Segensworth Road (West)
 Fareham
 Hampshire
 PO15 5RQ
 Tel: 01329 847 783

Croydon

Capital Business Centre
 22 Carlton Road
 South Croydon
 London
 CR2 0BS
 Tel: 02034 788 076

London

85 Tottenham Court Road
 London
 W1T 4TQ
 Tel: 02034 022 352

Edinburgh

83 Princes Street
 Edinburgh
 EH2 2ER
 Tel: 0131 247 7577

Port Talbot

Unit 19 Kenfig Industrial Estate
 Margam
 Port Talbot
 SA13 2PE
 Tel: 01659 749 823

www.recltd.co.uk

EXECUTIVE SUMMARY

Site Address	Land at the junction of Southleigh Road and Horndean Road, Emsworth, Hampshire
Grid Reference	474307,107048
Site Area	6.47 hectares (ha)

Initial Conceptual Site Model

Limited on or off-site potential sources of contamination, possible contaminant pathway through shallow gravel strata with nearby surface watercourses identified as the most sensitive receptor. Groundwater vulnerability in the vicinity of the site is low due to the London Clay Formation acting as an aquitard and the lack of any potable water abstractions from the Secondary A Aquifer in the gravel deposits on site.

Geotechnical Assessment

It is considered that ground conditions should allow for the construction of shallow strip foundations bearing on the underlying natural clays at a depth of 1.00 m bgl. Allowable bearing pressures should be confirmed for foundation design purposes with *in situ* standard penetration testing.

The underlying soils are predominantly cohesive in matrix and a preliminary assessment suggests that they are unlikely to provide a high degree of soakage potential for drainage systems. Some limited infiltration was observed within the shallow gravel strata.

In situ CBR tests and laboratory CBR analysis suggests that the clays could provide a risk conservative CBR design percentage of 7 % for the construction of new highways and infrastructure. CBR values should be confirmed along routes of proposed roads using plate load testing.

pH and sulphate analysis required to confirm Design Sulphate Class and Aggressive Chemical Environment for Concrete Classification.

London Clay Formation assessed in principal as suitable for use in constructing off-site balancing pond, subject to geotechnical testing and assessment during construction.

Recommendations

No significant sources of potential contamination identified by desk study but additional site investigation be undertaken to include:

- Plate load testing to confirm CBR values for proposed roads;
- Limited testing of shallow soils for assessment of potential contamination impact as identified in the DTS;
- Standard penetration testing to confirm allowable bearing pressures; and
- pH and sulphate analysis to confirm Design Sulphate Class and the Aggressive Chemical Environment for Concrete Classification.

Further geotechnical testing and assessment of London Clay Formation by geotechnical engineer to be made during construction of off-site balancing pond.

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APPENDICES

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Appendix VI	Geotechnical testing results
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Appendix VIII	Soil Infiltration Testing Results

1.0 INTRODUCTION

1.1 Background

Resource and Environmental Consultants Ltd (REC) have been commissioned by C & A Consulting Engineers Ltd to undertake a Phase I and Phase II Site Investigation on land at the corner of Southleigh Road and Horndean Road, Emsworth, Hampshire.

A site location map is presented as Figure 1 in Appendix III.

The scope of work consisted of a Phase I desk top study and a Phase II intrusive ground investigation, comprising five shallow trial pits and *in situ* dynamic cone penetrometer (DCP) California Bearing Ratio (CBR) tests to provide data for road design.

1.2 Proposed Development

It is understood that the proposed development is to comprise low rise residential housing with an off-site balancing pond for surface water attenuation. No further details have been provided to us by the Client.

1.3 Objectives

The objectives of the geo-environmental investigation are to:

- Review historical plans, geology, hydrogeology, site sensitivity, flood-plain issues, mining records and any local authority information available in order to complete a Desk Study in line with Environment Agency (EA) document Model Procedures for the Management of Contaminated Land (Contaminated Land Report 11 (CLR11));
- Undertake a preliminary stage of sampling and analysis to provide an overview of geo-environmental issues identified;
- Assess the implications of any potential geo-environmental risks, liabilities and development constraints associated with the site in relation to the future use of the site and in relation to off-site receptors;
- Provide an assessment of the soakage of the underlying soils to assist in the design of infiltration based SuDS;
- Provide geotechnical recommendations to assist with the design and construction of the off-site balancing pond; and
- Provide recommendations regarding future works required.

1.4 Limitations

The limitations of this report are presented in Appendix I.

1.5 Confidentiality

REC has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from REC; a charge may be levied against such approval.

2.0 SITE SETTING

2.1 Site Details

Site Address	Land at the corner of Southleigh Road and Horndean Road, Emsworth, Hampshire, PO10 7PU
National Grid Reference	474307,107048
Site Area	6.47 ha

All acronyms used within this report are defined in the Glossary presented in Appendix II.

A site location map is presented as Figure 1 in Appendix III.

2.2 Current Site Use

Site Description

The subject site is comprised of an approximately rectangular plot of land aligned north-west to south-east and covering approximately 6.47ha. The site comprises two fields with a small wooded area dividing them.

Entry to the site was via a wooden gate west of the site and across the fields. The site boundary comprised of mature hedging as well as post and rail wooden fencing around the northern and top eastern sector of the site. A brick wall, which appeared to be the end of boundary wall for the local residential properties, ran along the lower eastern site boundary and surface water drainage ditches formed the southern boundary of the site with further fields beyond.

The surface of the majority of the site comprised worked ground of silt mud, pastoral fields, with crop roots.

In the central eastern part of the site a small wooded area surrounded an open pond approximately 50 m by 70 m in size which divided the northern field from the southern field.

The current site layout plan is presented as Figure 2 in Appendix III.

Hazardous Materials Storage

No above ground storage tanks (AST) or underground storage tanks (USTs) were observed at the site.

Polychlorinated Biphenyls (PCBs)

No equipment that may potentially contain PCBs was observed at the site.

Waste Storage

No potentially hazardous waste streams are generated at the property.

Drainage Issues

REC received drainage plans showing the land drains which cover the majority of the site and discharge into ditches surrounding the site.

Fuel Pipelines

None identified on site or in the records provided by Groundsure.

2.3 Surrounding Area

The surrounding land uses are summarised below:

Direction	Land Use
North	Domestic residential dwellings.
East	Domestic residential dwellings and a school.
South	Agricultural land and recreational ground.
West	Agricultural land.

3.0 SITE HISTORY

3.1 Historical Development

A review of historical mapping pertinent to the site is summarised in Table 3.1 below.

Table 3.1 Summary of Potentially Contaminative Historical Land Uses

Map Edition	Historical Land Use	
	On-Site	Off-Site
1859 to 1866	The site is shown as open fields with various field boundaries, small trees and ditches. A track is shown along the southern boundary of the site.	Eastleigh farm is shown ~350 m to the west of the site and Redman's Farm is shown ~200 m to the east of the site. The road layout is shown similar to the current road layout with Horndean Road to the east of the site and Southleigh Road to the north of the site. The railway line and Emsworth station are shown ~ 500 m to the south and south-east of the site. An old gravel pit is shown approximately 900 m to the north of the site. Wooded areas are shown to the north of the site as well.
1895 to 1897	A large pond (approximately 50 x 70 m) is now shown in the central northern section of the site.	Residential properties are now shown adjacent to the site to the east.
1906 to 1908	No significant change in land use	Redman's Farm is now shown as Fairfield Farm and residential development of the land to the east of the site has continued.
1932 to 1942	No significant change in land use	Gradual residential development of the land to the east of the site continues, including Helstonleigh, a residential dwelling ~60 m east of the site which has an irregular 30 x 20 m pond in the garden. On the 1940 OS sheet Helstonleigh is now shown as Ravensbury and the pond is still shown.
1951 to 1954	No significant change in land use	Woodlands Avenue is now shown ~ 60 m east of the central area of the site running west to east with residential development along both sides.
1968 to 1973	No significant change in land use	Extensive residential development has occurred to the east and north-east of the site including the addition of Helston Drive ~30 m east of the northern sector of the site running west to east. In excess of 100 houses have been built as part of the New Brighton village development. Electricity substations are shown 120 m east of site on Helston Drive and 180 m east of the site on Woodlands Avenue.

1990 to 1991	No significant change in land use	Additional residential development of the land to the north of the site has occurred. The A27 trunk road has been constructed approximately 450 m to the south of the site running west to east. A school is also now shown 200 m south-east of the site.
2002	No significant change in land use	No significant change in land use
2012	No significant change in land use	No significant change in land use

3.2 Planning History

REC has undertaken a review of online planning records held by Havant Borough Council but no environmentally pertinent information relevant to the site has been obtained.

4.0 ENVIRONMENTAL SETTING

4.1 Geology & Hydrogeology

The British Geological Survey (BGS) map for the site, (Sheet 316, 1:50,000, Fareham, Solid & Drift edition) indicates that the site is underlain by the following geological sequence:

Geological Unit	Classification	Description	Aquifer Classification
River Terrace Deposits	Superficial	Sand, Silt & Clay	Secondary A
HEAD	Superficial	Clayey Gravel	Secondary A
London Clay Formation	Bedrock	Clay, Silt & Sand	Unproductive

The Groundsure report indicates there are no groundwater or surface water abstractions within a 1.0km radius of the site. There are no potable abstraction licences within 1km of the subject site and the site is not located within a groundwater Source Protection Zone (SPZ) however groundwater flooding susceptibility within 50m of the site is very high.

Within a 500m radius of the site there are 31 river network entries, five of which are on site. The site is located within a 250m radius from both zone 2 and 3 flood plains

4.2 Geotechnical Data

Geotechnical Data presented within the Groundsure report identifies the following ground conditions:

Hazard	Designation
Shrink-Swell Clay	Low
Landslides	Very Low
Ground Dissolution	Null – Negligible
Compressible Ground	Negligible
Collapsible Deposits	Low
Running Sand	Low

4.4 Hydrology

Surface water features in the vicinity of the subject site are as follows:

Surface Water Feature	Quality*	Distance (m)	Direction
Primary River West Brook	n/a	On site	n/a
Primary drain West Brook	n/a	On site	n/a
Tertiary River	n/a	On site	n/a
Extended culvert (greater than 50m)	n/a	On site	n/a

*Chemical water quality as classified under the EA's General Quality Assessment (GQA) Scheme

The Groundsure report indicates that there are a further 21 detailed river network entries found within 500m from the study site consisting of primary, secondary and tertiary rivers. The site is located within both flood plain 2 and 3 zones.

4.5 Radon Risk Potential

The GroundSure Report indicates that the site is in a Radon Affected Area, with between 1 and 3% of properties are above the Action Level for Radon.

4.6 Industrial Land Uses

The site is situated within a predominantly residential and agricultural area. The contemporary trade directory identifies five industrial land uses within 250m of the subject site, the closest of which relate to gas governor station 29 and 37m north-west of the site. Two electric sub stations are situated 140 and 181m east of the site and an air and water filtration company is located 220m north-east of the site.

4.7 Underground High Pressure Oil & Gas Pipelines

The Groundsure report identified no underground high pressure oil and gas pipelines within the study site.

4.8 Sensitive Land Uses

The closest residential properties are located adjacent to the eastern boundary of the site. No Sites of Special Scientific Interest (SSSI) are identified within 1 km of the subject site and the site is located within a Nitrate Vulnerable Zone (NVZ). No other environmentally sensitive land uses have been identified within close proximity to the subject site.

4.9 Site Sensitivity Assessment

The site is considered to be located within a low to moderate sensitivity setting due to the following reasons:

- Residential properties are located in close proximity;
- Superficial strata classified as Secondary A Aquifers;
- No nearby groundwater abstractions for potable water supplies; and,
- Numerous surface watercourses within influencing distance of the site.

5.0 CONSULTATIONS

5.1 Local Authority Contaminated Land Officer

REC attempted to make contact with representatives of Havant Borough Council regarding the subject site but no response was forthcoming within the reporting timescale.

5.2 Landfill Sites and Waste Treatment Sites

There are no current or historic landfill sites located within 250m of the subject site. No other waste disposal or waste transfer facilities were identified within a 250m radius of the subject site. Several landfill sites are detailed as being within a 1.5 km radius of the site, as detailed in the table below.

Landfill name/operator	Description /licensed wastes	Distance (m)	Direction	License status
Southleigh Landfill Site / Leigh Environmental	A1 Co-Disposal Landfill	873	North-west	Active
Southleigh Forest	Inert, Commercial	970	North	Active*
East of Church Hall	Inert, Industrial	1137	East	Active*
Blackbush Hanger	Inert, Industrial, Commercial	1177	North	Active*

* These are shown as historic landfills on the EA data

5.3 Regulatory Database

The following information has been obtained from a commercially available environmental database.

Table 5.1 Summary of Groundsure Data

Database Entry	0 to 249m	250 to 500m	Details
Contaminated Land Register Entries and Notices	0	0	n/a
Authorised industrial processes (IPC/IPPC/LAPPC).	0	0	n/a
Fuel Stations Entries	0	1	313 m south of the site, Shell Service Station on A27 (eastbound)
Licensed radioactive substances	0	0	n/a
Enforcements, prohibitions or prosecutions	0	1	330 m south of the site relating to the Elf Service Station and the associated Petrol Vapour Recovery Process. No details of the enforcement are provided.
Discharge Consents	1	2	On site – Revoked discharge consent at White House, Horndean Road for sewage discharges to freshwater river. Off site – 279 m west at Woodbine Cottage, Eastleigh Road for sewer storm overflow to unnamed drain and 282 m south-west at Southleigh Farm, Southleigh Road for miscellaneous discharges to freshwater river.
Pollution Incidents	1	1	Both 160 m north and 235 m east of site relate to Category 2 (Significant) air impact landfill odour events in 2004.
Consents issued under the Planning (Hazardous Substances) Act 1990	0	0	n/a
Control of Major Accident Hazard (COMAH) sites	0	0	n/a

6.0 INITIAL CONCEPTUAL SITE MODEL (CSM)

6.1 Initial CSM

In accordance with Environment Agency, CLR 11 (2004) and BSI 10175 (Code of Practice for Investigation of Potentially Contaminated Land), REC Ltd have developed an initial CSM to identify potential contamination sources, migration pathways and receptors within the study area.

6.2 Contaminant Sources

On-site Potential Sources

REC Ltd has identified the following possible on site potential sources:

- The subject site has been historically used for agricultural uses and, as such, localised contamination from spills or leaks from farming machinery and localised use of pesticides.

Off-site Potential Sources

REC Ltd has identified the following possible off site potential sources:

- Construction of residential properties adjacent to the eastern boundary; and
- Electrical Sub-Stations 120 and 180 m east of site.

6.3 Potential Pathways

REC Ltd has identified the following possible pathways:

- Soil ingestion;
- Vertical and lateral migration; and
- Dermal contact.

6.4 Potential Receptors

REC Ltd has identified the following possible receptors:

- Shallow groundwater and surface watercourses through lateral migration, particularly through the underlying strata;
- The underlying Secondary A Aquifers are potentially receptors; and
- Residents of any future development on site.

6.5 Summary of Initial CSM

- Should any impact from historical farming activities be present within the shallow groundwater this may pose a risk to the adjacent surface watercourses through lateral migration, particularly if the underlying alluvium strata comprise permeable sand and gravel.
- Residents of any future development could be potentially at risk from historic farming contamination through dermal contact with contaminated soils and soil ingestion.
- The underlying Secondary AAquifer is also potentially a receptor for any contamination from historical farm activities, particularly if any preferential pathways are created during the construction of the proposed development.
- Construction workers are not considered to be a plausible receptor as exposure will be managed through the use of appropriate PPE and hygienic working practices as required under HSE / CDM regulations. Furthermore, the length of any exposure is likely to be for a short duration;

7.0 PRELIMINARY GEOTECHNICAL SITE INVESTIGATION

7.1 Preliminary Site Investigation

7.1.1 General

A preliminary site investigation was undertaken to assess the geotechnical suitability of the cohesive materials on-site for use in the construction of an off-site balancing pond feature, to assess the California Bearing Ratio (CBR) of materials for proposed road construction and to assess the infiltration characteristics of the underlying soils in order to identify potential abnormal development constraints and to assist in the development of cost effective management / drainage options. The intrusive investigation work that was completed is summarised in Table 7.1.

REC worked to the Client's scope of works for the site investigation which, at this preliminary stage, excluded any intrusive investigation and/or chemical analysis for potential contamination at the site.

Exploratory fieldwork was completed from 3rd to 4th October 2013. The works are summarised in Table 7.1.

Table 7.1 Summary of Fieldwork

Exploratory Fieldwork	Location Hole	Type	Maximum Depth (m bgl)
Soakaway Infiltration Test	TP101	Trial Pit	1.00
Soakaway Infiltration Test	TP102	Trial Pit	1.50
Soakaway Infiltration Test	TP103	Trial Pit	2.00
Soakaway Infiltration Test	TP104	Trial Pit	2.50
Soakaway Infiltration Test	TP105	Trial Pit	3.00
General site coverage	TP107	Trial Pit	3.50
General site coverage	TP108	Trial Pit	0.45
Soakaway Infiltration Test	TP109	Trial Pit	0.50
General site coverage	TP110	Trial Pit	4.00
Soakaway Infiltration Test	TP111	Trial Pit	0.65
California Bearing Ratio Test	DCP101	DCP	0.91
California Bearing Ratio Test	DCP102	DCP	0.91
California Bearing Ratio Test	DCP103	DCP	0.91
California Bearing Ratio Test	DCP104	DCP	0.90
California Bearing Ratio Test	DCP105	DCP	0.79

Notes

m bgl – metres below ground level.

DCP – dynamic cone penetrometer test

The ground conditions encountered are indicated on the logs which are provided in Appendix V.

Soakaway infiltration tests need to be carried out three times in accordance to BRE guidance. This was only able to be completed on one of the positions (TP109) as the first test on all the other trial pits did not reach the 75 percentile for soil infiltration. Five of the tests were fenced and left to run overnight, but still failed to reach the 75 percentile for soil infiltration. The results of the infiltration testing are summarised in Table 8.2 below and full infiltration testing results are presented in Appendix VIII.

In situ CBR tests were undertaken at selected locations using a dynamic cone penetrometer (DCP) probe. Tests were undertaken at depths from ground level to 1 m below ground level in order to intersect the likely pavement sub-formation level. The DCP results are summarised in Table 8.3 below and are presented in full in Appendix VII.

8.0 GROUND AND GROUNDWATER CONDITIONS

8.1 Ground Conditions

8.1.1 Summary of Ground Conditions

The ground investigation generally confirms the published geology and identifies the strata set out in Table 8.1 below:

Table 8.1 Summary of Strata

Strata	Typical Description	Min Depth to Top of Strata (m)	Max Depth to Top of Strata (m)	Max Thickness (m)
MADE GROUND	Brown SILT topsoil with flint gravel and brick fragments	0.00	0.00	0.35
GRAVEL	Loose medium to coarse flint GRAVEL in clay matrix	0.25	0.35	0.65
LONDON CLAY	Stiff, orange/grey mottled CLAY	0.38	0.90	> 3.50 (base not proven)

8.1.2 Side Stability and Ease of Excavation

The sides of the exploratory trial pit excavations appeared to be stable during excavation.

8.1.3 Soil Infiltration

Soakaway tests were undertaken in seven trial pits. The results are presented below in Table 8.2 and full infiltration calculation sheets are included in Appendix VIII.

Table 8.2 Soil Infiltration Results

Location	Depth (m bgl)	Material	Test No.	Soil Infiltration Rate (m/s)
TP101	1.00	Flint GRAVEL and London CLAY	Test No. 1	8.96×10^{-7} m/s*
TP102	1.50	Flint GRAVEL and London CLAY	Test No. 1	1.91×10^{-6} m/s*
TP103	2.00	Flint GRAVEL and London CLAY	Test No. 1	9.51×10^{-7} m/s*
TP104	2.50	Flint GRAVEL and London CLAY	Test No. 1	4.07×10^{-7} m/s*
TP105	3.00	Flint GRAVEL and London CLAY	Test No. 1	3.97×10^{-7} m/s*
TP109	0.50	Flint GRAVEL	Test No. 1	1.26×10^{-4} m/s
			Test No. 2	9.12×10^{-5} m/s
			Test No. 3	7.83×10^{-5} m/s
TP111	0.65	Flint GRAVEL and London CLAY	Test No. 1	1.59×10^{-5} m/s*

* Test data extrapolated to give infiltration data for information purposes only

Soil infiltration was taken over the wetted area from between 75% and 25% of the effective depth. Where water did not infiltrate sufficiently for the head to fall to 25% or 75% of the effective depth then the test data has been considered extrapolated out to provide an indicative soil infiltration rate.

The head of water in trial pits TP101, 102 and 111 fell below 25% of the effective depth, but did not reach 75% of the effective depth of the trial pit and the time figure for 75% of the effective depth had to therefore be extrapolated. The head of water in TP103, 104 and 105 did not even reach 25% of the effective depth of the trial pit, so time figures for both 25 % and 75% of the effective depth had to therefore be extrapolated.

The fact that only one of the trial pits (TP109) was able to be run three times, in line with BRE365, indicates that only shallow soakaways may be viable for the site using the gravels as a receiving strata for surface water drainage. The limited infiltration characteristics of the cohesive materials on site indicate that it would be suitable for use off site in the construction of engineered bund walls for a balancing pond feature.

The application of soakaway drainage will ultimately be dependent on the specific requirements of the development. All soakaways should be designed in accordance with BRE Special Digest 365 – *Soakaway Design*.

8.1.4 California Bearing Ratio

The California Bearing Ratio (CBR) for the soils was measured using *in situ* tests and also by laboratory analysis of samples recovered from site. The results are summarised in Table 8.3.

In situ tests were undertaken using a Dynamic cone penetration (DCP) probe. The result sheets are included in Appendix VII and the locations are shown on the site plan which is included in Appendix III. CBR results have been averaged from the blow counts across the strata tested and any abnormally high blow counts ignored as these are likely to be from larger granular material and so represent anomalies.

Laboratory analysis certificates are presented in Appendix VI.

Table 8.3 Summary of CBR Testing

Location	Depth (m)	Strata	In Situ or Lab Test	CBR (%)
DCP101	0.91	Topsoil, flint GRAVEL and London CLAY	<i>In Situ</i>	19.5
DCP102	0.91	Topsoil, flint GRAVEL and London CLAY	<i>In Situ</i>	15.7
DCP103	0.91	Topsoil, flint GRAVEL and London CLAY	<i>In Situ</i>	27.5
DCP104	0.90	Topsoil, flint GRAVEL and London CLAY	<i>In Situ</i>	18.4
DCP105	0.79	Topsoil, flint GRAVEL and London CLAY	<i>In Situ</i>	7.8
TP103	1.00	Yellowish brown slightly sandy CLAY	Lab	12.8
TP104	2.50	Yellowish brown slightly sandy CLAY	Lab	11.8
TP105	0.50	Greyish brown silty clayey GRAVEL	Lab	19.6
TP105	1.50	Yellowish brown slightly sandy CLAY	Lab	11.8
TP110	3.50	Yellowish brown slightly sandy CLAY	Lab	11.8

8.1.5 Soil Consistency

In situ hand shear vanes were measured of the clay encountered during the preliminary site investigation using a hand held shear vane. The results of the tests are presented in Table 8.4 and generally confirm the natural clay deposits to vary between soft and firm. The shear strengths are also included on the exploratory hole logs (Appendix IV).

Table 8.4 Summary of Hand Shear Strength Test Results

Location	Sample Depth (m)	Field Description	Undrained Shear Strength (kN/m ²)	Consistency
TP102	1.00	Slightly gravelly CLAY	40	Firm
	1.50	Slightly gravelly CLAY	30	Soft
TP103	1.00	CLAY	48	Firm
	1.50	CLAY	50	Firm
	2.00	CLAY	68	Firm
TP104	1.00	Slightly gravelly CLAY	40	Firm
	1.50	Slightly gravelly CLAY	28	Soft
	2.00	Slightly gravelly CLAY	34	Soft
	2.50	Slightly gravelly CLAY	42	Firm
TP105	1.00	Slightly gravelly CLAY	54	Firm
	1.50	Slightly gravelly CLAY	32	Soft
	2.00	Slightly gravelly CLAY	58	Firm
	2.50	Slightly gravelly CLAY	50	Firm
TP107	1.00	CLAY	30	Soft
	1.50	CLAY	18	Soft
	2.00	CLAY	32	Soft
	2.50	CLAY	20	Soft
TP110	1.00	Slightly gravelly CLAY	42	Firm
	1.50	Slightly gravelly CLAY	42	Firm
	2.50	Slightly gravelly CLAY	44	Firm

8.2 Groundwater Conditions

No groundwater was encountered within any of the investigation positions undertaken on site.

8.3 Classification Testing

8.3.1 Atterberg Limits Tests

Atterberg limits testing was carried out on representative samples of the London Clay (Table 8.5).

Table 8.5 Results of the Atterberg Limits Tests

Location	Depth (m)	Natural Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Plasticity Index (%)	Percentage passing 425µm sieve (%)	Modified Plasticity Index
TP102	0.50	28.9					
TP103	1.00	30.5	26	54	28	92	25.76
TP104	1.50	31.2	26	56	30	94	28.20
TP104	2.50	31.5	27	56	29	95	27.55
TP105	0.50	27.8					
TP105	1.50	30.9					
TP105	3.00	33.0	25	54	29	90	26.10
TP107	1.00	32.1	25	52	27	88	23.76
TP107	3.50	31.8					
TP110	0.50	28.4					
TP110	1.50	30.2	25	52	27	87	23.49

TP110	3.50	32.4	27	55	28	89	24.92
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The Atterberg Limits determinations, summarised in Table 8.5, show the cohesive deposits of the London Clay Formation to be of high plasticity. After correction, to account for the >425µm content, the modified plasticity indices show the material to be of medium volume change potential.

