

GROUND INVESTIGATION REPORT

PROPOSED SCHOOL EXPANSION
TROSNANT PRIMARY SCHOOL
HAVANT
HAMPSHIRE

Prepared for:
Hampshire County Council

July 2016

Report No: 5715

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Executive Summary

Hampshire County Council is proposing the expansion of the existing teaching facilities at Trosnant Primary School, Havant, Hampshire. The development will consist of a new 4-classroom block to the southwest linked to the main school building by a covered walkway and a new 2-classroom extension of the eastern corner of the school.

The geological map of the area shows the site to be underlain by the London Clay Formation, which typically comprises blue-grey or grey-brown, slightly calcareous, silty to very silty clay, clayey silt and sometimes silt, with some layers of sandy clay. Superficial deposits comprising River Terrace Deposits are shown to overlie the bedrock geology of the area.

In order to confirm the underlying ground conditions a ground investigation comprising five mini percussive boreholes, two machine excavated trial pits, three in-situ soakaway tests, five hand excavated inspection pits and two in-situ CBR tests was carried out.

The soil sequence beneath the proposed development consisted of made ground, comprising either asphalt and sub-base, or grass over brown, orange brown and grey silty sandy gravelly clay to a depth of between 0.20m and 1.20m. The made ground was underlain by River Terrace deposits typically comprising dense to very dense silty very clayey gravels of flint to a depth of between 1.40m and 2.00m. The River Terrace deposits were underlain by the London Clay Formation comprising firm to stiff, locally soft, brown becoming dark grey silty, locally sandy clay to the maximum investigated depth of 5.00m.

We recommend mass concrete strip foundations founded within the River Terrace deposits with an allowable bearing capacity of 100kN/m² can be used for design purposes. The depth to the above in-situ founding horizons is likely to vary between typically 0.20m and 1.20m below the existing ground level.

The recommended bearing capacity is considered conservative in order to minimise the risk of overstressing the underlying London Clay Formation which was found to be locally soft. However, it is recommended that the foundations be founded as shallow as possible.

Plasticity tests have shown that the shallow deposits exhibit typically no shrinkage potential. Therefore, the base of any foundations should lie at least 450mm below final ground level.

If design loads of the floor slabs are less than or equal to typically 5kN/m², floor slabs can be designed as ground bearing. Alternatively the floor slabs may be designed as suspended.

All buried shallow concrete should, as a minimum, conform to Class AC1 of BRE Special Digest 1 (2005).

California Bearing Ratio (CBR) values were carried out in two of the hand excavated inspection pits