8.3.2 Particle Size Distribution

Three samples of the clayey gravel and three samples of the London Clay Formation underwent particle size distribution analysis (Table 8.6).

Table 8.6 Granulometric composition of the sample tested

Location	Depth (mbgl)	Granulometric Composition (%)			
		Silt/Clay	Sand	Gravel	Cobbles
TP102	0.5	29	9	62	0
TP104	1.5	89	11	0	0
TP105	1.5	90	10	0	0
TP107	3.5	93	7	0	0
WS105	0.5	34	13	53	0
WS110	0.5	34	8	58	0

8.3.3 Dry Density/Moisture Content Relationship

The determination of dry density and moisture content relationship was carried out on one sample of the clayey gravel and a total of four samples of the London Clay Formation (Table 8.7).

Table 8.7 Results of the Determination of dry density and moisture content relationship

Location	Depth (mbgl)	Optimum Moisture Content (%)	Maximum Dry Density (Mg/m ³)
TP103	1.0	20.8	1.69
TP104	2.5	25.3	1.57
TP105	0.5	20.8	1.69
TP105	1.5	26.2	1.55
TP110	3.5	26.5	1.52

9.0 GEOTECHNICAL ASSESSMENT

9.1 Proposed Development

REC understands that the site is to be redeveloped for residential end use. It is understood that the proposed development will comprise residential houses with associated landscaping and infrastructure. Details of the proposed loadings are not known and therefore a line loading of 75 kN/m has been assumed for preliminary assessment purposes only.

Given the nature of the proposed development it is considered that the structure meets the criteria of Geotechnical Category 1 of Euro Code 7.

Given the nature of the development it is considered that acceptable risk from settlement is a total settlement value of 25 mm for a masonry structure.

9.2 Summary of Ground Conditions

Ground conditions identified at the site are summarised in Table 9.1 below:

Table 9.1 Summary of Ground Conditions

Strata	Typical Description	Min Depth to Top of Strata (m)	Max Depth to Top of Strata (m)	Max Thickness (m)
MADE GROUND	Brown SILT topsoil with flint gravel and brick fragments	0.00	0.00	0.35
GRAVEL	Loose medium to coarse flint GRAVEL in clay matrix	0.25	0.35	0.65
LONDON CLAY	Stiff, orange/grey mottled CLAY	0.38	0.90	> 3.50 (base not proven)

9.3 Site Preparation

The site should be cleared and any vegetation below areas of proposed development stripped in accordance with Series 200 of the Specification for Highway Works. This should include:

- Roots present below the footprint of proposed structures and infrastructure should be grubbed out and the resulting void in filled with suitable compacted engineered fill;
- Redundant services should be sealed off and grubbed out and replaced with suitable compacted engineered fill; and,

9.4 Foundation Conditions and Bearing Capacity

General

It is considered that the Made Ground and gravels are not suitable for a founding material due to the inherent variability of the material. It is therefore that conventional strip footings into the natural cohesive material (London Clay Formation) are adopted.

Strip Foundations

Strip foundations should be constructed directly onto the London Clay Formation or at least 150 mm in to the underlying stiff clay. At depths of 1.00 m bgl or greater an allowable bearing capacity of 100 to 150 kN/m² has been assumed using a Factor of safety of 3. It is

recommended that additional site investigation work is undertaken, including shallow boreholes to gather *in situ* geotechnical test (standard penetration test) data to inform foundation design specifications.

Atterberg limits determinations, summarised in Table 8.5 show the clay to be high plasticity and as such the sides of the foundations may require protection using clay board or similar.

Foundation depths should take account of the presence of existing and proposed trees with foundations deepened locally in accordance with the requirements of NHBC Standards for a clay of high plasticity. It is recommended that at the working drawing stage a foundation schedule is prepared for the development taking account of the soil plasticity and the locations of trees.

9.5 Ground Floor Slabs

Due to the minimal presence of the Made Ground/topsoil and gravel (up to 1.00 m bgl) it is considered that ground bearing floor slabs may be suitable, however will require detailed design to accommodate variability of the material and account for differential settlement.

Should a ground bearing floor slab be used the formation will need to be proof rolled and any loose or soft zones removed and replaced with compacted materials. Further consideration will need to be given to organic material and roots underlying the proposed footprint, it is therefore recommended that in order to minimise the potential for floor slab cracking associated with roots that a suspended floor slab is used.

In conclusion, although a ground bearing floor slab may be suitable it is recommended that suspended floor slabs are used in the final design.

Using a suspended floor slab will remove the potential for roots damaging the slab; minimise the potential for variability in strength and consistency and provide ventilation of the under floor void, required to prevent condensation.

The Atterberg Limits determinations, summarised in Table 8.5, show the clay content of the gravel strata to be of high plasticity and as such liable to heave and therefore it is considered that a suspended floor slab would be more appropriate.

9.6 Pavement Construction

An assessment of the likely California Bearing Ratio (CBR) for the site has been assessed from the following sources:

- *In situ* CBR tests undertaken using the DCP probe;
- Laboratory CBR tests undertaken on re-compacted soil samples;
- Correlations with undrained shear strength (summarised in Table 8.2) from Black and Lister;
- Correlations with plasticity index (summarised in Table 8.5) from HD25/94; and
- Description of the materials encountered in the exploratory holes.

Based on this it is considered that a CBR value of less than 7% is adopted, however it is recommended that this be re-assessed using on site plate load tests on the formation level material.

Following excavation the sub-formation should be proof rolled and any soft material inspected and removed.

9.7 Drainage

The presence of depths of Made Ground/topsoil and gravel across the site may result in settlement. It is therefore recommended that drain runs are designed using steeper gradients and flexible joints to allow for some differential settlement.

The soil infiltration tests indicate very poor soil infiltration rates that are characteristics of the low permeability of the underlying cohesive material. The shallow gravel strata did display indications of moderate infiltration potential but, generally, it is considered that the underlying soils are unlikely to provide a high degree of soakage potential for drainage systems.

9.8 Concrete Durability

No chemical analysis of soil samples recovered from the site was undertaken with respect to pH and sulphate. It is recommended that this chemical analysis is included within the scope of works of further site investigation at the site and the Design Sulphate Class and the Aggressive Chemical Environment for Concrete Classification are then determined in line with the recommendations provided in BRE Special Digest 1 (2005).

9.9 Excavations

Site observations indicated that excavations should be feasible in the near surface with normal plant as the trial pits were stable

Groundwater seepage was not recorded in any of the trial pits excavated at the site. After periods of heavy rainfall it considered that conventional sump pumping of open excavations should be adequate.

9.10 Minerals

There are no minerals of economic value underlying the site at shallow depth and mining is considered to be very unlikely. There are no mine entries recorded or likely at this site.

The site is considered to be minerally stable.

9.11 Further Works

It is recommended that the following further works potentially be undertaken at the site to reduce development costs and risk:

- Plate load testing to confirm CBR values for proposed roads;
- Standard penetration testing to confirm allowable bearing pressures; and
- pH and sulphate analysis to confirm Design Sulphate Class and the Aggressive Chemical Environment for Concrete Classification.

9.12 Construction Activity and Inspection

The following activities and inspections should be incorporated in to the site works:

- Due to the variability of the soils at the site it is recommended that sufficient allowance is made for the inspection of formation and sub formations to foundations and pavement construction;
- Excavations where access is required should be subject to a risk assessment from a

competent person and where appropriate mitigation measures such as benching back the sides or use of support systems in accordance with CIRIA R97 utilised;

- It is considered that de-watering may be required, especially following periods of heavy rainfall. Removal of surface water and water within trenches should be possible with conventional sump pumping. Discharge of any water should be agreed with the relevant regulatory body and be undertaken under a trade effluent discharge, where required. Measures to remove silt and suspended solids may be required and consideration should be given to provision of space for settling tanks or an attenuation pond;
- Where access to confined spaces is required appropriate mitigation measures should be addressed within the Construction Stage Health and Safety Plan; and
- The presence of potential contamination and mitigation measures should be addressed as part of the Construction Stage Health and Safety Plan and should include measures to design out the risks, reduce their impact and finally the use of Personnel Protective Equipment (PPE).

10.0 EARTHWORKS ASSESSMENT

10.1 Introduction

It is understood that the proposed development will comprise the construction of a bund wall for an off-site balancing pond to hold approximately 20, 000 cubic metres of storm water for a 1 in 100 year plus climate change storm event. It is understood that it is proposed that the new bund walls to retain water are to be constructed out of material excavated from the proposed foundations on site.

The ground investigation undertaken identified the site to be underlain by up to 0.35m of Made Ground, overlying a thin layer of loose medium to coarse flint GRAVEL in clay matrix up to a maximum thickness of 0.65 m which, in turn, overlaid the London Clay Formation comprising of stiff, orange/grey mottled CLAY.

10.2 Characteristic Geotechnical Parameters – London Clay Formation

Compaction tests carried out using the 4.5kg hammer give maximum dry densities in the range of 1.52 to 1.69 Mg/m³. The corresponding optimum moisture contents are in the range of 20.8 to 26.5 %.

The natural moisture content data indicates a range of between 27.8 % and 33.0 %, with average moisture content of around 30.7 % indicating the *in situ* clays of the London Clay Formation are on the wet side of the optimum moisture content.

Processing the soil to achieve optimum moisture content should be achievable, given that natural moisture content it is relatively close to the optimum moisture content and ripping the soil and allowing it to dry before placing is considered a feasible solution.

Based on the results of the both the *in situ* and laboratory geotechnical testing the following characteristic geotechnical parameters are recommended for use in any subsequent geotechnical design (Table 10.1).

Table 10.1 Characteristic Geotechnical Parameters of Soils

Stratum	Geotechnical Parameter		Notes	Characteristic Value
London Clay Formation	Unit Weight	bulk γ	Typical Values after	18kN/m ³
	Undrained Shear Strength	c_u (kN/m ²)	Based on Liquidity Index (LI) correlation – LI of 0.17 from: MC-31, PL-26, PI-29	65kn/m2
		$\phi_u = 0^\circ$		
	Effective Shear Strength	$c' = 0$		
		$\phi' (^\circ)$	Based on relationship with plasticity Index	26° (conservative)
	Maximum Dry Density		Average to 3.50m	1.60
	Optimum Moisture Content		Average to 3.50m	24%
	CBR Value			12% (Conservative)

10.3 General

It is considered that the Made Ground is not suitable for use within the construction of any earth structures.

Similarly, the gravel material would not be considered suitable for use within the construction of any earth structures as it is unlikely to retain water as a standalone material.

The stiff clays of the London Clay Formation encountered are considered to be a suitable site won material for re-engineering and use in the construction of embankments associated with the lagoon extension.

It is considered any topsoil, Made Ground and gravel will be stripped from the proposed route of the embankment in order to minimise drainage problems and differential settlements along the transition of the proposed embankment. Similarly, it is considered that any topsoil, Made Ground and gravel will be stripped from the area of the proposed balancing pond in order that the clays of the London Clay Formation be accessed. Stripped material should be disposed of off-site or utilised as landscaping fill on-site.

After stripping of the topsoil, Made Ground and gravel, exposure of the underlying London Clay Formation to inclement weather and construction disturbance should be minimised to avoid degradation of the soil.

Outline design parameters for embankment construction are given in Table 10.2 below:

Table 10.2 Design parameters for earthworks

Material	Effective angle of friction, Φ' (degrees)	Effective cohesion, c' (kN/m ²)	Undrained Shear Strength, C_u (kN/m ²)	Bulk Density (Mg/m ³)	Unit Weight (kN/m ³)
Clay (London Clay)	26° (conservative)	0	25 – 65	1800-2200	18

10.4 Material Classification

It is considered that locally won clay material (London Clay Formation), from the foundation excavations on-site, are suitable for use within the bund wall construction. Because of the long term settlement associated with even well compacted cohesive soils due to elevated pore water pressures, it is essential that the cut and fill process is well controlled with particular attention placed on control of moisture levels of the soils.

Laboratory assessments have been made of the London Clay Formation encountered on site and in accordance with the Manual of Contract Documents for Highway Works, Volume 1, Specification for Highway Works, Series 600, Earthworks as amended in November 2005, this material should be classed as a General Cohesive Fill, Class 2B (dry cohesive material).

The volumes of material required are unknown at this stage. Should the site won material be insufficient for the construction of the embankments required, consideration may be given to utilising imported material but it is considered that assessment of materials to be imported at source will be required prior to bringing the materials onto site.

10.5 Filling Placement

In the areas which require filling, the stripped surfaces should be proof rolled in the presence of a geotechnical engineer. Any areas exhibiting significant deflections under proof rolling should be treated by over excavation and replacement with compacted cohesive fill.

All fill material should be placed in horizontal layers, the maximum thickness of which will be dependent upon the suitability and type of compaction plant available, for the purposes of this preliminary report, it is assumed that lifts will comprise thicknesses of 600mm.

All Class 2 fill material should be compacted to a minimum of 90% maximum dry density, except for the upper 1.0m, which should be compacted to a minimum of 95% maximum dry density. To validate compaction, field inspections and *in situ* testing of earthworks must be undertaken by a geotechnical engineer.

Each lift should be tested to ensure compliance with the specification and to validate the fill compaction. It is recommended that the *insitu* testing is undertaken in accordance with guidance contained within Highways Design Series 600 and that the following tests adopted. Frequency of testing is to be confirmed by the designer:

Table 10.3 Compaction Validation Tests

Test	Method	Frequency
Density Testing	Sand Replacement	TBC
Density Testing	Nuclear Density Testing (NDT)	TBC
Atterberg Limits	Laboratory analysis	TBC
Moisture Content	Laboratory analysis	TBC
<i>In situ</i> shear strength	Hand Shear vane	TBC
California Bearing Ratio	<i>In situ</i> CBR by plate load or DCP	TBC

11.0 CONCLUSIONS & RECOMMENDATIONS

Initial Conceptual Site Model

Limited on or off-site potential sources of contamination, possible contaminant pathway through shallow gravel strata with nearby surface watercourses identified as the most sensitive receptor. Groundwater vulnerability in the vicinity of the site is low due to the London Clay Formation acting as an aquitard and the lack of any potable water abstractions from the Secondary A Aquifer in the gravel deposits on site.

Geotechnical Assessment

It is considered that ground conditions should allow for the construction of shallow strip foundations bearing on the underlying natural clays at a depth of 1.00 m bgl. Allowable bearing pressures should be confirmed for foundation design purposes with *in situ* standard penetration testing.

The underlying soils are predominantly cohesive in matrix and a preliminary assessment suggests that they are unlikely to provide a high degree of soakage potential for drainage systems. Some limited infiltration was observed within the shallow gravel strata.

In situ CBR tests and laboratory CBR analysis suggests that the clays could provide a risk conservative CBR design percentage of 7 % for the construction of new highways and infrastructure. CBR values should be confirmed along routes of proposed roads using plate load testing.

pH and sulphate analysis required to confirm Design Sulphate Class and Aggressive Chemical Environment for Concrete Classification.

London Clay Formation assessed in principal as suitable for use in constructing off-site balancing pond, subject to geotechnical testing and assessment during construction.

Recommendations

No significant sources of potential contamination identified by desk study but additional site investigation be undertaken to include:

- Plate load testing to confirm CBR values for proposed roads;
- Limited testing of shallow soils for assessment of potential contamination impact as identified in the DTS;
- Standard penetration testing to confirm allowable bearing pressures; and
- pH and sulphate analysis to confirm Design Sulphate Class and the Aggressive Chemical Environment for Concrete Classification.

Further geotechnical testing and assessment of London Clay Formation by geotechnical engineer to made during construction of off-site balancing pond.

END OF REPORT

**APPENDIX I
LIMITATIONS**

1. This report and its findings should be considered in relation to the terms of reference and objectives agreed between REC Ltd and the Client as indicated in Section 1.2.
2. For the work, reliance has been placed on publicly available data obtained from the sources identified. The information is not necessarily exhaustive and further information relevant to the site may be available from other sources. When using the information it has been assumed it is correct. No attempt has been made to verify the information.
3. This report has been produced in accordance with current UK policy and legislative requirements for land and groundwater contamination which are enforced by the local authority and the Environment Agency. Liabilities associated with land contamination are complex and requires advice from legal professionals.
4. During the site walkover reasonable effort has been made to obtain an overview of the site conditions. However, during the site walkover no attempt has been made to enter areas of the site that are unsafe or present a risk to health and safety, are locked, barricaded, overgrown, or the location of the area has not been made known or accessible.
5. Access considerations, the presence of services and the activities being carried out on the site limited the locations where sampling locations could be installed and the techniques that could be used.
6. In addition to the above REC Ltd note that when investigating, or developing, potentially contaminated land it is important to recognise that sub-surface conditions may vary spatially and also with time. The absence of certain ground, ground gas, and contamination or groundwater conditions at the positions tested is not a guarantee that such conditions do not exist anywhere across the site. Due to the presence of existing buildings and structures access could not be obtained to all areas. Additional contamination may be identified following the removal of the buildings or hard standing.
7. Site sensitivity assessments have been made based on available information at the time of writing and are ultimately for the decision of the regulatory authorities.
8. Where mention has been made to the identification of Japanese Knotweed and other invasive plant species and asbestos or asbestos-containing materials this is for indicative purposes only and do not constitute or replace full and proper surveys.
9. The executive summary, conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the report in full.
10. This report presents an interpretation of the geotechnical information established by excavation, observation and testing. Whilst every effort is made in interpretative reporting to assess the soil conditions over the Site it should be noted that natural strata vary from point to point and that man made deposits are subject to an even greater diversity. Groundwater conditions are dependent on seasonal and other factors. Consequently there may be conditions present not revealed by this investigation.
11. REC can not be held responsible for any use of the report or its contents for any purpose other than that for which it was prepared. The copyright in this report and other plans and documents prepared by REC is owned by them and no such plans or documents may be reproduced, published or adapted without written consent. Complete copies of this may, however, be made and distributed by the client as is expected in dealing with matters related to its commission. Should the client pass copies of the report to other parties for information, the whole report should be copied, but no professional liability or warranties shall be extended to other parties by REC in this connection without their explicit written agreement there to by REC.
12. Rather, this investigation has been undertaken to provide a preliminary characterisation of the existing sub-surface geotechnical characteristics and make up and the findings of this study are our best interpretation of the data collected, within the scope of work and agreed budget. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.
13. This investigation has been undertaken to reasonably characterise existing sub-surface conditions and the findings of this study are our best interpretation of the data collected, within the scope of work and agreed budget. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.

APPENDIX II
GLOSSARY

TERMS

AST	Above Ground Storage Tank
BGS	British Geological Survey
BSI	British Standards Institute
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CIEH	Chartered Institute of Environmental Health
CIRIA	Construction Industry Research Association
CLEA	Contaminated Land Exposure Assessment
CSM	Conceptual Site Model
DNAPL	Dense Non-Aqueous Phase Liquid (chlorinated solvents, PCB)
DWS	Drinking Water Standard
EA	Environment Agency
EQS	Environmental Quality Standard
GAC	General Assessment Criteria
GL	Ground Level
GSV	Gas Screening Value
HCV	Health Criteria Value
ICSM	Initial Conceptual Site Model
LNAPL	Light Non-Aqueous Phase Liquid (petrol, diesel, kerosene)
ND	Not Detected
LMRL	Lower Method Reporting Limit
NR	Not Recorded
PAH	Poly Aromatic Hydrocarbon
PCB	Poly-Chlorinated Biphenyl
PID	Photo Ionisation Detector
QA	Quality Assurance
SGV	Soil Guideline Value
SPH	Separate Phase Hydrocarbon
Sp.TPH (CWG)	Total Petroleum Hydrocarbon (Criteria Working Group)
SPT	Standard Penetration Test
SVOC	Semi Volatile Organic Compound
UST	Underground Storage Tank
VCCs	Vibro Concrete Columns
VOC	Volatile Organic Compound
WTE	Water Table Elevation

UNITS

m	Metres
km	Kilometres
%	Percent
%v/v	Percent volume in air
mb	Milli Bars (atmospheric pressure)
l/hr	Litres per hour
µg/l	Micrograms per Litre (parts per billion)
ppb	Parts Per Billion
mg/kg	Milligrams per kilogram (parts per million)
ppm	Parts Per Million
mg/m ³	Milligram per metre cubed
m bgl	Metres Below Ground Level

m bcl
mAOD
kN/m²
µm

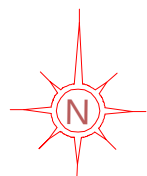
Metre Below Cover Level
Metres Above Ordnance Datum (sea level)
Kilo Newtons per metre squared
Micro metre

APPENDIX III
FIGURES

Key

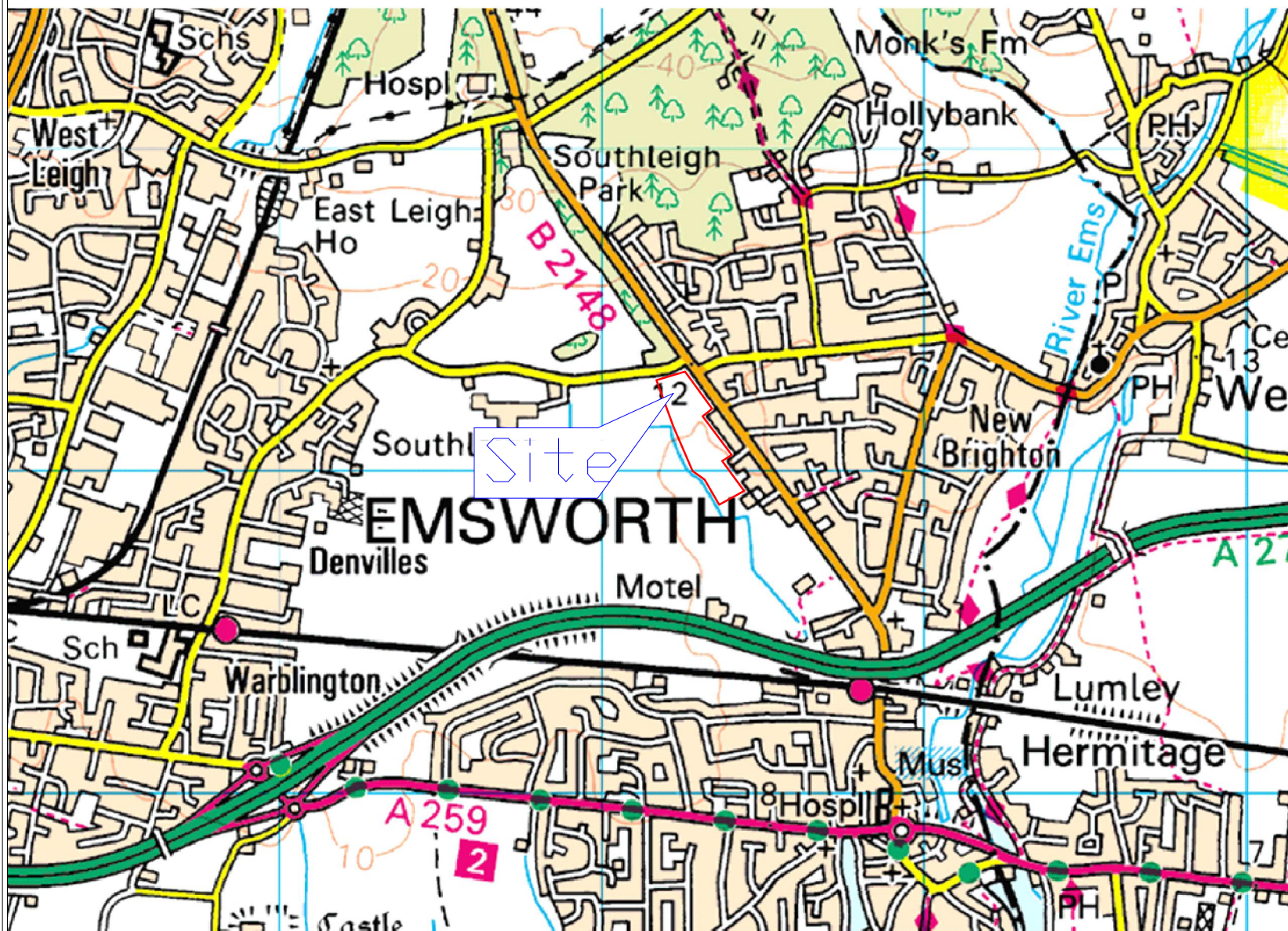


Site Location



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1Km

Key



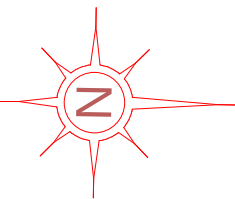
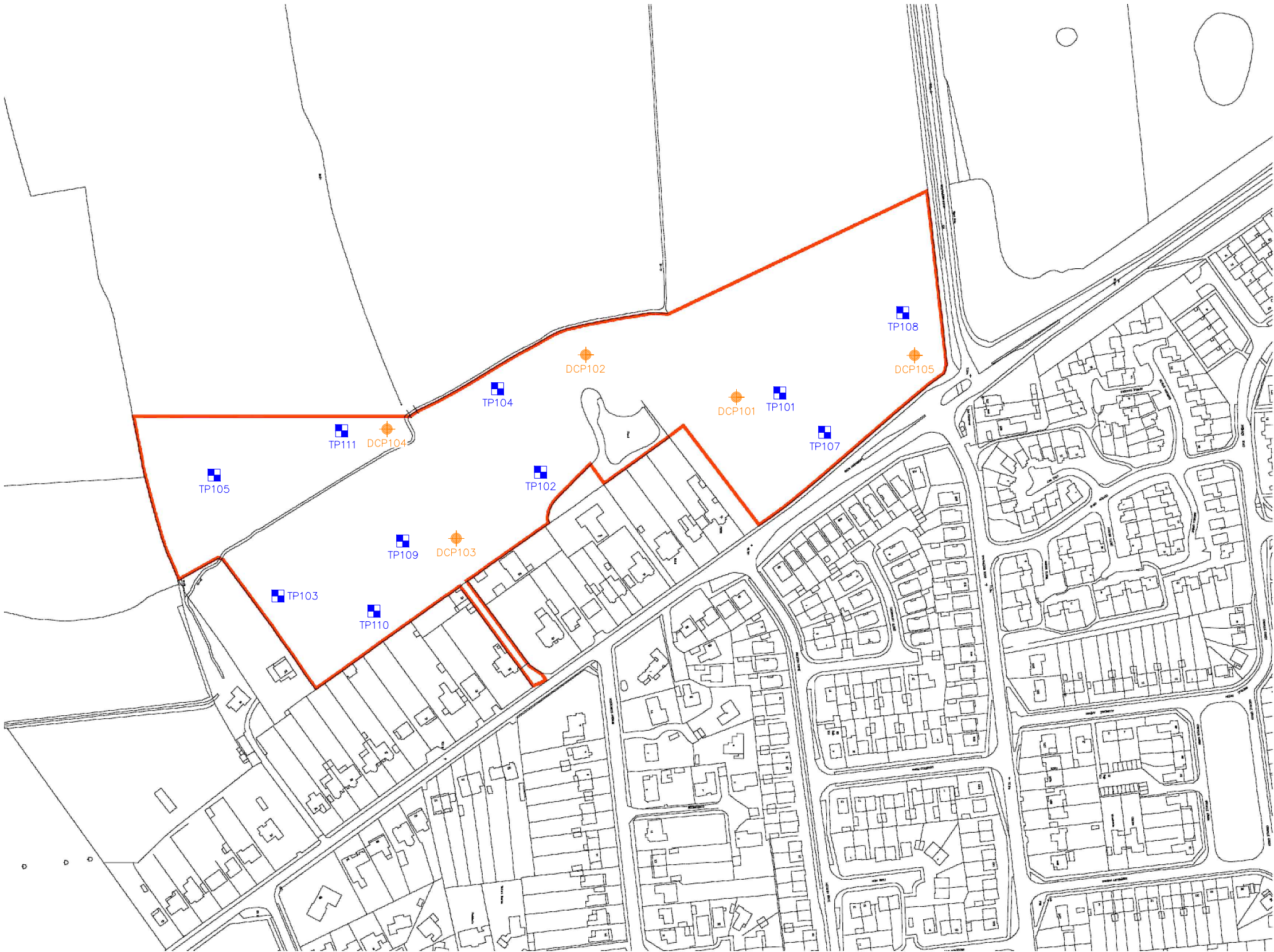
TP101

Approximate Trial Pit Location



DCP101

Approximate Dynamic Cone Penetrometer Test Location



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Resource and Environmental
Consultants Ltd
Osprey House, Pacific Quay
Manchester, M50 2UE
Tel: 0161 868 1300
Fax: 0161 868 1301
E-mail: sales@recitd.co.uk
Website: www.recitd.co.uk

Job Title:

Horndene Road,
Emsworth

Client:

C&A Consulting
Engineers

Job No: 20568

Drawn By: R. Willoughby

Approved By: M. Dyer

Scale: Not To Scale

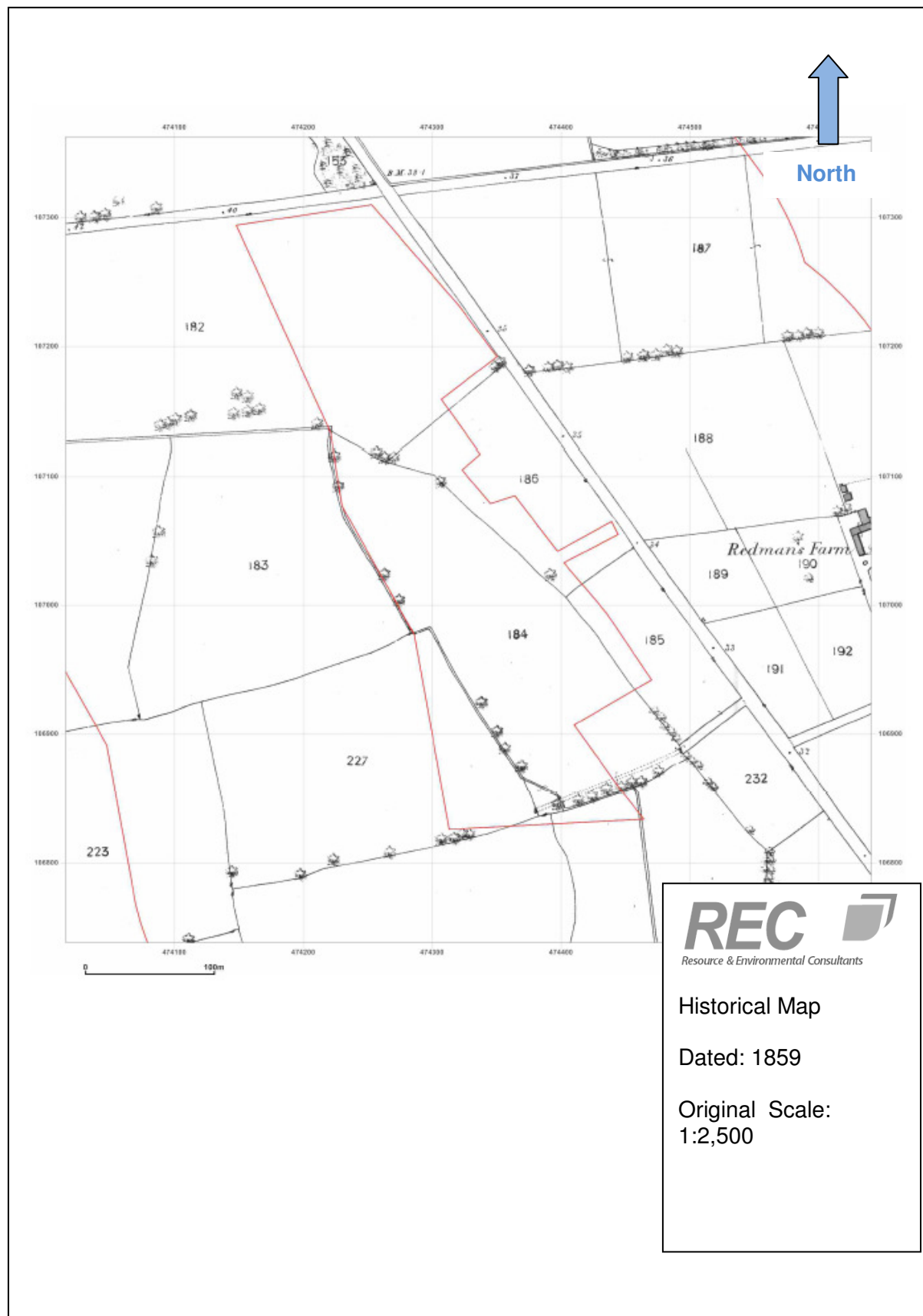
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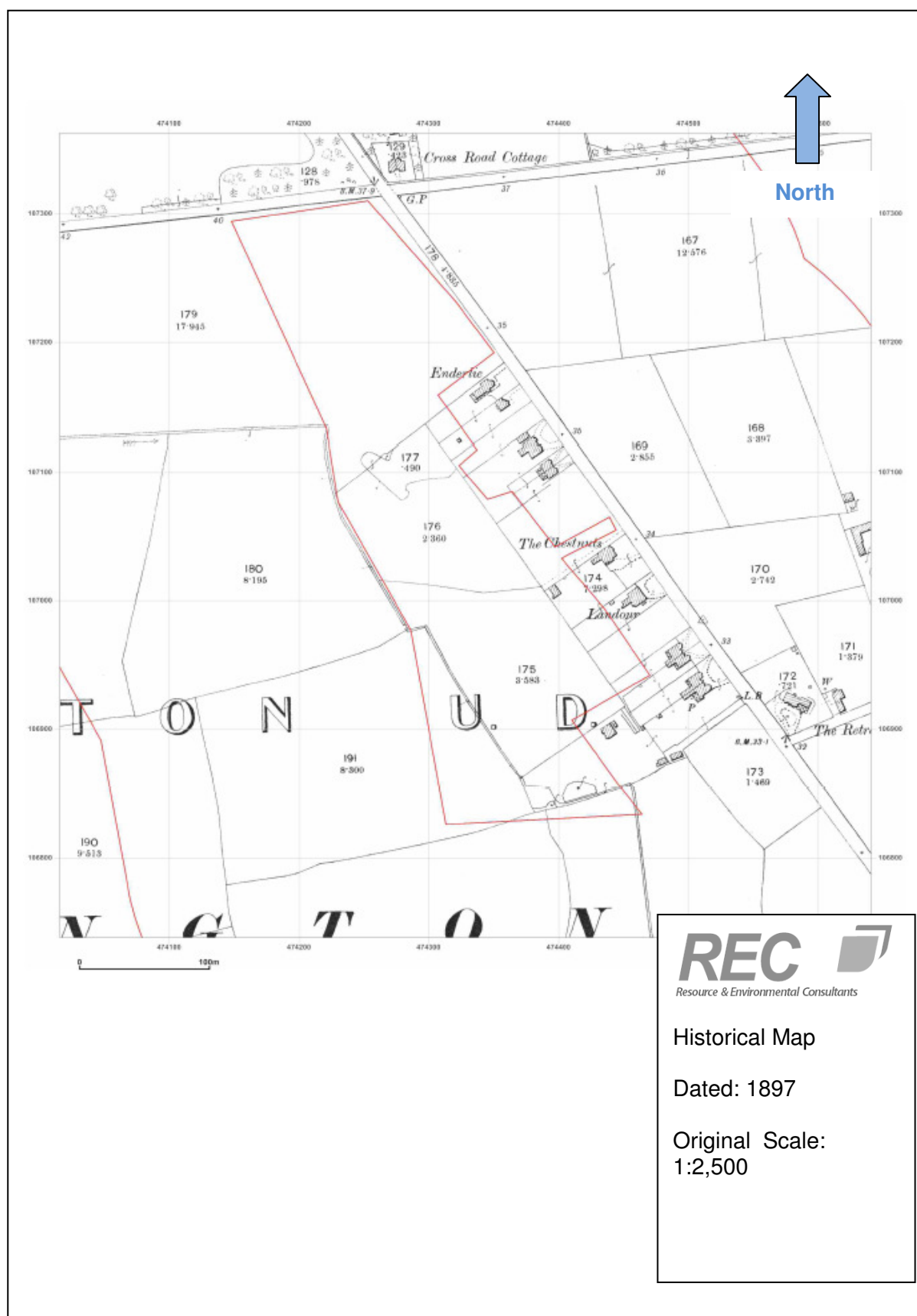
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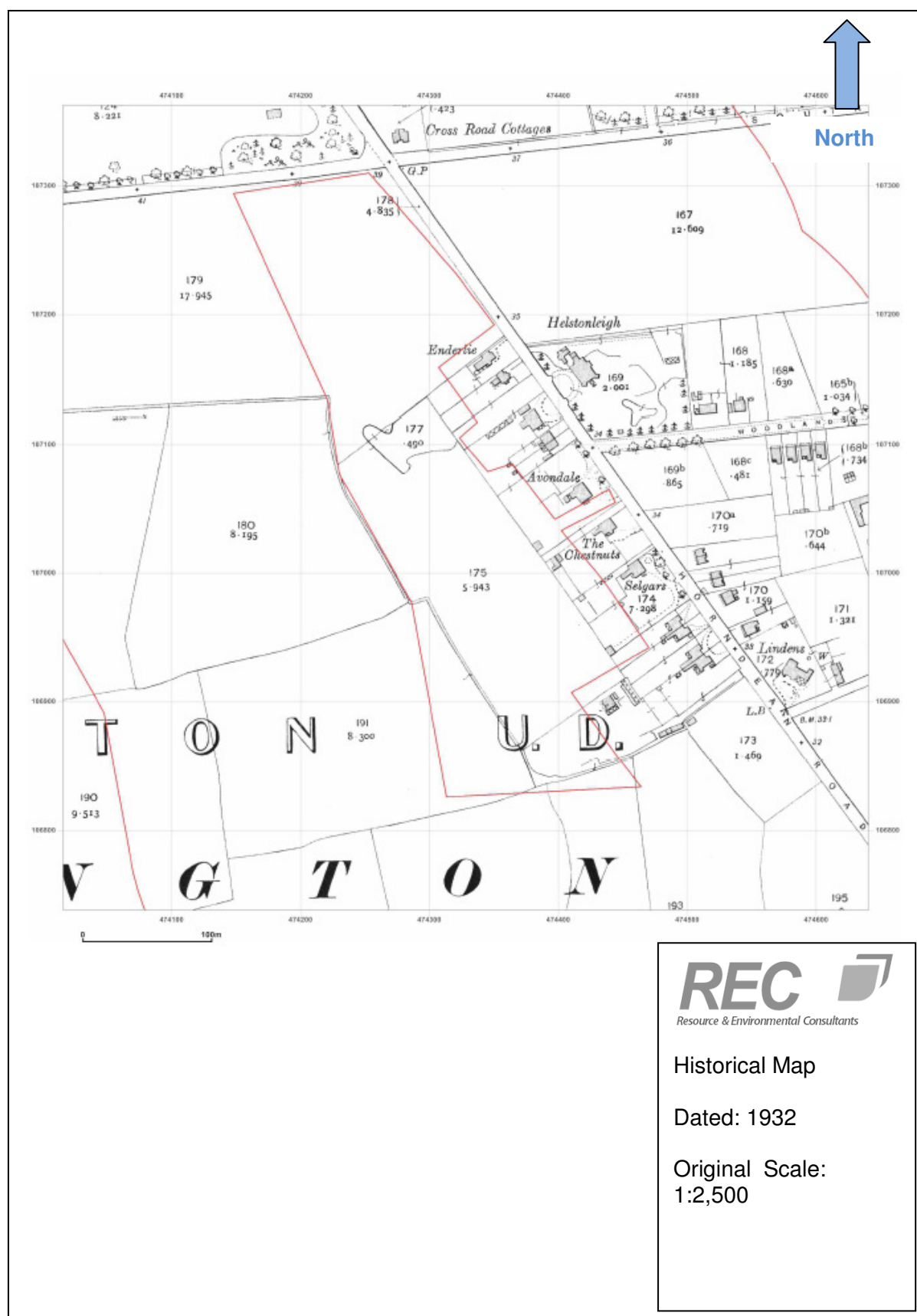
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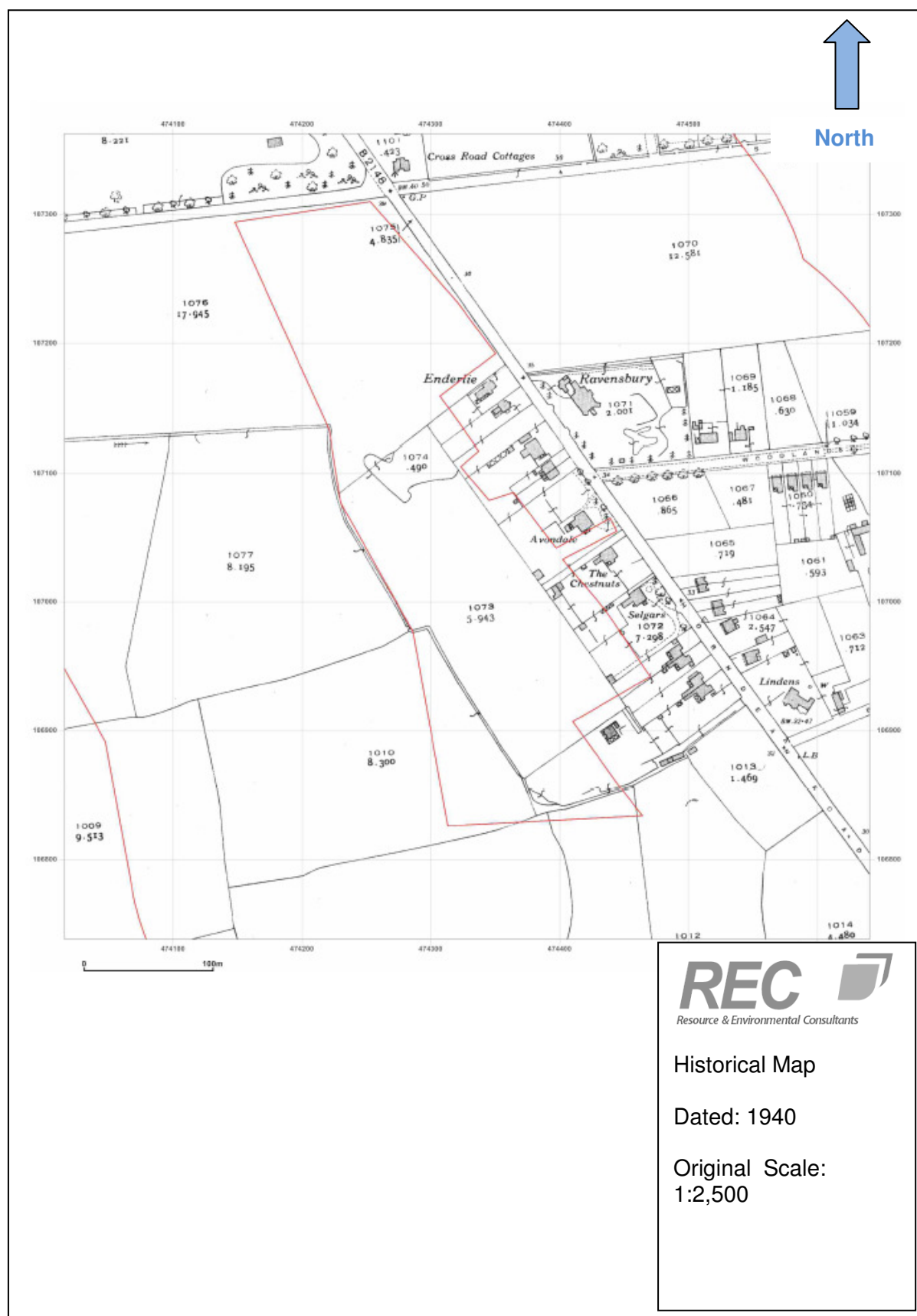
20568p1r0-001
Site Investigation
Location Plan

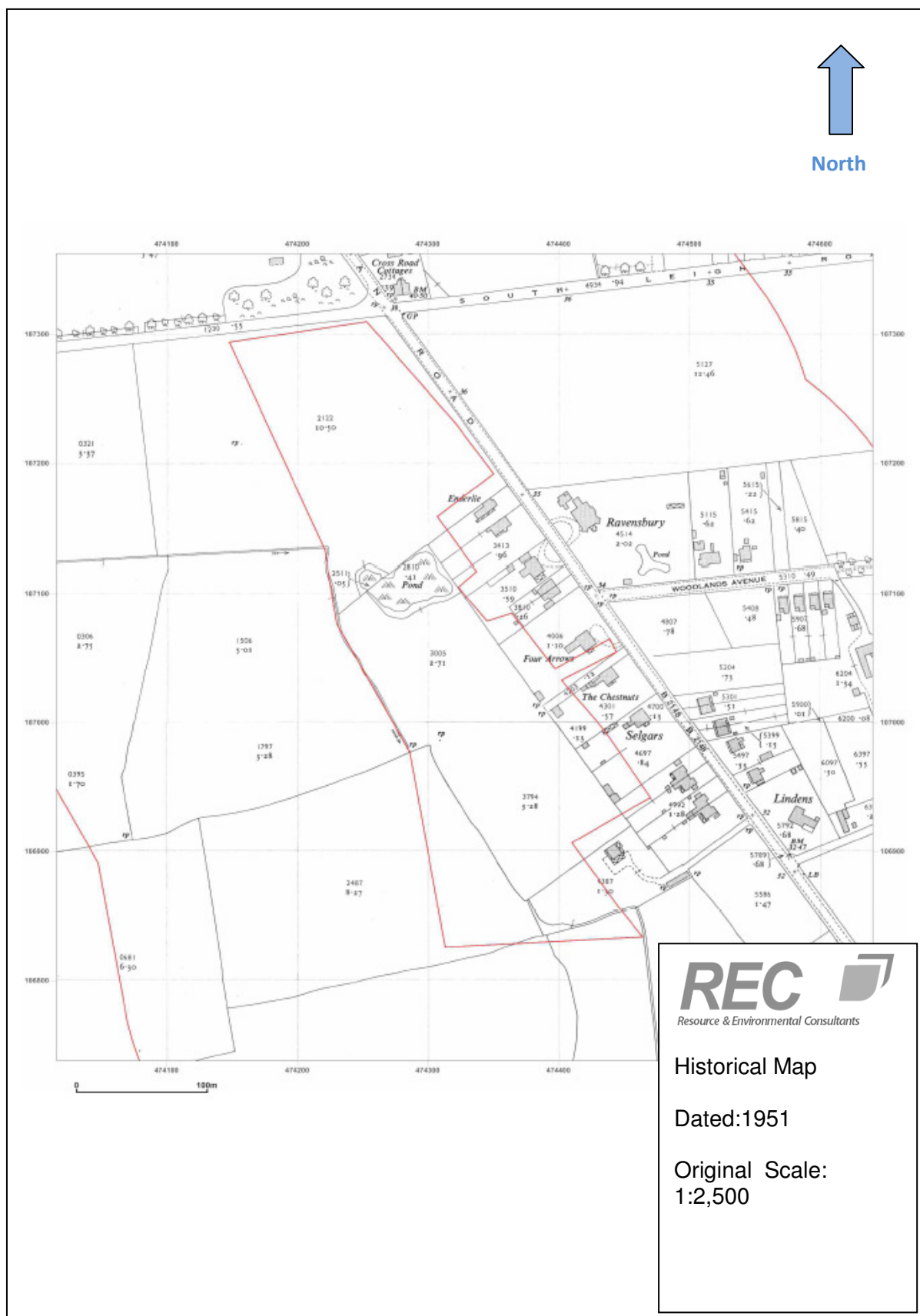
APPENDIX IV
HISTORICAL MAPS













REC 
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Historical Map

Dated: 1969

Original Scale:
1:2,500

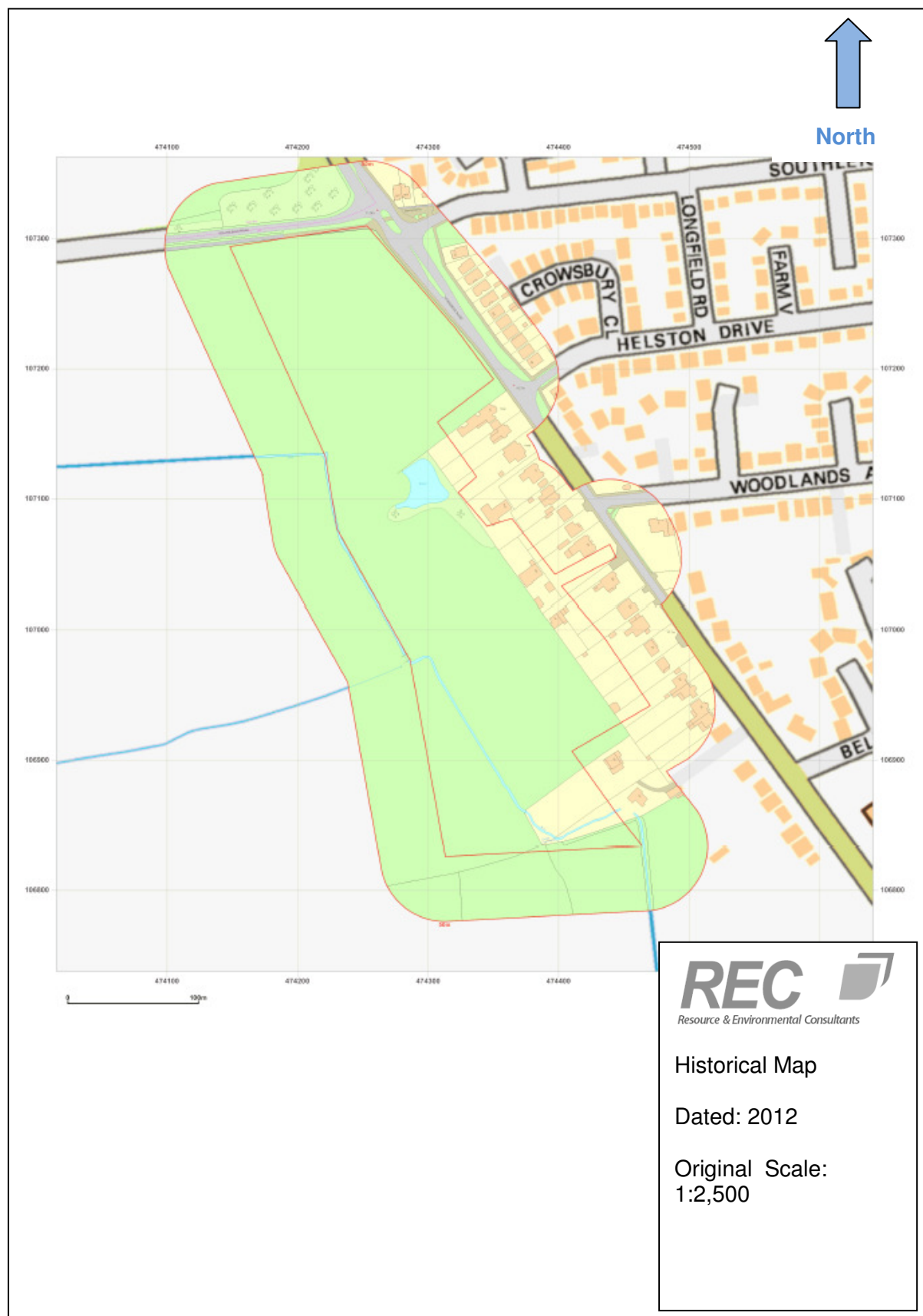


REC 
Resource & Environmental Consultants

Historical Map

Dated: 1981

Original Scale:
1:2,500



APPENDIX V
REC EXPLORATORY LOGS

Trial Pit Log

Trialpit No

TP101

Sheet 1 of 1

Project Name: Horndean Road

Project No.
20568

Co-ords: -
Level:

Date
03/10/2013

Location: Emsworth

Dimensions
(m):

2.5

Scale

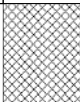
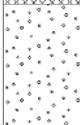
1:25

Client: C&A Consulting Engineers Ltd

Depth
1.00

0.6

Logged
HC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
				0.35			Brown, gravelly SILT with rootlets. Gravel of fine to coarse sub-angular to sub-rounded flint. MADE GROUND	
				0.80			Fine to coarse, sub-angular, loose flint GRAVEL within a silty clayey matrix. GRAVEL	
				1.00			Stiff orange mottled grey London CLAY.	
							End of pit at 1.00 m	1
								2
								3
								4
								5

Remarks: Trial Pit excavated by JCB 3XC, following scanning of location using a CAT. No groundwater encountered. Soakaway testing undertaken at location. Trial pit backfilled with arisings upon completion and compacted using weight of machine.

Stability: Stable, No wall collapse.

Trial Pit Log

Trialpit No

TP102

Sheet 1 of 1

Project Name: Horndean Road

Project No.
20568

Co-ords: -
Level:

Date
03/10/2013

Location: Emsworth

Dimensions
(m):

2.5

Scale

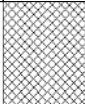
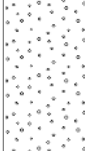
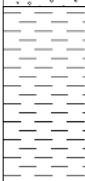
1:25

Client: C&A Consulting Engineers Ltd

Depth
1.50

0.6

Logged
HC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.50	B		0.35			Brown, gravelly SILT with rootlets. Gravel of fine to coarse sub-angular flint and brick. MADE GROUND	
							Coarse sub-rounded to sub-angular loose GRAVEL within a silty clayey matrix. GRAVEL	
	1.00	B	HVP=40	0.90			Stiff orange mottled grey London CLAY. Slightly gravelly. Gravel of medium to coarse, sub-angular flint. CLAY	1
	1.50	B	HVP=30	1.50			End of pit at 1.50 m	2
								3
								4
								5

Remarks: Trial Pit excavated by JCB 3XC, following scanning of location using a CAT. No groundwater encountered. Trial pit backfilled with arisings upon completion and compacted using weight of machine. HVP stands for Hand Vane Pit.

Stability: Stable, No wall collapse.

Trial Pit Log

Trialpit No

TP103

Sheet 1 of 1

Project Name: Horndean Road

Project No.
20568

Co-ords: -
Level:

Date
03/10/2013

Location: Emsworth

Dimensions
(m):

2.5

Scale

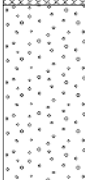
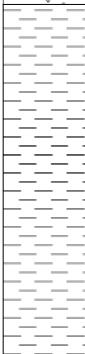
1:25

Client: C&A Consulting Engineers Ltd

Depth
2.00

0.6

Logged
HC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
				0.25			Dark brown fine SILT soil with sporadic flint gravel. MADE GROUND	
	0.50	B					Light brown sandy clay GRAVEL. Sand is coarse grained. Gravel is coarse. GRAVEL	
				0.84			Dark brown, firm, high plasticity, CLAY. CLAY	1
	1.00	B	HVP=48					
	1.60	B	HVP=50					
			HVP=68	2.00				2
							End of pit at 2.00 m	
								3
								4
								5

Remarks: Trial Pit excavated by JCB 3XC, following scanning of location using a CAT. No groundwater encountered.
Trial pit backfilled with arisings upon completion and compacted using weight of machine.

Stability: Stable, No wall collapse.

Trial Pit Log

Trialpit No

TP104

Sheet 1 of 1

Project Name: Horndean Road

Project No.
20568

Co-ords: -
Level:

Date
03/10/2013

Location: Emsworth

Dimensions
(m):

2.5

Scale

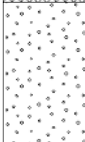
1:25

Client: C&A Consulting Engineers Ltd

Depth
2.50

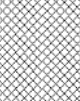
0.6

Logged
HC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
				0.27			Brown, gravelly SILT with rootlets. Gravel of fine to coarse sub-angular to sub-rounded flint. MADE GROUND	
	0.50	B		0.75			Loose, sub-rounded to sub-angular, medium to coarse GRAVEL of flint within an orange clayey matrix GRAVEL	
	1.00	B	HVP=40				Orange mottled, grey, stiff slightly gravelly CLAY. Gravel to cobble sized sub-rounded flint inclusion. CLAY	1
	1.50	B	HVP=28					
	2.00	B	HVP=34					2
	2.50	B	HVP=42	2.50				
							End of pit at 2.50 m	3
								4
								5

Remarks: Trial Pit excavated by JCB 3XC, following scanning of location using a CAT. No groundwater encountered. Trial pit backfilled with arisings upon completion and compacted using weight of machine. HVP stands for Hand Vane Pit.

Stability: Stable, No wall collapse.

 Resource & Environmental Consultants Ltd				Trial Pit Log				Trialpit No TP105 Sheet 1 of 1	
Project Name: Horndean Road				Project No. 20568		Co-ords: - Level:		Date 03/10/2013	
Location: Emsworth				Dimensions (m):		2.5 		Scale 1:25	
Client: C&A Consulting Engineers Ltd				Depth 3.00		0.6 		Logged HC	
Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
	Depth	Type	Results						
				0.35			Brown, gravelly SILT. Gravel is medium to coarse, sub-angular flint. MADE GROUND		
	0.50	B					Loose, medium to coarse, sub-rounded to sub-angular flint GRAVEL, with an orange clayey matrix. GRAVEL		
	1.00	B	HVP=54	0.90			Orange mottled, grey, stiff slightly gravelly CLAY. Gravel to cobble sized angular to sub-rounded flint inclusions. CLAY		
	1.50	B	HVP=32						
	2.00	B	HVP=58						
	2.50	B	HVP=50						
	3.00	B		2.80			Dark grey, blue, sandy CLAY. CLAY		
				3.00			End of pit at 3.00 m		
Remarks: Trial Pit excavated by JCB 3XC, following scanning of location using a CAT. No groundwater encountered. Soakaway testing undertaken at location. Trial pit backfilled with arisings upon completion and compacted using weight of machine. HVP stands for Hand Vane Pit.									
Stability: Stable, No wall collapse.									

Trial Pit Log

Trialpit No

TP107

Sheet 1 of 1

Project Name: Horndean Road

Project No.
20568

Co-ords: -
Level:

Date
03/10/2013

Location: Emsworth

Dimensions
(m):

2.5

Depth
3.50

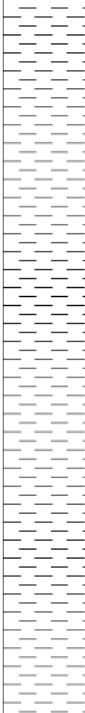
0.6

Scale

1:25

Logged
HC

Client: C&A Consulting Engineers Ltd

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
				0.32			Top soil, brown gravelly SILT, Gravel is fine to coarse, sub-angular flint. MADE GROUND	
	0.50	B		0.60			Loose sub-angular to sub-rounded, medium to coarse GRAVEL of flint within an orange clayey matrix. GRAVEL	
	1.00	B	HVP=30				Stiff orange mottled grey CLAY	1
	1.50	B	HVP=18					
	2.00	B	HVP=32					2
	2.50	B	HVP=20					
	3.00	B		3.00			Dark grey, slightly sandy, silty CLAY	3
	3.50 3.50	B B		3.50			End of pit at 3.50 m	4
								5

Remarks: Trial Pit excavated by JCB 3XC, following scanning of location using a CAT. No groundwater encountered. Trial pit backfilled with arisings upon completion and compacted using weight of machine. HVP stands for Hand Vane Pit.

Stability: Stable, No wall collapse.

Stability: Stable, No wall collapse.

Trial Pit Log

Trialpit No

TP109

Sheet 1 of 1

Project Name: Horndean Road

Project No.
20568

Co-ords: -
Level:

Date
03/10/2013

Location: Emsworth

Dimensions
(m):

2.5

Scale

1:25

Client: C&A Consulting Engineers Ltd

Depth
0.50

0.6

Logged
HC

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
				0.28			Dark brown gravelly SILT. Gravel of fine to coarse sub-angular flint and brick. MADE GROUND	
				0.50			Loose sub-rounded to sub-angular, medium to coarse gravel of flint within a silty clayey matrix. GRAVEL	
							End of pit at 0.50 m	
								1
								2
								3
								4
								5

Remarks: Trial Pit excavated by JCB 3XC, TP only reached depth of 0.5m because purpose was for shallow soakaway in the gravel.

Stability: Stable, No wall collapse.

Stability: Stable, No wall collapse.

Stability: Stable, No wall collapse.

APPENDIX VI
GEOTECHNICAL TESTING RESULTS



CONFIDENTIAL SOILS TEST REPORT

14 November 2013

FAO Adrian King

REC Ltd

Unit D3, Segensworth Business Centre

Segensworth Road (West)

Fareham

Hampshire

PO15 5RQ

Tel/Fax: +44 (0) 1329 847 783

Dear Adrian,

Thank you for consulting GSSL Ltd for your Geotechnical testing needs. GSSL Ltd is pleased to submit this **final interim** test report for laboratory testing.

Client Ref/Order No: 20571/13/1031AK

Test Report Number: GS-20571

Contract Reference: 20571 Horndean Road, Havant

Sample ID & Visual Descriptions(s): page 2 (client's description also included)

Results: Page 3-19

Test(s) Requested;

Determination of Moisture Content Oven Drying Method	{BS 1377-2:1990 Cl.3.2}
Determination of the Liquid Limit – Cone Penetrometer (Definitive Method)	{BS 1377-2:1990 Cl.4.3}
Determination of the Plastic Limit, Plasticity Index	{BS 1377-2:1990 Cl.5}
Determination of Particle Density – Small Pyknometer Method	{BS 1377-2:1990 Cl. 8.3}
Determination of Particle Size Distribution by wet sieving	{BS 1377-2:1990 Cl. 9}
Determination of dry density/moisture content relationship	{BS 1377-4:1990 Cl. 3}
Determination of the California Bearing Ratio (Un-soaked / Top & Bottom ends)	{BS 1377-4: 1990 Cl.7}

If you have any questions or require additional information, then please do not hesitate to contact us.

Yours Sincerely

Tony Dixon
Managing Director

Any opinions and interpretations expressed within this report are outside the scope of our UKAS Accreditation.

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Page 1 of 19



Summary of laboratory soil descriptions

Contract Ref: 20571 Horndean Road, Havant

Report Ref. No: GS-20571

Client ID	Depth (m)	Description of Samples
TP102	0.50	Greyish brown silty clayey GRAVEL
TP105	0.50	Greyish brown silty clayey GRAVEL
TP110	0.50	Greyish brown silty clayey GRAVEL
TP103	1.00	Yellowish brown slightly sandy CLAY
TP104	1.50	Yellowish brown slightly sandy CLAY
TP104	2.50	Yellowish brown slightly sandy CLAY
TP105	1.50	Yellowish brown slightly sandy CLAY
TP105	3.00	Grey slightly sandy CLAY
TP107	1.00	Yellowish brown slightly sandy CLAY
TP107	3.50	Grey slightly sandy CLAY
TP110	1.50	Yellowish brown slightly sandy CLAY
TP110	3.50	Yellowish brown slightly sandy CLAY

Approved Signatory:

Date Reported: 04/11/13



Determination of Moisture Content, Atterberg Limits & Particle Density

Contract Ref: 20571 Horndean Road, Havant
Sample Preparation: Specimens taken from their Wet State

Report Ref. No: GS-20571

Client ID	Depth (m)	Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity Index %	% Passing 425µm test sieve	Particle Density Mg/m ³
TP102	0.50	28.9	-	-	-	-	-
TP105	0.50	27.8	-	-	-	-	-
TP110	0.50	28.4	-	-	-	-	-
TP103	1.00	30.5	54	26	28	92	2.67
TP104	1.50	31.2	56	26	30	94	2.68
TP104	2.50	31.5	56	27	29	95	2.68
TP105	1.50	30.9	-	-	-	-	-
TP105	3.00	33.0	54	25	29	90	2.67
TP107	1.00	32.1	52	25	27	88	2.66
TP107	3.50	31.8	-	-	-	-	-
TP110	1.50	30.2	52	25	27	87	2.66
TP110	3.50	32.4	55	27	28	89	2.68

Certification:-

Sample Preparation: In accordance with BS 1377-1 & 2 :1990. Moisture Content, Liquid Limit, Plastic Limit & Particle Density were determined in accordance with BS 1377-2: 1990 Test results reported herein do not apply to samples other than those supplied. GSSL Ltd neither accepts responsibility for nor makes claim as to the final use & purpose of the materials(s).

Approved Signatory:

Date Reported: 14/11/13



Determination of Particle Size Distribution (Wet Sieving)

Report Ref. No: GS-20571

GSSL Sample ID A1

Client ID TP102 @ 0.50m

Client: REC Ltd
Site: 20571 Horndean Road, Havant

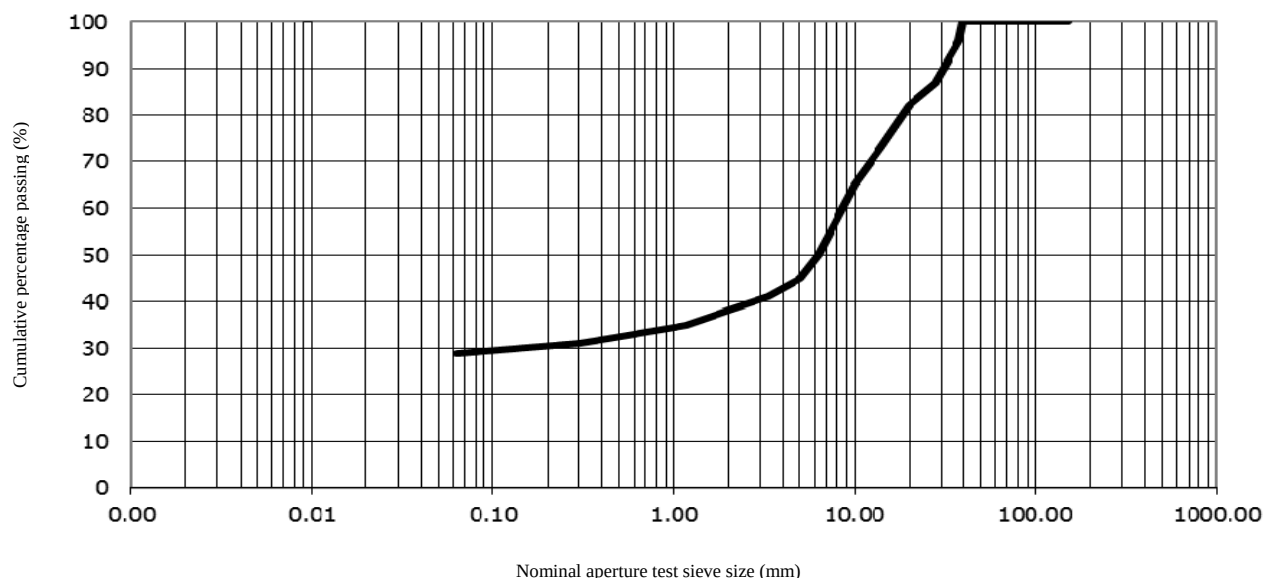
Date Sampled: N/A
Sampled from: -

Material Specification: N/A
Sample Description: Greyish brown silty clayey GRAVEL
Sample Type: Disturbed
Sampled by: Client
Date Sampled: N/A

Remarks: -

BS Test Sieve (mm)	% Material Passing
100	100
90	100
75	100
63	100
50	100
40	100
37.5	96
28	87
20	82
14	73
10	65
6.3	50
5	45
3.35	41
2	38
1.18	35
0.6	33
0.425	32
0.3	31
0.15	30
0.063	29

Soil Fraction	Total Percentage
COBBLES	-
GRAVEL	62
SAND	9
SILT / CLAY	29



Sample Preparation: In accordance with BS 1377-1 & 2:1990

Certification:-

Certified that the Particle Size Distribution was determined in accordance with BS 1377-2: 1990 Method 9

Test results reported herein do not apply to samples other than those supplied. GSSL Ltd neither accepts responsibility for nor makes claim as to the final use & purpose of the materials(s)

Approved Signatory:

Date Reported: 14/11/13

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Determination of Particle Size Distribution (Wet Sieving)

Report Ref. No: GS-20571

GSSL Sample ID A2
Client ID WS105 @ 0.50m

Client: REC Ltd
Site: 20571 Horndean Road, Havant

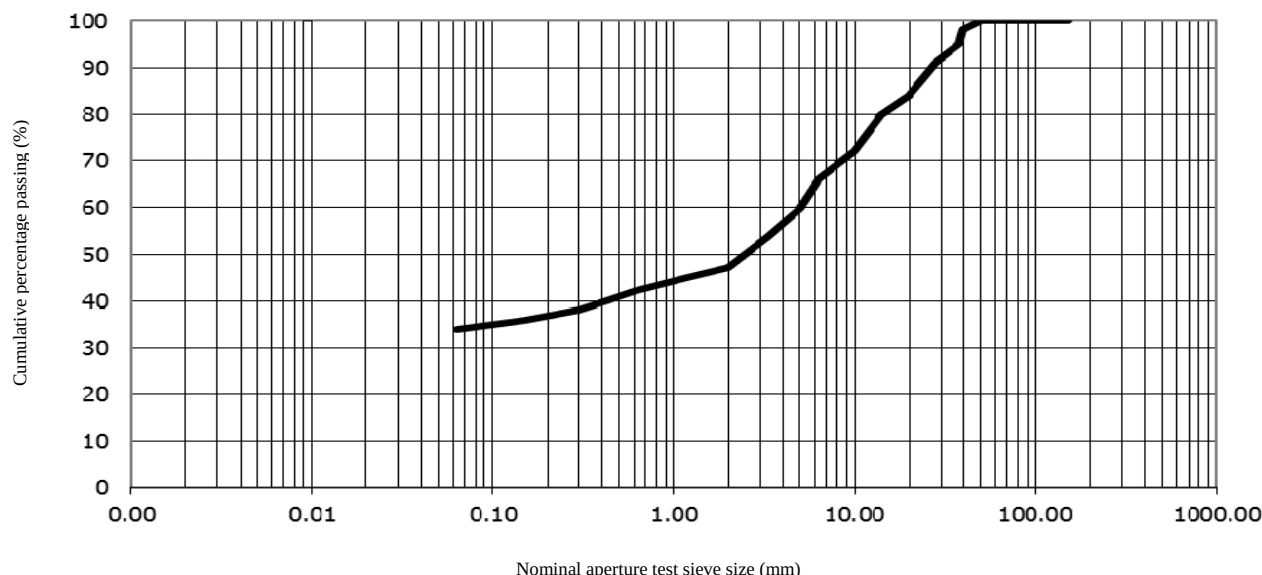
Date Sampled: N/A
Sampled from: -

Material Specification: N/A
Sample Description: Greyish brown silty clayey GRAVEL
Sample Type: Disturbed
Sampled by: Client
Date Sampled: N/A

Remarks: -

BS Test Sieve (mm)	% Material Passing
100	100
90	100
75	100
63	100
50	100
40	98
37.5	95
28	91
20	84
14	80
10	72
6.3	66
5	60
3.35	54
2	47
1.18	45
0.6	42
0.425	40
0.3	38
0.15	36
0.063	34

Soil Fraction	Total Percentage
COBBLES	-
GRAVEL	53
SAND	13
SILT / CLAY	34



Sample Preparation: In accordance with BS 1377-1 & 2:1990

Certification:-

Certified that the Particle Size Distribution was determined in accordance with BS 1377-2: 1990 Method 9

Test results reported herein do not apply to samples other than those supplied. GSSL Ltd neither accepts responsibility for nor makes claim as to the final use & purpose of the materials(s)

Approved Signatory:

Date Reported: 14/11/13

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Determination of Particle Size Distribution (Wet Sieving)

Report Ref. No: GS-20571

GSSL Sample ID A3
Client ID WS110 @ 0.50m

Client: REC Ltd
Site: 20571 Horndean Road, Havant

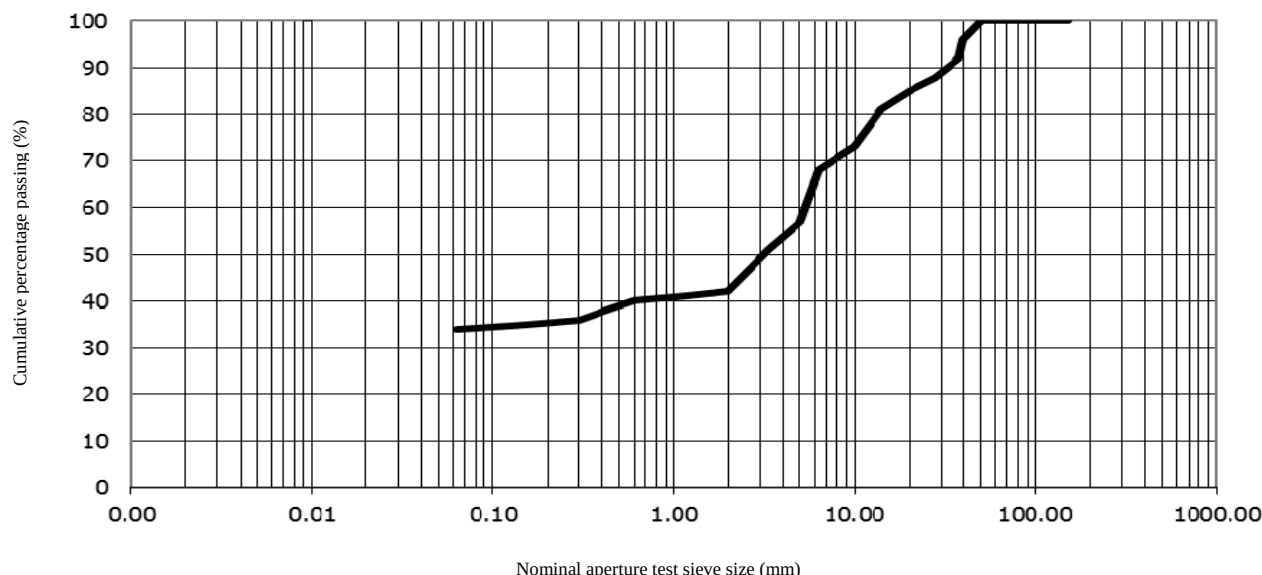
Date Sampled: N/A
Sampled from: -

Material Specification: N/A
Sample Description: Greyish brown silty clayey GRAVEL
Sample Type: Disturbed
Sampled by: Client
Date Sampled: N/A

Remarks: -

BS Test Sieve (mm)	% Material Passing
100	100
90	100
75	100
63	100
50	100
40	96
37.5	92
28	88
20	85
14	81
10	73
6.3	68
5	57
3.35	51
2	42
1.18	41
0.6	40
0.425	38
0.3	36
0.15	35
0.063	34

Soil Fraction	Total Percentage
COBBLES	-
GRAVEL	58
SAND	8
SILT / CLAY	34



Sample Preparation: In accordance with BS 1377-1 & 2:1990

Certification:-

Certified that the Particle Size Distribution was determined in accordance with BS 1377-2: 1990 Method 9

Test results reported herein do not apply to samples other than those supplied. GSSL Ltd neither accepts responsibility for nor makes claim as to the final use & purpose of the materials(s)

Approved Signatory:

Date Reported: 14/11/13

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Determination of Particle Size Distribution (Wet Sieving)

Report Ref. No: GS-20571

GSSL Sample ID A4

Client ID TP104 @ 1.50m

Client: REC Ltd
Site: 20571 Horndean Road, Havant

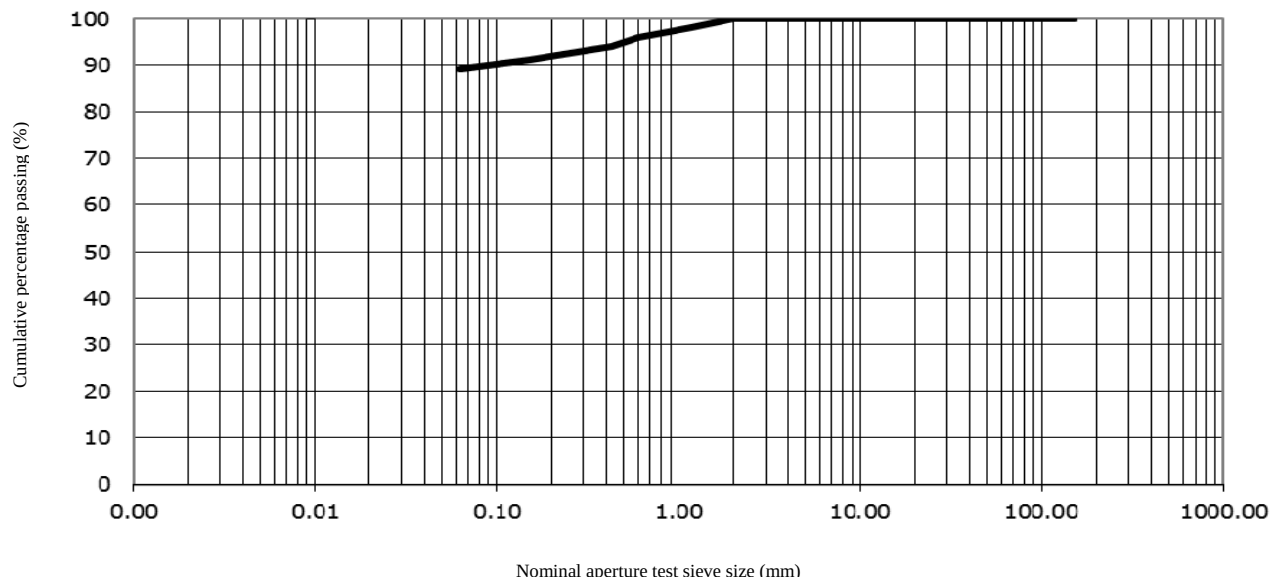
Date Sampled: N/A
Sampled from: -

Material Specification: N/A
Sample Description: Yellowish brown slightly sandy CLAY
Sample Type: Disturbed
Sampled by: Client
Date Sampled: N/A

Remarks: -

BS Test Sieve (mm)	% Material Passing
100	100
90	100
75	100
63	100
50	100
40	100
37.5	100
28	100
20	100
14	100
10	100
6.3	100
5	100
3.35	100
2	100
1.18	98
0.6	96
0.425	94
0.3	93
0.15	91
0.063	89

Soil Fraction	Total Percentage
COBBLES	-
GRAVEL	-
SAND	11
SILT / CLAY	89



Sample Preparation: In accordance with BS 1377-1 & 2:1990

Certification:-

Certified that the Particle Size Distribution was determined in accordance with BS 1377-2: 1990 Method 9

Test results reported herein do not apply to samples other than those supplied. GSSL Ltd neither accepts responsibility for nor makes claim as to the final use & purpose of the materials(s)

Approved Signatory:

Date Reported: 14/11/13

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Determination of Particle Size Distribution (Wet Sieving)

Report Ref. No: GS-20571

GSSL Sample ID

A5

Client ID

TP105 @ 1.50m

Client:

REC Ltd

Site:

20571 Horndean Road, Havant

Date Sampled:

N/A

Sampled from:

-

Material Specification:

N/A

Sample Description:

Yellowish brown slightly sandy CLAY

Sample Type:

Disturbed

Sampled by:

Client

Date Sampled:

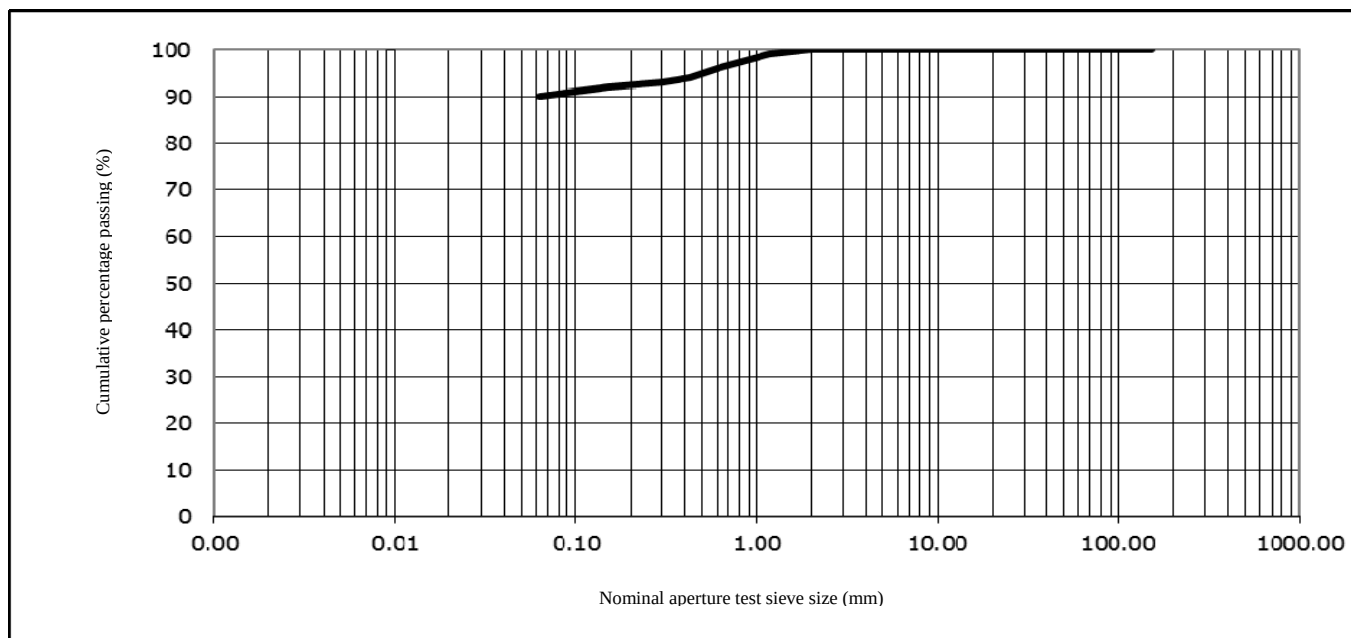
N/A

Remarks:

-

BS Test Sieve (mm)	% Material Passing
100	100
90	100
75	100
63	100
50	100
40	100
37.5	100
28	100
20	100
14	100
10	100
6.3	100
5	100
3.35	100
2	100
1.18	99
0.6	96
0.425	94
0.3	93
0.15	92
0.063	90

Soil Fraction	Total Percentage
COBBLES	-
GRAVEL	-
SAND	10
SILT / CLAY	90



Sample Preparation: In accordance with BS 1377-1 & 2:1990

Certification:-

Certified that the Particle Size Distribution was determined in accordance with BS 1377-2: 1990 Method 9

Test results reported herein do not apply to samples other than those supplied. GSSL Ltd neither accepts responsibility for nor makes claim as to the final use & purpose of the materials(s)

Approved Signatory:

Date Reported: 14/11/13

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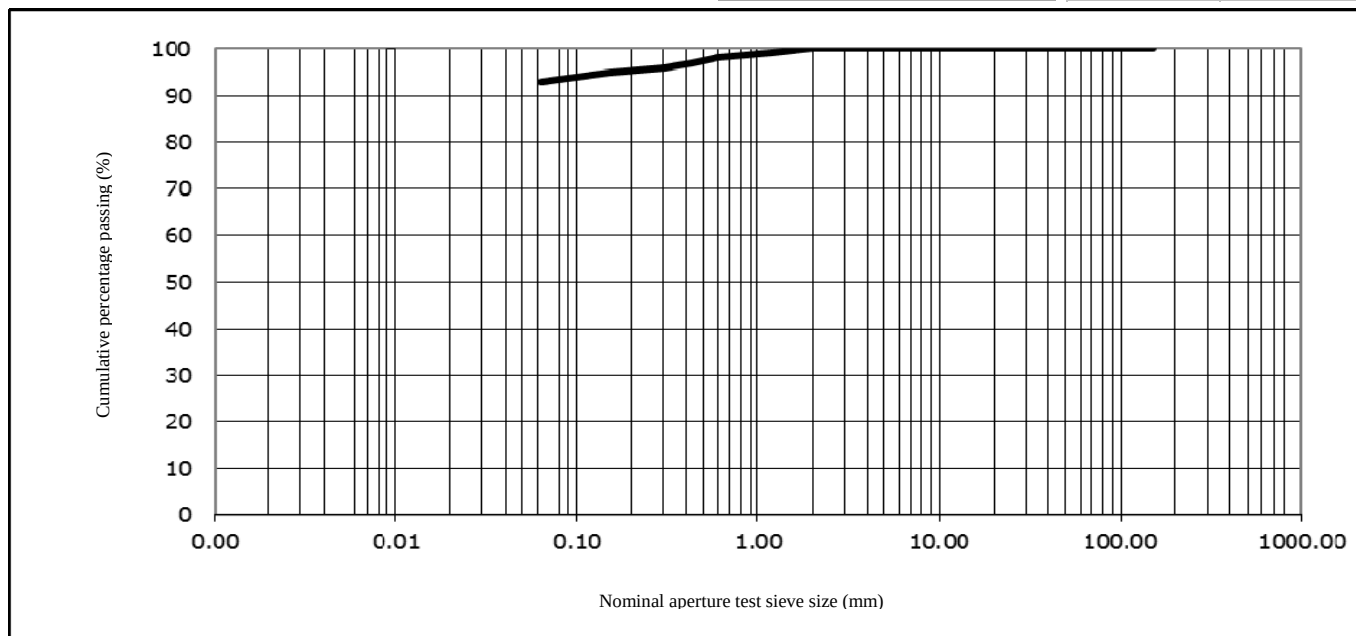
Determination of Particle Size Distribution (Wet Sieving)

Report Ref. No: GS-20571

GSSL Sample ID: A6
Client ID: TP107 @ 3.50m
Client: REC Ltd
Site: 20571 Horndean Road, Havant
Date Sampled: N/A
Sampled from: -
Material Specification: N/A
Sample Description: Grey slightly sandy CLAY
Sample Type: Disturbed
Sampled by: Client
Date Sampled: N/A
Remarks: -

BS Test Sieve (mm)	% Material Passing
100	100
90	100
75	100
63	100
50	100
40	100
37.5	100
28	100
20	100
14	100
10	100
6.3	100
5	100
3.35	100
2	100
1.18	99
0.6	98
0.425	97
0.3	96
0.15	95
0.063	93

Soil Fraction	Total Percentage
COBBLES	-
GRAVEL	-
SAND	7
SILT / CLAY	93



Sample Preparation: In accordance with BS 1377-1 & 2:1990

Certification:-

Certified that the Particle Size Distribution was determined in accordance with BS 1377-2: 1990 Method 9

Test results reported herein do not apply to samples other than those supplied. GSSL Ltd neither accepts responsibility for nor makes claim as to the final use & purpose of the materials(s)

Approved Signatory:

Date Reported: 14/11/13

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Determination of Dry Density Relationship/Moisture Content.

Contract Ref: 20571 Horndean Road, Havant **Report Ref. No:** GS-20571

Method of Compaction: 4.5Kg Rammer

Sample ID: TP105 @ 0.50m

Sample Description: Greyish brown silty clayey GRAVEL

Sample Type: BULK

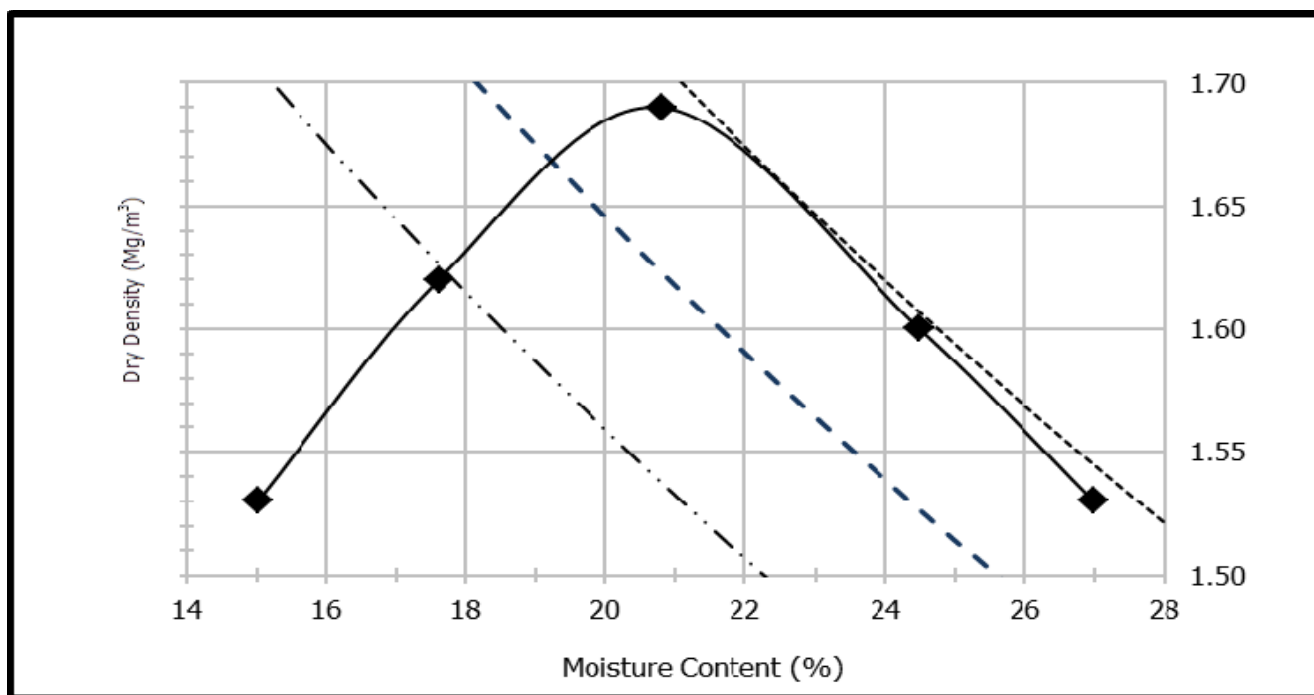
Amount Retained on: 37.5mm Test Sieve: 5% 20mm Test Sieve: 16%

Particle Density (Mg/m^3): 2.65 assumed

As received Moisture Content (%): 27.8

OPTIMUM MOISTURE CONTENT (%): 20.8

MAXIMUM DRY DENSITY (Mg/m^3): 1.69



Comments: Air Voids Lines plotted at 0%, 5% and 10% Values

Certification:-

Sample Preparation: In accordance with BS 1377-1 & 4 :1990

Certified that the test was carried out in accordance with BS 1377-4:1990, Method 3

Test results reported herein do not apply to samples other than those supplied. GSSL Ltd neither accepts responsibility for nor makes claim as to the final use & purpose of the materials(s)

Approved Signatory:

Date Reported: 14/11/13



Determination of Dry Density Relationship/Moisture Content.

Contract Ref: 20571 Horndean Road, Havant **Report Ref. No:** GS-20571

Method of Compaction: 2.5Kg Rammer

Sample ID: TP103 @ 1.00m

Sample Description: Yellowish brown slightly sandy CLAY

Sample Type: BULK

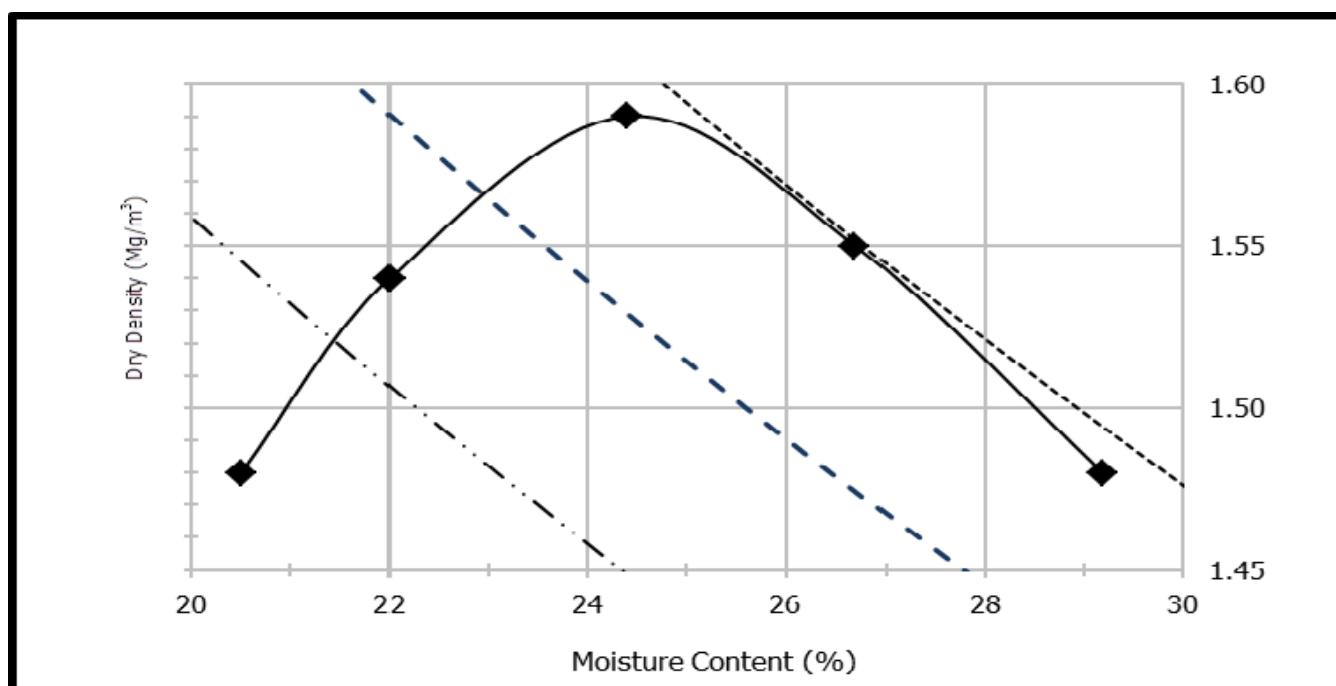
Amount Retained on: 37.5mm Test Sieve: 0% 20mm Test Sieve: 0%

Particle Density (Mg/m^3): 2.67 *measured*

As received Moisture Content (%): 30.5

OPTIMUM MOISTURE CONTENT (%): 20.8

MAXIMUM DRY DENSITY (Mg/m^3): 1.69



Comments: Air Voids Lines plotted at 0%, 5% and 10% Values

Certification:-

Sample Preparation: In accordance with BS 1377-1 & 4 :1990

Certified that the test was carried out in accordance with BS 1377-4:1990, Method 3

Test results reported herein do not apply to samples other than those supplied. GSSL Ltd neither accepts responsibility for nor makes claim as to the final use & purpose of the materials(s)

Approved Signatory:

Date Reported: 14/11/13



Determination of Dry Density Relationship/Moisture Content.

Contract Ref: 20571 Horndean Road, Havant **Report Ref. No:** GS-20571

Method of Compaction: 2.5Kg Rammer

Sample ID: TP104 @ 2.50m

Sample Description: Yellowish brown slightly sandy CLAY

Sample Type: BULK

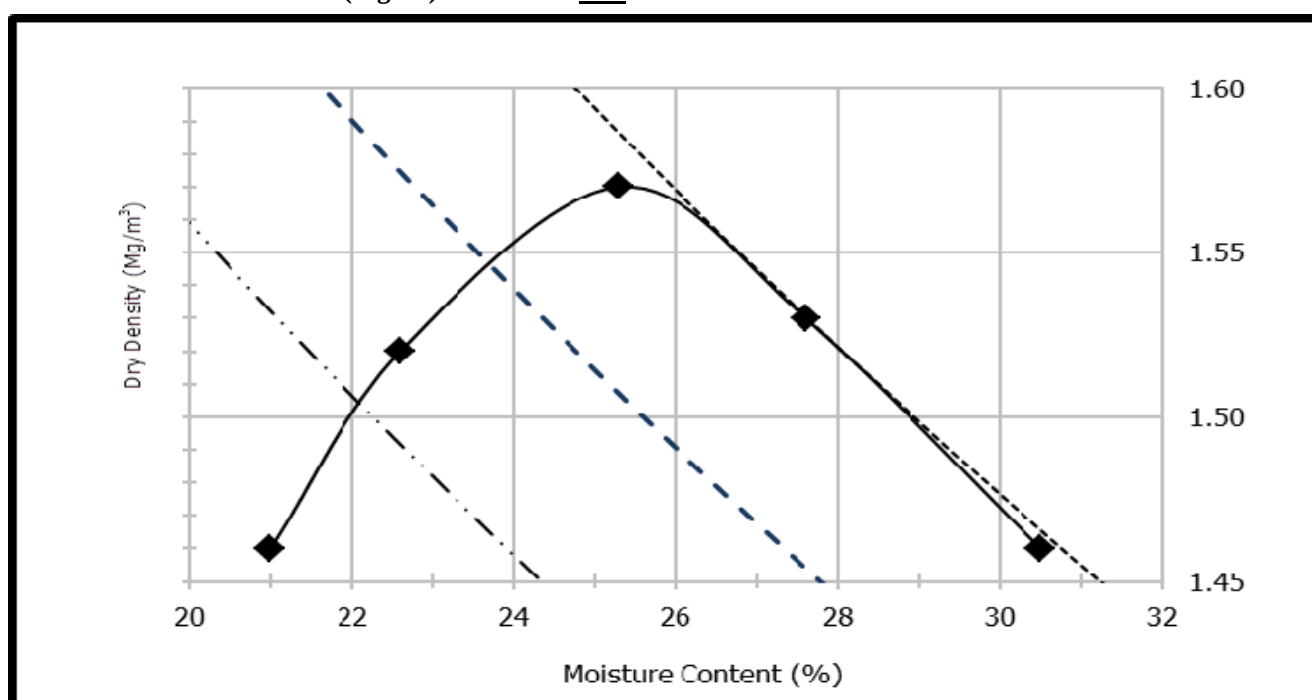
Amount Retained on: 37.5mm Test Sieve: 0% 20mm Test Sieve: 0%

Particle Density (Mg/m^3): 2.68 *measured*

As received Moisture Content (%): 31.5

OPTIMUM MOISTURE CONTENT (%): 25.3

MAXIMUM DRY DENSITY (Mg/m^3): 1.57



Comments: Air Voids Lines plotted at 0%, 5% and 10% Values

Certification:-

Sample Preparation: In accordance with BS 1377-1 & 4 :1990

Certified that the test was carried out in accordance with BS 1377-4:1990, Method 3

Test results reported herein do not apply to samples other than those supplied. GSSL Ltd neither accepts responsibility for nor makes claim as to the final use & purpose of the materials(s)

Approved Signatory:

Date Reported: 14/11/13



Determination of Dry Density Relationship/Moisture Content.

Contract Ref: 20571 Horndean Road, Havant **Report Ref. No:** GS-20571

Method of Compaction: 2.5Kg Rammer

Sample ID: TP105 @ 1.50m

Sample Description: Yellowish brown slightly sandy CLAY

Sample Type: BULK

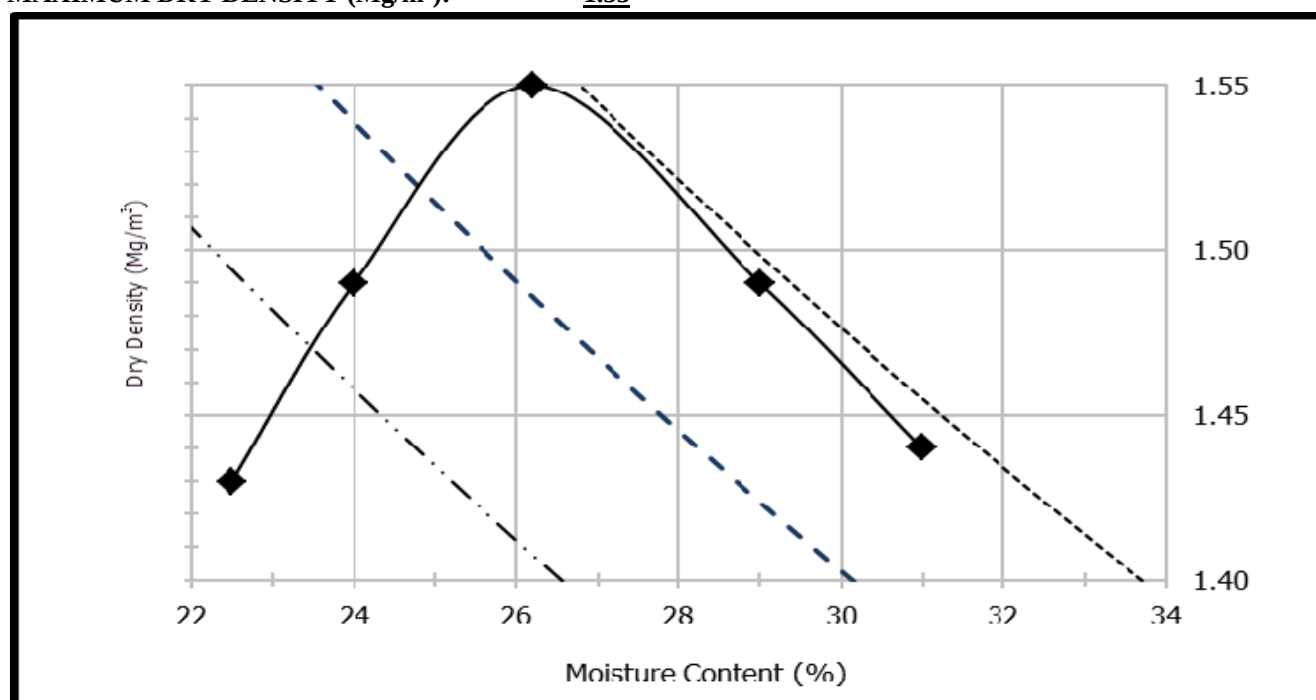
Amount Retained on: 37.5mm Test Sieve: 0% 20mm Test Sieve: 0%

Particle Density (Mg/m^3): 2.68 measured

As received Moisture Content (%): 30.9

OPTIMUM MOISTURE CONTENT (%): 26.2

MAXIMUM DRY DENSITY (Mg/m^3): 1.55



Comments: Air Voids Lines plotted at 0%, 5% and 10% Values

Certification:-

Sample Preparation: In accordance with BS 1377-1 & 4 :1990

Certified that the test was carried out in accordance with BS 1377-4:1990, Method 3

Test results reported herein do not apply to samples other than those supplied. GSSL Ltd neither accepts responsibility for nor makes claim as to the final use & purpose of the materials(s)

Approved Signatory:

Date Reported: 14/11/13



Determination of Dry Density Relationship/Moisture Content.

Contract Ref: 20571 Horndean Road, Havant **Report Ref. No:** GS-20571

Method of Compaction: 2.5Kg Rammer

Sample ID: TP110 @ 3.50m

Sample Description: Yellowish brown slightly sandy CLAY

Sample Type: BULK

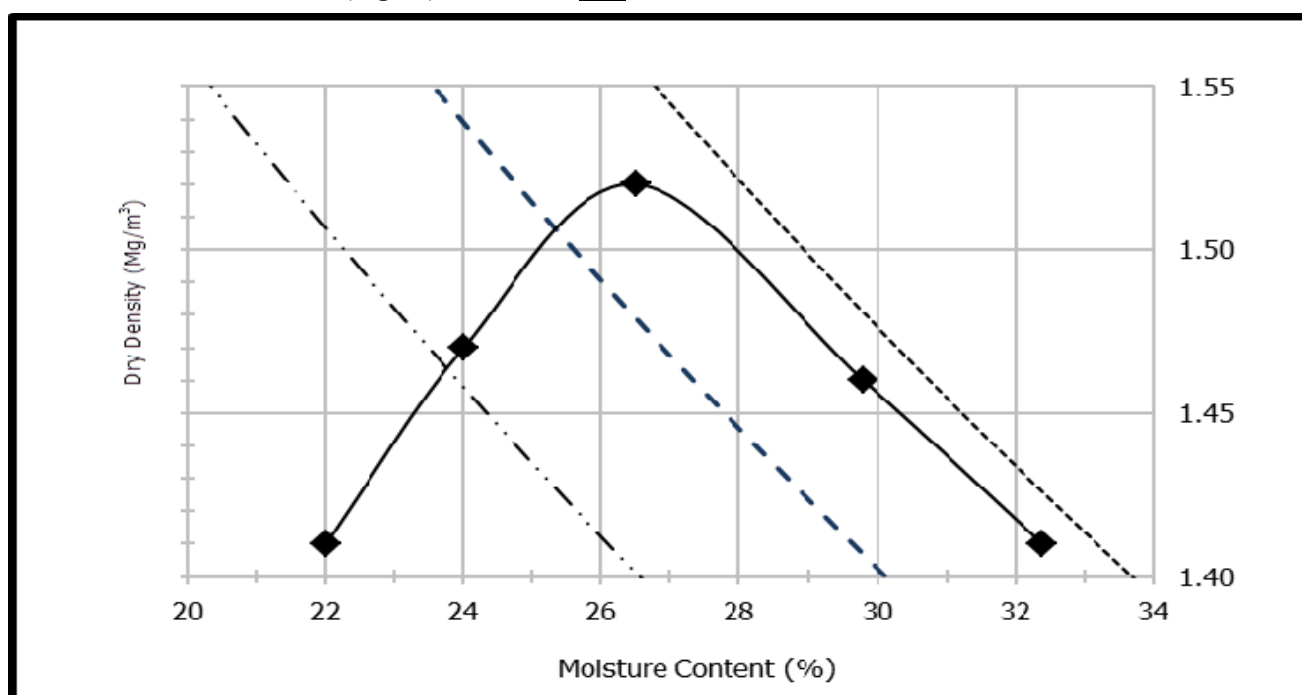
Amount Retained on: 37.5mm Test Sieve: 0% 20mm Test Sieve: 0%

Particle Density (Mg/m^3): 2.68 measured

As received Moisture Content (%): 32.4

OPTIMUM MOISTURE CONTENT (%): 26.5

MAXIMUM DRY DENSITY (Mg/m^3): 1.52



Comments: Air Voids Lines plotted at 0%, 5% and 10% Values

Certification:-

Sample Preparation: In accordance with BS 1377-1 & 4 :1990

Certified that the test was carried out in accordance with BS 1377-4:1990, Method 3

Test results reported herein do not apply to samples other than those supplied. GSSL Ltd neither accepts responsibility for nor makes claim as to the final use & purpose of the materials(s)

Approved Signatory:

Date Reported: 14/11/13

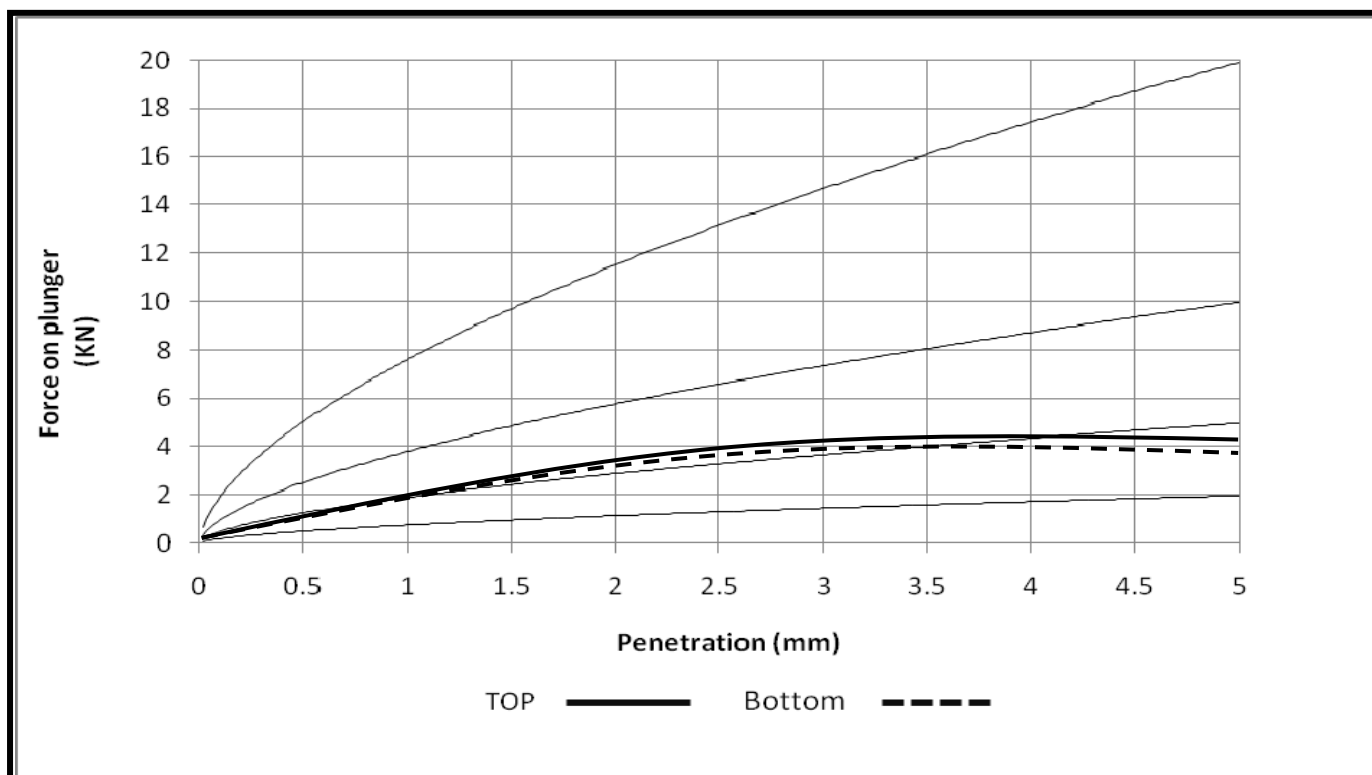


Determination of California Bearing Ratio BS 1377: Part 4:1990

Contract Ref: 20571 Horndean Road, Havant
Sample description: Greyish brown silty clayey GRAVEL
Client Sample ID: TP105 @ 0.50m

Report Ref. No: GS-20571

INITIAL SAMPLE CONDITIONS		TEST CONDITIONS		Method of compaction:	
Moisture Content %:	27.8	Surcharge Kg:	13	Final Moisture Content %	2.5kg rammer
Bulk Density (measured) Mg/m ³ :	2.00	Soaking Time hrs:	-	Sample Top	27.8
Dry Density (measured) Mg/m ³ :	1.72	Swelling mm:	-	Sample Bottom	27.8
Percentage retained on 20mm BS test sieve:	16	Remarks: Tested in accordance with BS1377: 1990 Part 4 Sample preparation method 2.5kg rammer			
				Calculated CBR Value %	
				CBR @ 2.5mm = 30.1 CBR @ 5.0mm = 20.3	
				CBR @ 2.5mm = 28.5 CBR @ 5.0mm = 18.9	



Certification:-

Sample Preparation: In accordance with BS 1377-4: 1990 : Clause 7.2.4.4. Moisture Content determined in accordance with BS 1377-2: 1990 Clause 3.2.
CBR Tested in accordance with BS 1377-4: 1990 Clause 7

Approved Signatory:

Date Reported: 14/11/13

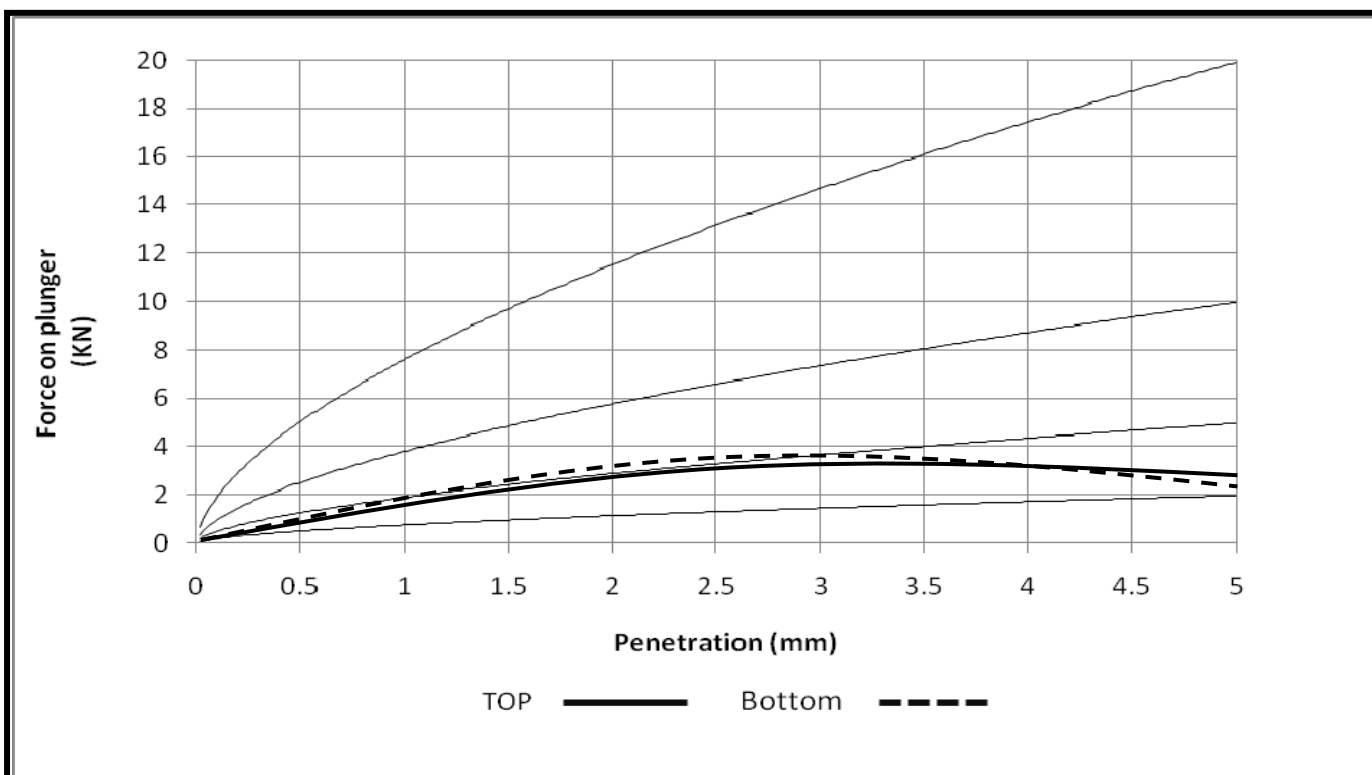


Determination of California Bearing Ratio BS 1377: Part 4:1990

Contract Ref: 20571 Horndean Road, Havant
Sample description: Yellowish brown slightly sandy CLAY
Client Sample ID: TP103 @ 1.00m

Report Ref. No: GS-20571

INITIAL SAMPLE CONDITIONS		TEST CONDITIONS		Method of compaction:	
Moisture Content %:	30.5	Surcharge Kg:	13	Final Moisture Content %	2.5kg rammer
Bulk Density (measured) Mg/m ³ :	1.95	Soaking Time hrs:	-	Sample Top	30.5
Dry Density (measured) Mg/m ³ :	1.70	Swelling mm:	-	Sample Bottom	30.5
Percentage retained on 20mm BS test sieve:	-	Remarks: Tested in accordance with BS1377: 1990 Part 4 Sample preparation method 2.5kg rammer			



Certification:-

Sample Preparation: In accordance with BS 1377-4: 1990 : Clause 7.2.4.4. Moisture Content determined in accordance with BS 1377-2: 1990 Clause 3.2.
CBR Tested in accordance with BS 1377-4: 1990 Clause 7

Approved Signatory:

Date Reported: 14/11/13

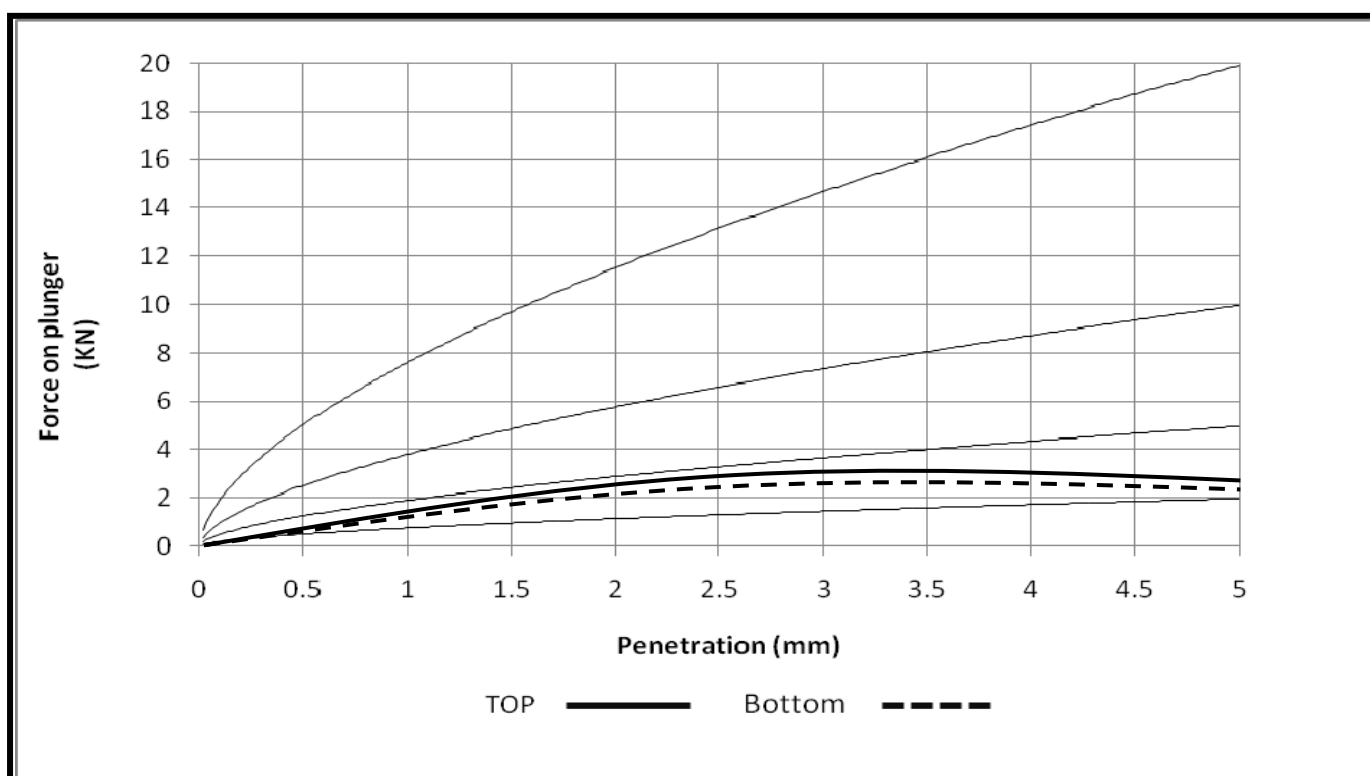


Determination of California Bearing Ratio BS 1377: Part 4:1990

Contract Ref: 20571 Horndean Road, Havant
Sample description: Yellowish brown slightly sandy CLAY
Client Sample ID: TP104 @ 2.50m

Report Ref. No: GS-20571

INITIAL SAMPLE CONDITIONS		TEST CONDITIONS		Method of compaction:	
Moisture Content %:	31.5	Surcharge Kg:	13	Final Moisture Content %	2.5kg rammer
Bulk Density (measured) Mg/m ³ :	1.94	Soaking Time hrs:	-	Sample Top	31.5
Dry Density (measured) Mg/m ³ :	1.70	Swelling mm:	-	Sample Bottom	31.5
Percentage retained on 20mm BS test sieve:	-	Remarks: Tested in accordance with BS1377: 1990 Part 4 Sample preparation method 2.5kg rammer			



Certification:-

Sample Preparation: In accordance with BS 1377-4: 1990 : Clause 7.2.4.4. Moisture Content determined in accordance with BS 1377-2: 1990 Clause 3.2.
CBR Tested in accordance with BS 1377-4: 1990 Clause 7

Approved Signatory:

Date Reported: 14/11/13

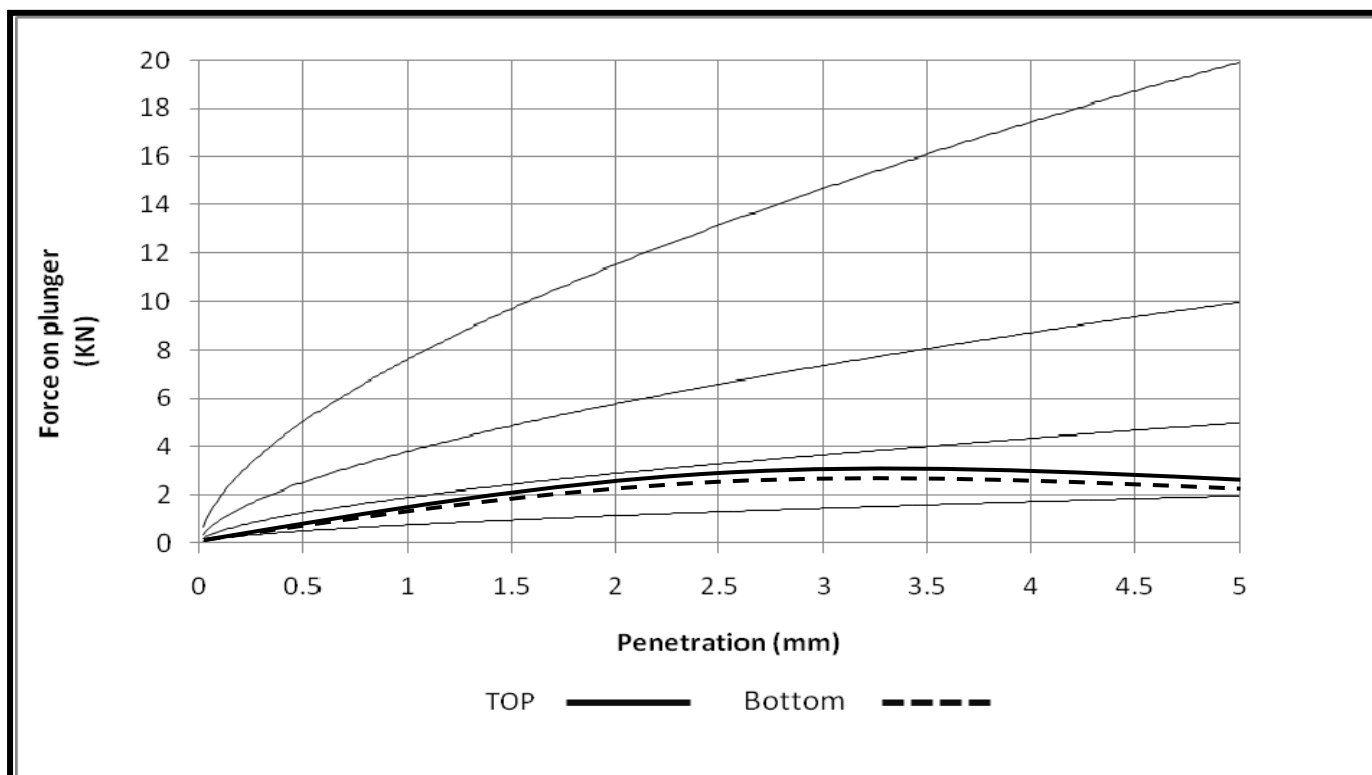


Determination of California Bearing Ratio BS 1377: Part 4:1990

Contract Ref: 20571 Horndean Road, Havant
Sample description: Yellowish brown slightly sandy CLAY
Client Sample ID: TP105 @ 1.50m

Report Ref. No: GS-20571

INITIAL SAMPLE CONDITIONS		TEST CONDITIONS		Method of compaction:	
Moisture Content %:	30.9	Surcharge Kg:	13	Final Moisture Content %	2.5kg rammer
Bulk Density (measured) Mg/m ³ :	1.95	Soaking Time hrs:	-	Sample Top	30.9
Dry Density (measured) Mg/m ³ :	1.71	Swelling mm:	-	Sample Bottom	30.9
Percentage retained on 20mm BS test sieve:	-	Remarks: Tested in accordance with BS1377: 1990 Part 4 Sample preparation method 2.5kg rammer			
				Calculated CBR Value %	
				CBR @ 2.5mm = 21.5 CBR @ 5.0mm = 13.1	
				CBR @ 2.5mm = 20.6 CBR @ 5.0mm = 10.5	



Certification:-

Sample Preparation: In accordance with BS 1377-4: 1990 : Clause 7.2.4.4. Moisture Content determined in accordance with BS 1377-2: 1990 Clause 3.2.
CBR Tested in accordance with BS 1377-4: 1990 Clause 7

Approved Signatory:

Date Reported: 14/11/13

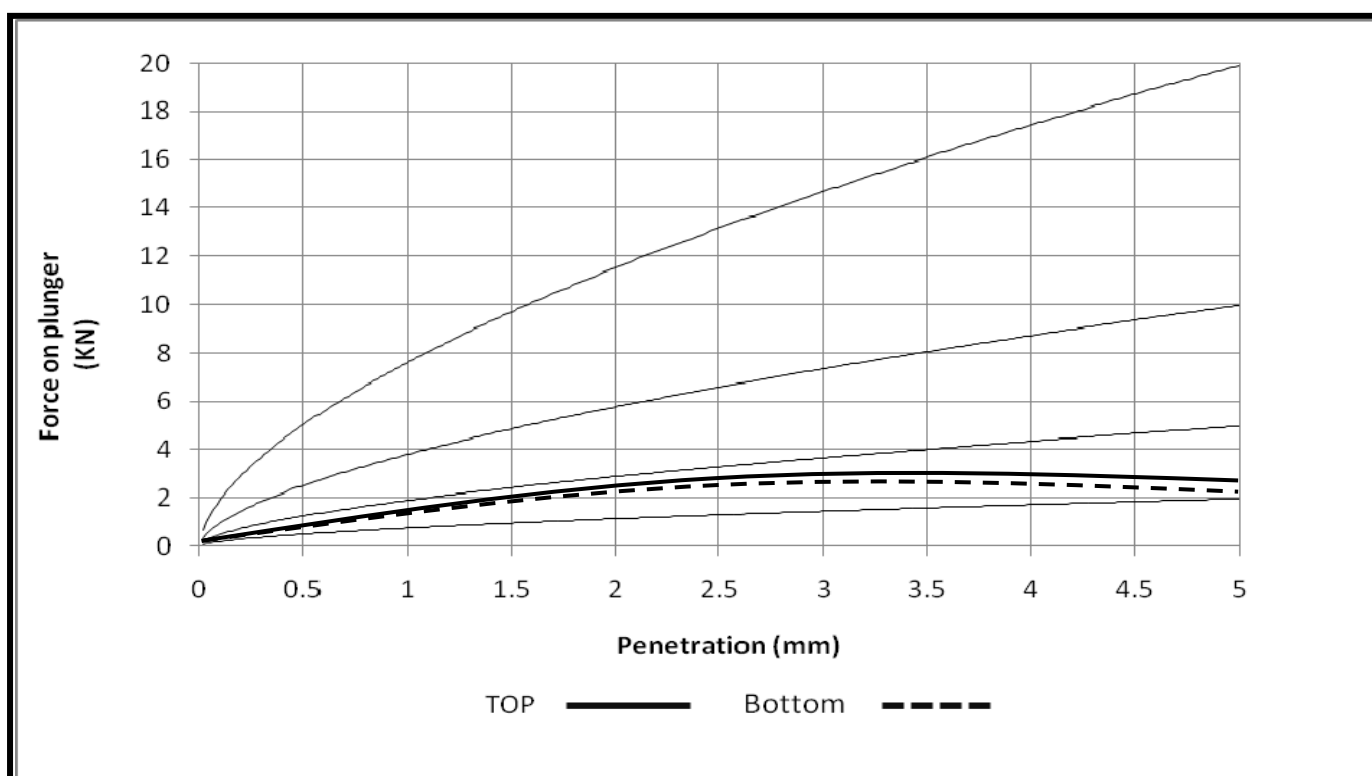


Determination of California Bearing Ratio BS 1377: Part 4:1990

Contract Ref: 20571 Horndean Road, Havant
Sample description: Yellowish brown slightly sandy CLAY
Client Sample ID: TP110 @ 3.50m

Report Ref. No: GS-20571

INITIAL SAMPLE CONDITIONS		TEST CONDITIONS		Method of compaction:		2.5kg rammer
Moisture Content %:	32.4	Surcharge Kg:	13	Final Moisture Content %		Calculated CBR Value %
Bulk Density (measured) Mg/m ³ :	1.95	Soaking Time hrs:	-	Sample Top	32.4	CBR @ 2.5mm = 21.5 CBR @ 5.0mm = 13.1
Dry Density (measured) Mg/m ³ :	1.71	Swelling mm:	-	Sample Bottom	32.4	CBR @ 2.5mm = 20.6 CBR @ 5.0mm = 10.5
Percentage retained on 20mm BS test sieve:	-	Remarks: Tested in accordance with BS1377: 1990 Part 4 Sample preparation method 2.5kg rammer				



Certification:-

Sample Preparation: In accordance with BS 1377-4: 1990 : Clause 7.2.4.4. Moisture Content determined in accordance with BS 1377-2: 1990 Clause 3.2.
CBR Tested in accordance with BS 1377-4: 1990 Clause 7

Approved Signatory:

Date Reported: 14/11/13

APPENDIX VII
DYNAMIC CONE PENETRATION TESTING CERTIFICATES

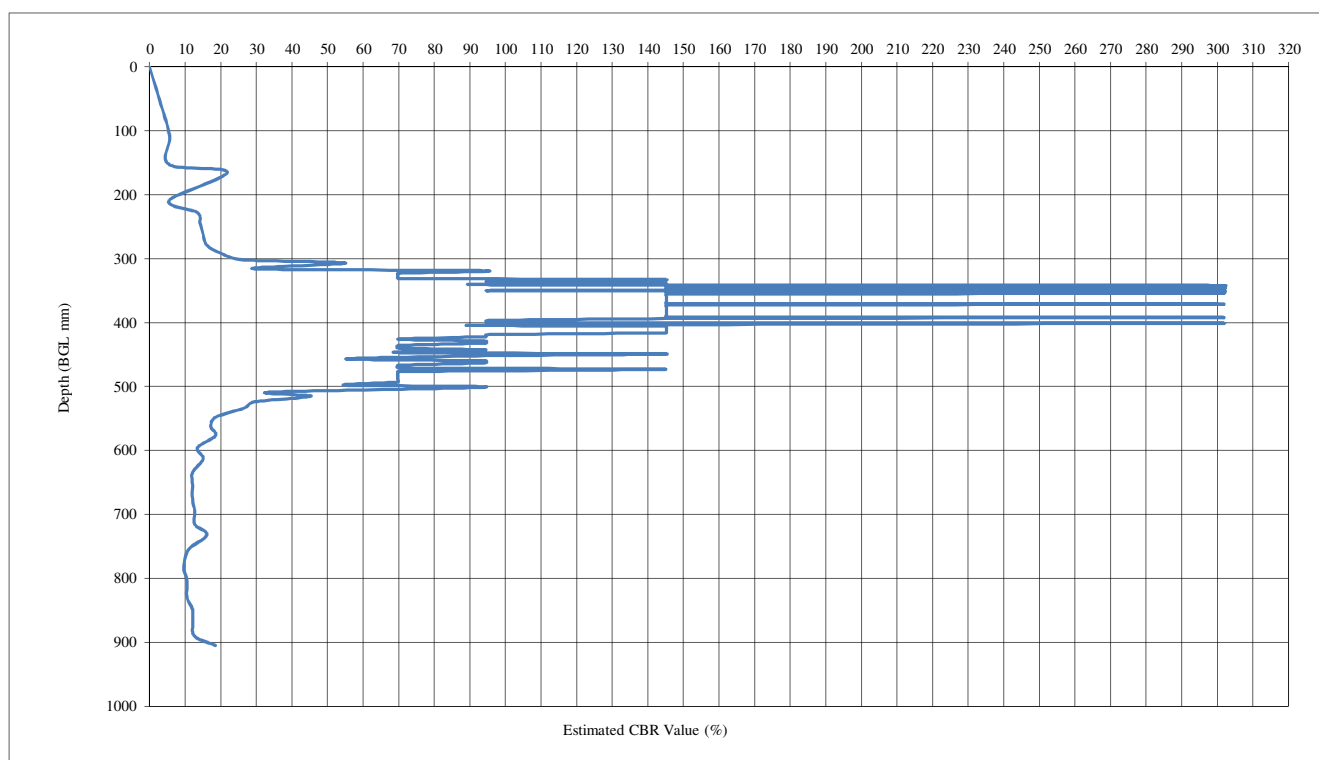


Determination of Dynamic Cone Penetrometer - Estimated CBR Value (%)

In Accordance with TRL Report PR/INT/277/04

Site Name	Horndean Road, Emsworth	Test Date:	04/10/2013
Site Ref	20568	Test Location:	DCP101
Test No.:			
Initial Depth (mm BGL):	43		
Final Depth (mm BGL):	904		

Estimated California Bearing Ratio Graph



Start Depth (mm) BGL	Finish Depth (mm) BGL	No. of Blows	Blows Per Layer	DCP mm/Blows	Ave Estimated Layer (CBR %)
0	209	5	5	41.80	6
209	606	90	85	4.67	59
606	755	100	10	14.90	1
755	905	107	7	21.43	12

Average estimated CBR value of 19.5% between 0.000 m - 0.905 m bgl

Comments

Site Engineer:	Checked By:	Date:	Approved By:	Date:
P. Sullivan	P. Dennis	07/10/2013	P. Dennis	28/10/2013

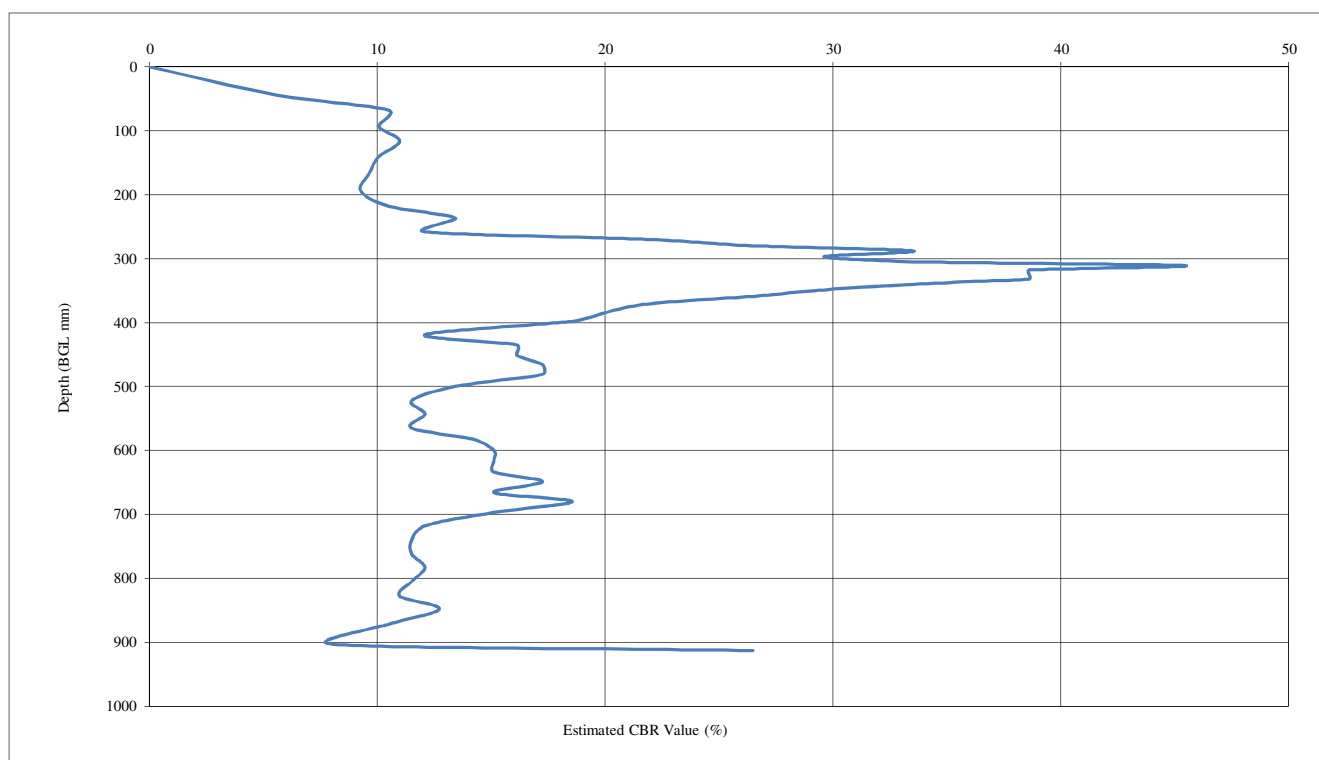


Determination of Dynamic Cone Penetrometer - Estimated CBR Value (%)

In Accordance with TRL Report PR/INT/277/04

Site Name	Horndean Road, Emsworth	Test Date:	04/10/2013
Site Ref	20568	Test Location:	DCP102
Test No.:			
Initial Depth (mm BGL):	43		
Final Depth (mm BGL):	913		

Estimated California Bearing Ratio Graph



Start Depth (mm) BGL	Finish Depth (mm) BGL	No. of Blows	Blows Per Layer	DCP mm/Blows	Ave Estimated Layer (CBR %)
0	194	7	7	27.71	9
194	258	10	3	21.33	12
258	522	32	22	12.00	22
522	762	45	13	18.46	14
762	903	51	6	23.50	11
903	913	52	1	10.00	26

Average estimated CBR value of 15.66% between 0.000 m - 0.913 m bgl

Comments

Site Engineer: P. Sullivan	Checked By: P. Dennis	Date: 07/10/2013	Approved By: P. Dennis	Date: 28/10/2013
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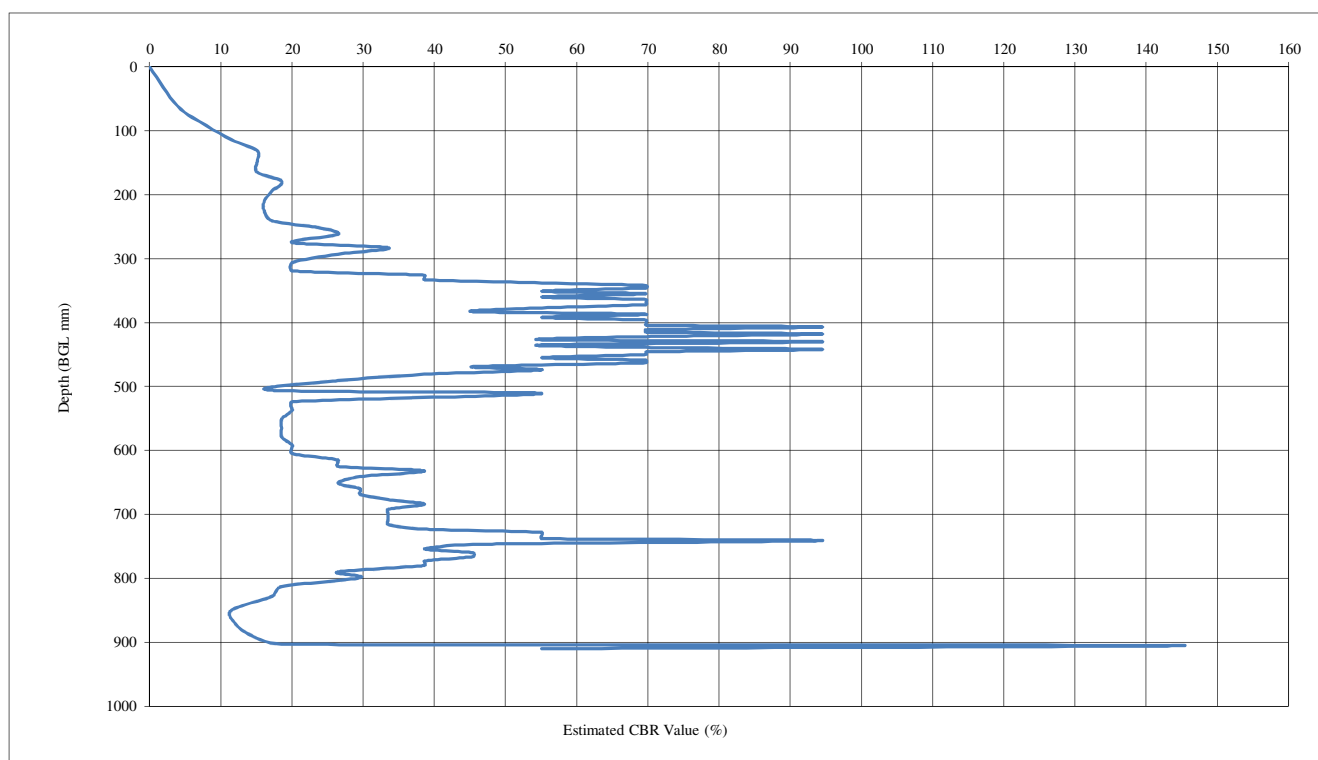


Determination of Dynamic Cone Penetrometer - Estimated CBR Value (%)

In Accordance with TRL Report PR/INT/277/04

Site Name	Horndean Road, Emsworth	Test Date:	04/10/2013
Site Ref	20568	Test Location:	DCP103
Test No.:			
Initial Depth (mm BGL):	50		
Final Depth (mm BGL):	910		

Estimated California Bearing Ratio Graph



Start Depth (mm) BGL	Finish Depth (mm) BGL	No. of Blows	Blows Per Layer	DCP mm/Blows	Ave Estimated Layer (CBR %)
0	226	10	10	22.60	11
226	319	18	8	11.63	23
319	506	56	38	4.92	56
506	579	62	6	12.17	22
579	850	93	31	8.74	31
850	910	98	5	12.00	22

Average estimated CBR value of 27.5% between 0.00 m - 0.91 m bgl

Comments

Site Engineer: P. Sullivan	Checked By: P. Dennis	Date: 07/10/2013	Approved By: P. Dennis	Date: 28/10/2013
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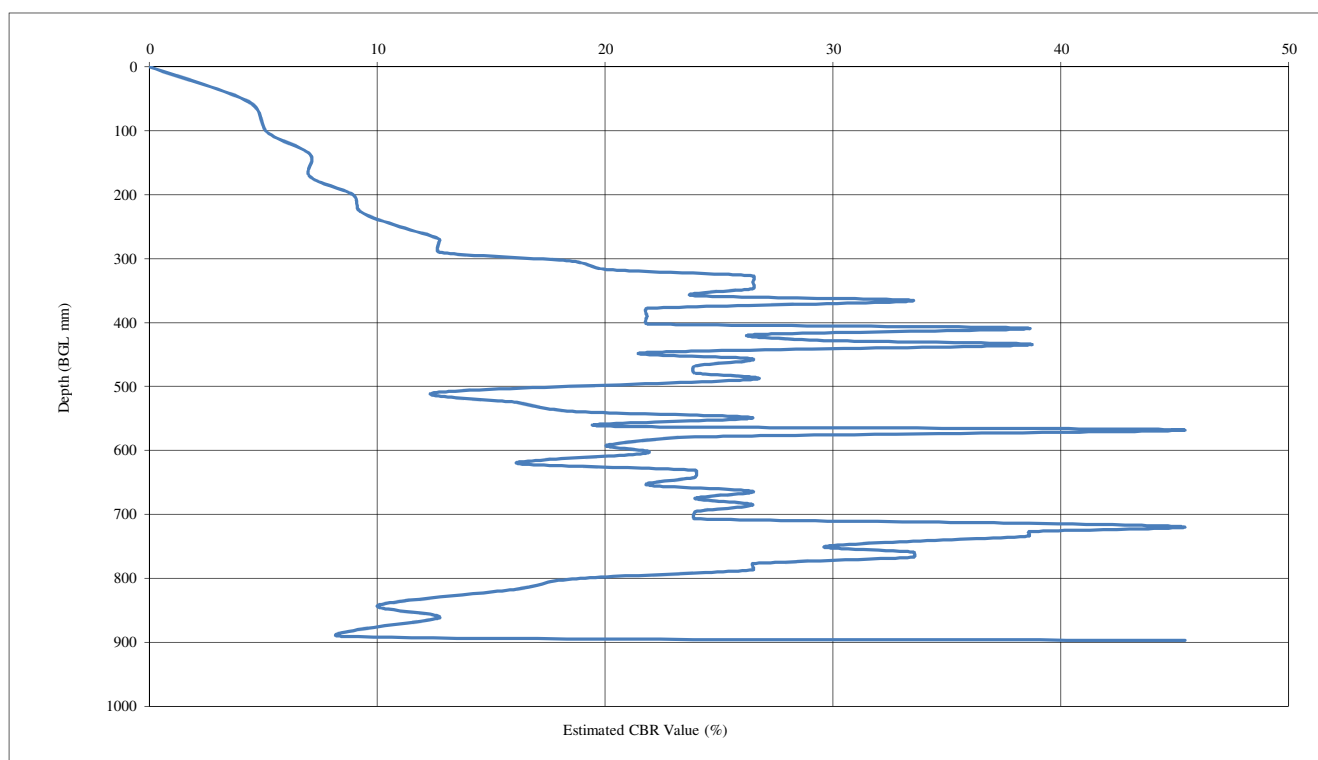


Determination of Dynamic Cone Penetrometer - Estimated CBR Value (%)

In Accordance with TRL Report PR/INT/277/04

Site Name	Horndean Road, Emsworth	Test Date:	04/10/2013
Site Ref	20568	Test Location:	DCP104
Test No.:			
Initial Depth (mm BGL):	58		
Final Depth (mm BGL):	897		

Estimated California Bearing Ratio Graph



Start Depth (mm) BGL	Finish Depth (mm) BGL	No. of Blows	Blows Per Layer	DCP mm/Blows	Ave Estimated Layer (CBR %)
0	290	9	9	32.22	8
290	509	29	20	10.95	24
509	620	38	9	12.33	21
620	842	59	21	10.57	25
842	897	62	3	18.33	14

Average estimated CBR value of 18.4% between 0.00 m - 0.89 m bgl

Comments

Site Engineer:	Checked By:	Date:	Approved By:	Date:
P. Sullivan	P. Dennis	07/10/2013	P. Dennis	28/10/2013

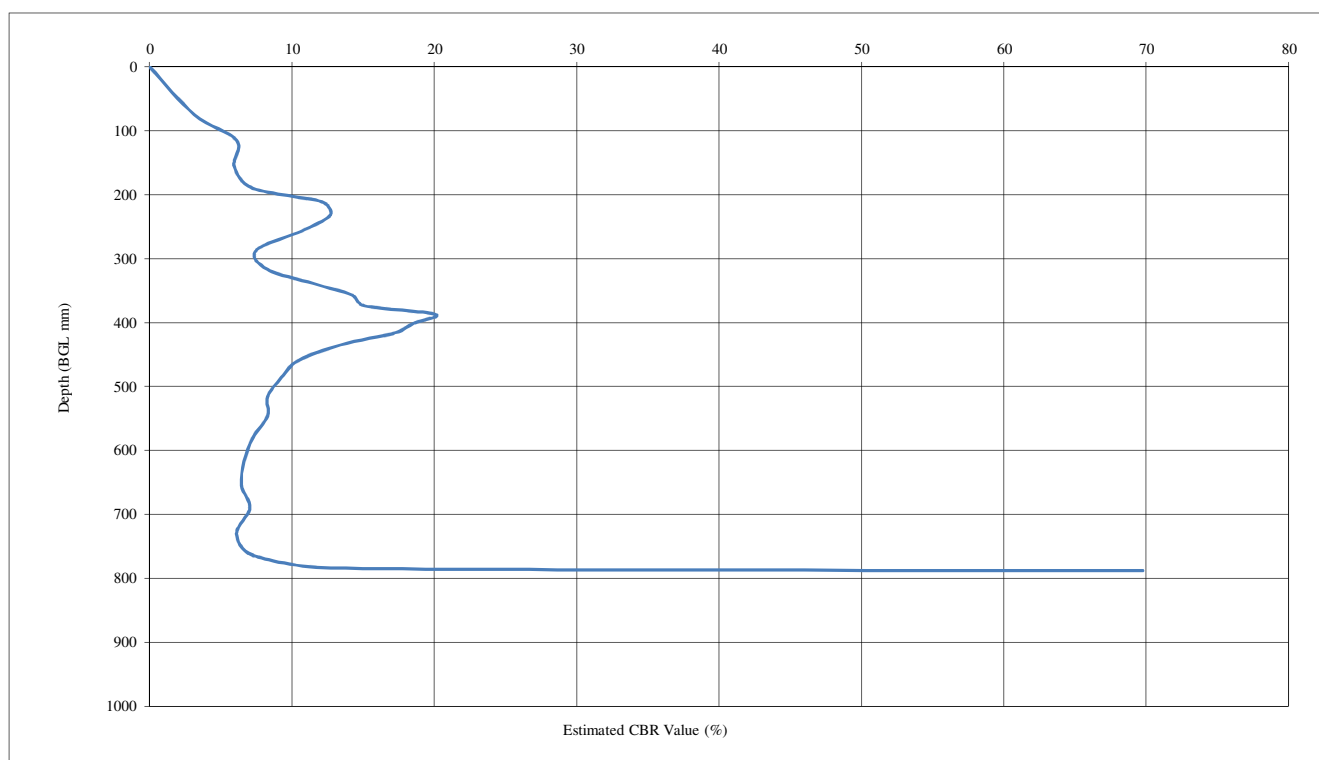


Determination of Dynamic Cone Penetrometer - Estimated CBR Value (%)

In Accordance with TRL Report PR/INT/277/04

Site Name	Horndean Road, Emsworth	Test Date:	04/10/2013
Site Ref	20568	Test Location:	DCP105
Test No.:			
Initial Depth (mm BGL):	180		
Final Depth (mm BGL):	788		

Estimated California Bearing Ratio Graph



Start Depth (mm) BGL	Finish Depth (mm) BGL	No. of Blows	Blows Per Layer	DCP mm/Blows	Ave Estimated Layer (CBR %)
0	196	3	3	65.33	4
196	287	8	5	18.20	14
287	516	19	11	20.82	12
516	764	26	7	35.43	7
516	788	28	2	136.00	2

Average estimated CBR value of 7.8% between 0.00m - 0.78m bgl

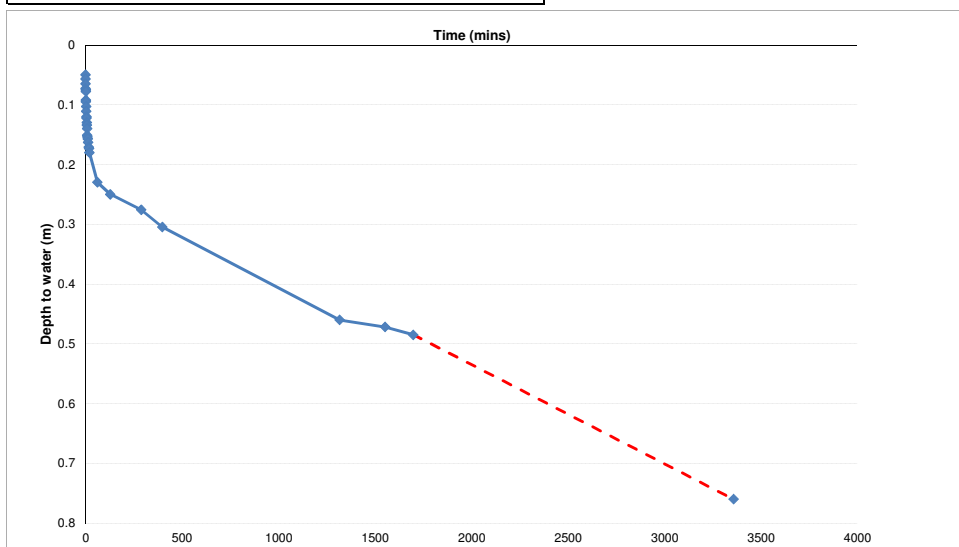
Comments

Site Engineer:	Checked By:	Date:	Approved By:	Date:
P. Sullivan	P. Dennis	07/10/2013	P. Dennis	28/10/2013

APPENDIX VIII
SOIL INFILTRATION TESTING RESULTS

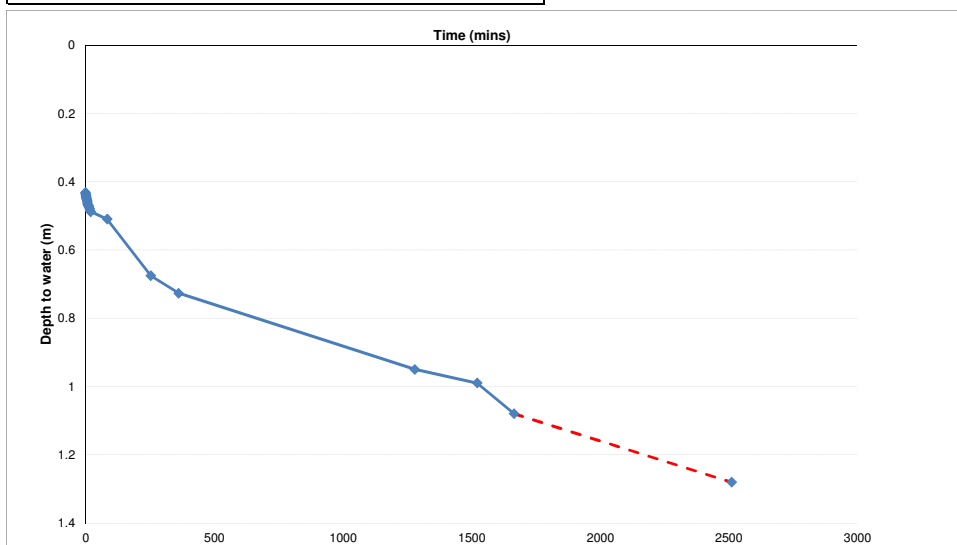
		Site Horndean Road, Emsworth Job Number 20568 Date of Test 03/10/2013	Trial Pit Number TP101 Length..... 2.00 m Width..... 0.65 m Depth..... 1.00 m Groundwater Level..... n/a
Remarks	TEST 1	TEST 2	TEST 3
Insufficient infiltration; Test 1 did not reach 75% infiltration and so was backfilled. Tests 2 and 3 not completed. Data was extrapolated to give infiltration rate.	Time(min)	Depth to Water (m)	
	0	0.05	
	0.15	0.057	
	0.3	0.065	
	0.45	0.073	
	1	0.075	
	1.3	0.078	
	2	0.092	
	2.3	0.095	
	3	0.103	
	3.3	0.111	
	4.3	0.12	
	5	0.122	
	6	0.13	
	7	0.134	
	8	0.14	
	9	0.151	
	10	0.154	
	12	0.157	
	14	0.163	
	16	0.171	
	18	0.173	
	20	0.18	
	61	0.23	
	127	0.25	
	288	0.276	
	398	0.305	
	1316	0.46	
	1553	0.472	
	1699	0.485	
	3358	0.76 (extrapolated data)	
Effective Storage Depth	m	0.95	
75% Effective Storage Depth	m	0.71	
(i.e. depth below GL)	m	0.29	
25% Effective Storage Depth	m	0.24	
(i.e. depth below GL)	m	0.76	
Effective Storage Depth 75%-25%	m	0.48	
Time to fall to 75% effective depth	mins	350	
Time to fall to 25% effective depth	mins	3358	
V (75%-25%)	m3	0.62	
a (50%)	m2	3.82	
t (75%-25%)	mins	3008	
SOIL INFILTRATION RATE	m/s	8.96E-07 (extrapolated data)	

DESIGN SOIL INFILTRATION RATE, f	8.96E-07
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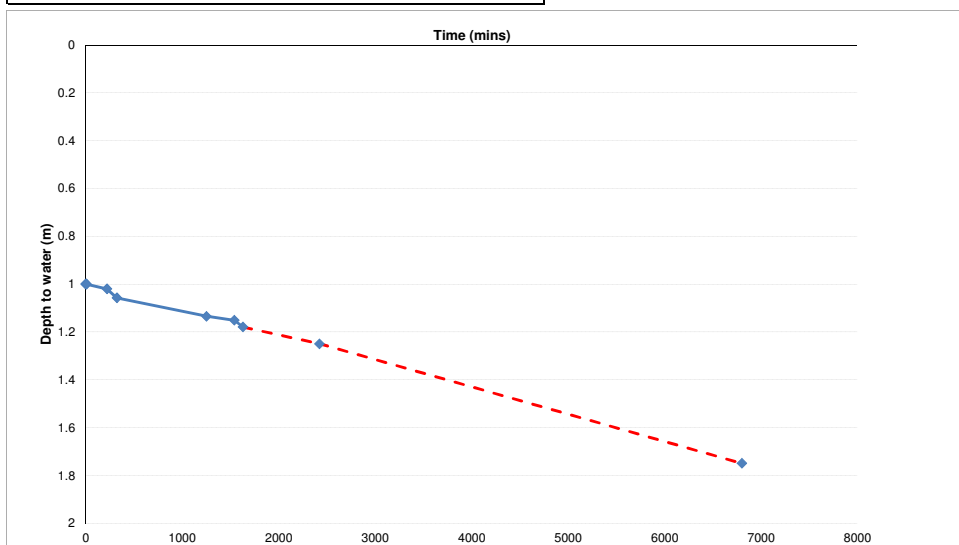
		Site Horndean Road, Emsworth Job Number 20568 Date of Test 03/10/2013	Trial Pit Number TP102 Length..... 2.00 m Width..... 0.65 m Depth..... 1.50 m Groundwater Level..... n/a
Remarks	TEST 1	TEST 2	TEST 3
Insufficient infiltration; Test 1 did not reach 75% infiltration and so was backfilled. Tests 2 and 3 not completed. Data has been extrapolated to give infiltration rate.	Time(min)	Depth to Water (m)	
	0	0.432	
	0.3	0.435	
	1	0.438	
	1.3	0.442	
	2	0.444	
	2.3	0.444	
	3	0.447	
	4	0.45	
	5	0.452	
	6	0.457	
	7	0.459	
	8	0.464	
	9	0.469	
	10	0.469	
	12	0.472	
	14	0.475	
	16	0.48	
	18	0.486	
	20	0.488	
	84	0.51	
	254	0.676	
	362	0.727	
	1280	0.95	
	1522	0.99	
	1666	1.08	
	2511	1.28 (extrapolated data)	
Effective Storage Depth	m	1.07	
75% Effective Storage Depth	m	0.80	
(i.e. depth below GL)	m	0.70	
25% Effective Storage Depth	m	0.27	
(i.e. depth below GL)	m	1.23	
Effective Storage Depth 75%-25%	m	0.53	
Time to fall to 75% effective depth	mins	320	
Time to fall to 25% effective depth	mins	2500	
V (75%-25%)	m3	0.69	
a (50%)	m2	2.78	
t (75%-25%)	mins	2180	
SOIL INFILTRATION RATE	m/s	1.91E-06 (extrapolated data)	

DESIGN SOIL INFILTRATION RATE, i 1.91E-06



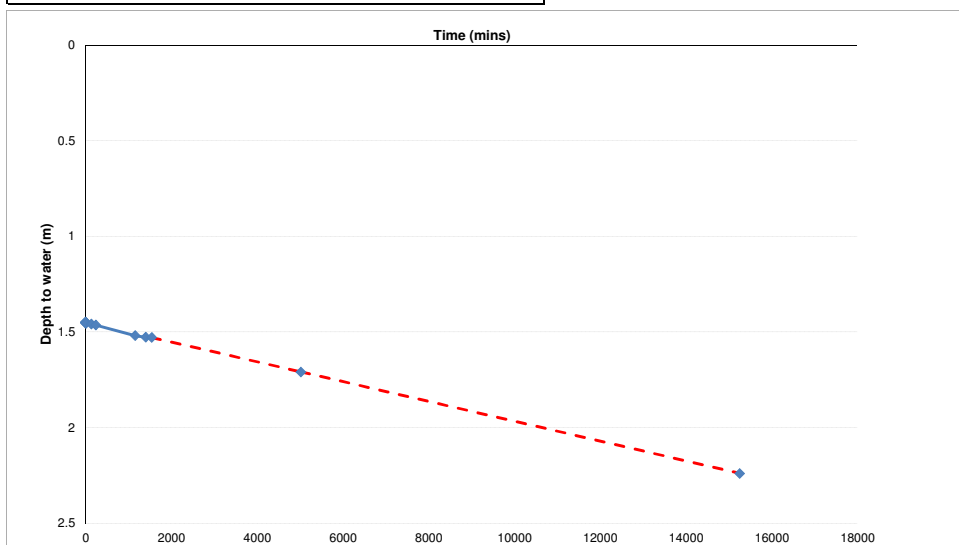
		Site Horndean Road, Emsworth Job Number 20568 Date of Test 03/10/2013	Trial Pit Number TP103 Length..... 2.00 m Width..... 0.65 m Depth..... 2.00 m Groundwater Level..... n/a
Remarks	TEST 1	TEST 2	TEST 3
Insufficient infiltration; Test 1 did not reach 25% or 75% infiltration and so was backfilled. Tests 2 and 3 not completed. Data has been extrapolated to give infiltration rate.	Time(min) Depth to Water (m) 0 1 5 1 10 1 221 1.02 326 1.058 1253 1.135 1543 1.152 1633 1.18 2423 1.25 6804 1.75 (extrapolated data)		
Effective Storage Depth m 75% Effective Storage Depth m (i.e. depth below GL) m 25% Effective Storage Depth m (i.e. depth below GL) m Effective Storage Depth 75%-25% m Time to fall to 75% effective depth mins Time to fall to 25% effective depth mins V (75%-25%) m3 a (50%) m2 t (75%-25%) mins	1.00 0.75 1.25 0.25 1.75 0.50 2423 6804 0.65 2.60 4381		
SOIL INFILTRATION RATE m/s	9.51E-07 (extrapolated data)		

DESIGN SOIL INFILTRATION RATE, f	9.51E-07
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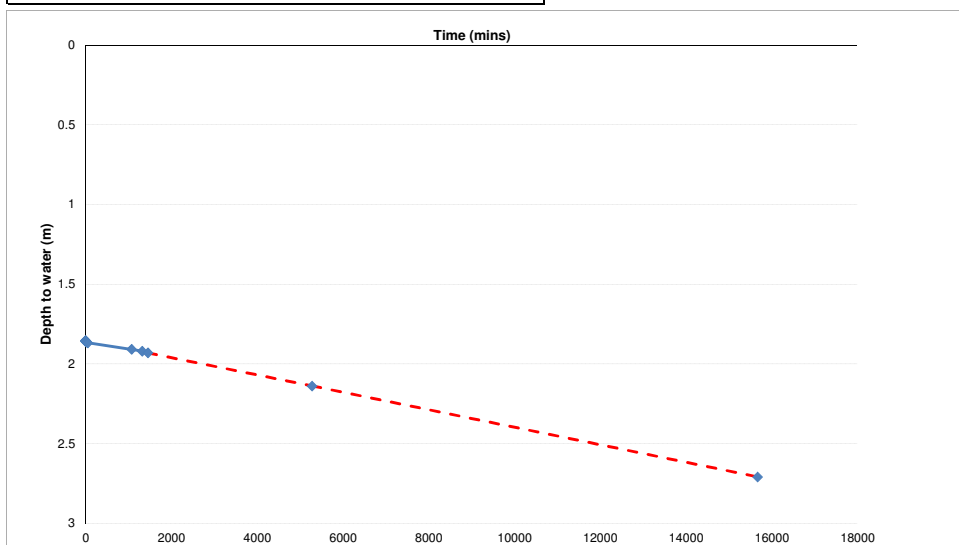
		Site Horndean Road, Emsworth Job Number 20568 Date of Test 03/10/2013	Trial Pit Number TP104 Length..... 1.95 m Width..... 0.65 m Depth..... 2.50 m Groundwater Level..... n/a
Remarks	TEST 1	TEST 2	TEST 3
Insufficient infiltration; Test 1 did not reach 25% or 75% infiltration and so was backfilled. Tests 2 and 3 not completed. Data has been extrapolated to give infiltration rate.	Time(min)	Depth to Water (m)	
	0	1.45	
	0.3	1.45	
	1.3	1.451	
	2	1.452	
	3	1.452	
	4	1.453	
	6	1.455	
	8	1.455	
	10	1.455	
	133	1.46	
	237	1.465	
	1156	1.52	
	1406	1.528	
	1545	1.53	
	5021	1.71	
	15257	2.24	(extrapolated data)
Effective Storage Depth	m	1.05	
75% Effective Storage Depth	m	0.79	
(i.e. depth below GL)	m	1.71	
25% Effective Storage Depth	m	0.26	
(i.e. depth below GL)	m	2.24	
Effective Storage Depth 75%-25%	m	0.53	
Time to fall to 75% effective depth	mins	5021	
Time to fall to 25% effective depth	mins	15257	
V (75%-25%)	m3	0.67	
a (50%)	m2	2.66	
t (75%-25%)	mins	10236	
SOIL INFILTRATION RATE	m/s	4.07E-07	(extrapolated data)

DESIGN SOIL INFILTRATION RATE, f	4.07E-07
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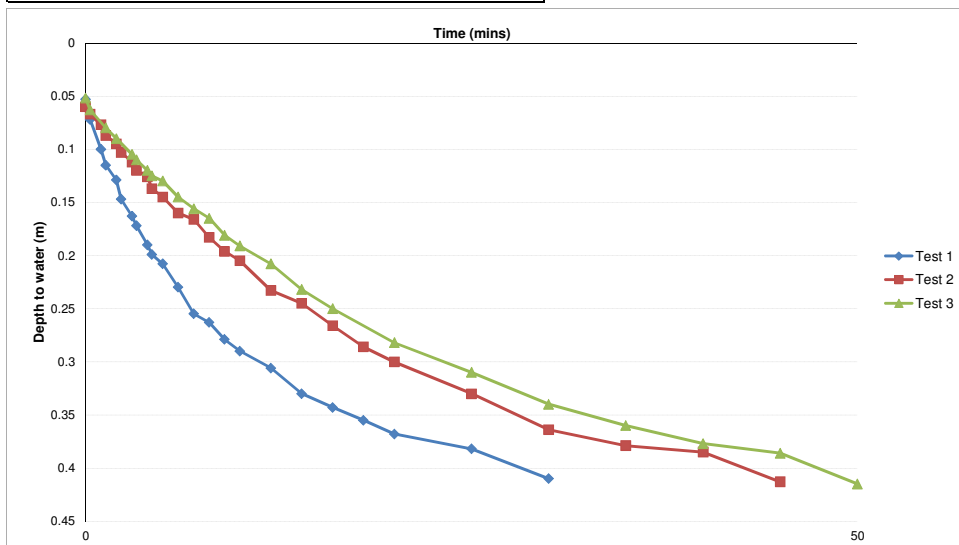
		Site Horndean Road, Emsworth Job Number 20568 Date of Test 03/10/2013	Trial Pit Number TP105 Length..... 1.95 m Width..... 0.65 m Depth..... 3.00 m Groundwater Level..... n/a
Remarks	TEST 1	TEST 2	TEST 3
Insufficient infiltration; Test 1 did not reach 25% or 75% infiltration and so was backfilled. Tests 2 and 3 not completed. Data has been extrapolated to give infiltration rate.	Time(min)	Depth to Water (m)	
	0	1.855	
	0.3	1.855	
	1	1.857	
	1.3	1.86	
	4	1.86	
	6	1.86	
	12	1.863	
	20	1.863	
	52	1.869	
	1072	1.91	
	1321	1.921	
	1458	1.932	
	5284	2.14	
	15674	2.71	
		(extrapolated data)	
Effective Storage Depth	m	1.15	
75% Effective Storage Depth	m	0.86	
(i.e. depth below GL)	m	2.14	
25% Effective Storage Depth	m	0.29	
(i.e. depth below GL)	m	2.71	
Effective Storage Depth 75%-25%	m	0.57	
Time to fall to 75% effective depth	mins	5284	
Time to fall to 25% effective depth	mins	15674	
V (75%-25%)	m3	0.73	
a (50%)	m2	2.93	
t (75%-25%)	mins	10390	
SOIL INFILTRATION RATE	m/s	3.97E-07	(extrapolated data)

DESIGN SOIL INFILTRATION RATE, f	3.97E-07
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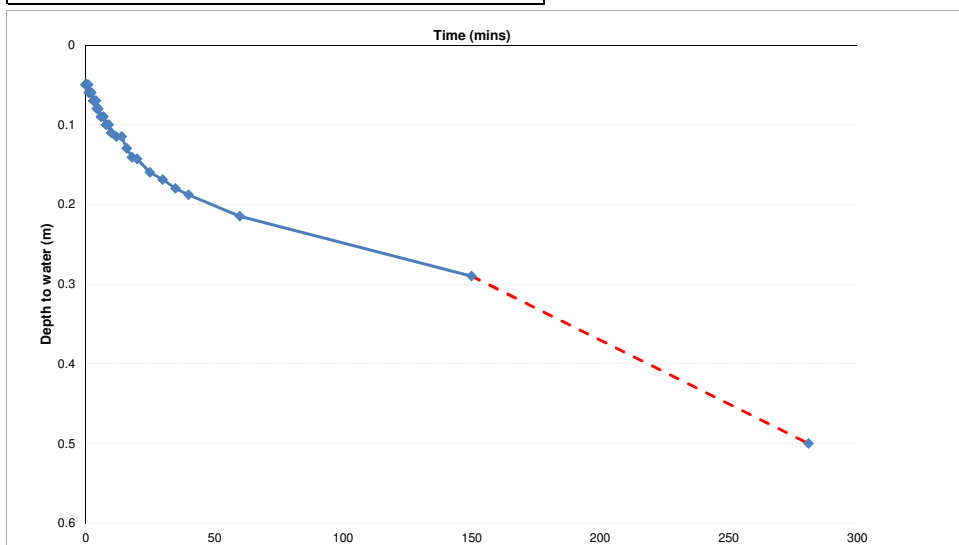
REC Resource & Environmental Consultants Ltd		Site Job Number Date of Test		Horndean Road, Emsworth 20568 04/10/2013		Trial Pit Number Length..... Width..... Depth..... Groundwater Level.....		TP109 1.50 m 0.65 m 0.50 m n/a	
Remarks		TEST 1		TEST 2		TEST 3			
Shallow trial pit, max depth of 0.5 m	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)			
	0	0.053	0	0.060	0	0.052			
	0.3	0.072	0.3	0.067	0.3	0.063			
	1	0.1	1	0.077	1.3	0.080			
	1.3	0.115	1.3	0.087	2	0.090			
	2	0.129	2	0.095	3	0.105			
	2.3	0.147	2.3	0.103	3.3	0.110			
	3	0.163	3	0.112	4	0.120			
	3.3	0.172	3.3	0.120	4.3	0.125			
	4	0.19	4	0.126	5	0.130			
	4.3	0.199	4.3	0.137	6	0.145			
	5	0.208	5	0.145	7	0.156			
	6	0.23	6	0.160	8	0.165			
	7	0.255	7	0.166	9	0.181			
	8	0.263	8	0.183	10	0.191			
	9	0.279	9	0.196	12	0.208			
	10	0.29	10	0.205	14	0.232			
	12	0.306	12	0.233	16	0.250			
	14	0.33	14	0.245	20	0.282			
	16	0.343	16	0.266	25	0.310			
	18	0.355	18	0.286	30	0.340			
	20	0.368	20	0.300	35	0.360			
	25	0.382	25	0.330	40	0.377			
	30	0.41	30	0.364	45	0.386			
			35	0.379	50	0.415			
			40	0.385					
			45	0.413					
	Effective Storage Depth	m	0.45	0.44	0.45				
	75% Effective Storage Depth	m	0.34	0.33	0.34				
	(i.e. depth below GL)	m	0.16	0.17	0.16				
25% Effective Storage Depth	m	0.11	0.11	0.11					
(i.e. depth below GL)	m	0.39	0.39	0.39					
Effective Storage Depth 75%-25%	m	0.22	0.22	0.22					
Time to fall to 75% effective depth	mins	2.45	7.30	7.30					
Time to fall to 25% effective depth	mins	27.00	41	47					
V (75%-25%)	m3	0.22	0.21	0.22					
a (50%)	m2	1.17	1.16	1.17					
t (75%-25%)	mins	25	34	40					
SOIL INFILTRATION RATE	m/s	1.26E-04	9.12E-05	7.83E-05					

DESIGN SOIL INFILTRATION RATE, f	7.83E-05
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		Site Horndean Road, Emsworth Job Number 20568 Date of Test 04/10/2013	Trial Pit Number TP111 Length..... 1.90 m Width..... 0.70 m Depth..... 0.65 m Groundwater Level..... n/a
Remarks	TEST 1	TEST 2	TEST 3
Insufficient infiltration; Test 1 did not reach 75% infiltration and so was backfilled. Tests 2 and 3 not completed. Data has been extrapolated to give infiltration rate.	Time(min)	Depth to Water (m)	
	0	0.05	
	0.15	0.05	
	0.3	0.05	
	0.45	0.05	
	1	0.05	
	1.3	0.06	
	2	0.06	
	2.3	0.06	
	3	0.07	
	3.3	0.07	
	4	0.07	
	4.3	0.08	
	5	0.08	
	6	0.09	
	7	0.09	
	8	0.1	
	9	0.1	
	10	0.11	
	12	0.115	
	14	0.115	
	16	0.13	
	18	0.141	
	20	0.143	
	25	0.16	
	30	0.169	
	35	0.18	
	40	0.188	
	60	0.215	
	150	0.29	
	281	0.5 (extrapolated data)	
Effective Storage Depth	m	0.60	
75% Effective Storage Depth	m	0.45	
(i.e. depth below GL)	m	0.20	
25% Effective Storage Depth	m	0.15	
(i.e. depth below GL)	m	0.50	
Effective Storage Depth 75%-25%	m	0.30	
Time to fall to 75% effective depth	mins	50	
Time to fall to 25% effective depth	mins	281	
V (75%-25%)	m3	0.40	
a (50%)	m2	1.81	
t (75%-25%)	mins	231	
SOIL INFILTRATION RATE	m/s	1.59E-05 (extrapolated data)	

DESIGN SOIL INFILTRATION RATE, f	1.59E-05
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REC Services

REC Ltd is a multi-disciplinary health, safety, environmental and energy consultancy. Our national coverage enables our local experts to provide cost effective and pragmatic consultancy services in an efficient and sustainable manner.



- Feasibility Studies
- Ground Source Heat Pumps Installation
- Air Source Heat Pump Installation
- System Design and Maintenance
- Solar Photovoltaic (PV) Systems
- Combined Heat and Power Systems



- Sound Insulation Testing
- Noise at Work Assessment
- Development Related Noise / Vibration
- Environmental Noise / Vibration



- Phase 1 Habitat Surveys
- Invasive Species
- Legally Protected Species Surveys
- Mitigation Schemes
- Ecological Impact Assessment (EclA)
- BREEAM & Code 4 Sustainable Homes
- Habitat Management Plans
- Management planning and targeted Biodiversity Action Plan survey
- Environmental Impact Assessment



- Asbestos Management Surveys
- Demolition/Refurbishment Surveys
- Analysis of Asbestos in Soils and Bulk Samples
- Air Testing for Clearances and Reassurance
- Legionella Risk Assessment



- Flood Risk & Consequence Assessment
- Strategic Flood Risk Assessment (SFRA)
- EIA Technical Chapters
- Assessment of Flood Levels
- Hydrology & Hydrogeology
- Flood Defence Structures
- Drainage Systems (SUDS) Design
- Mitigation Measures
- Soakaway Tests



- Air Quality Impact
- Odour Assessment
- Dispersion Modelling
- Stack Emission Testing
- Pollution Monitoring



- Geotechnical Investigation & Assessment
- Contaminated Land Investigation & Assessment
- Waste Management
- Groundwater Testing
- Environmental Impact Assessment



- Health, Safety & Environmental Management Systems
- Divestment / Acquisition Due Diligence Services
- Environment Permit Application & Support
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- Carbon Reporting
- Waste Minimisation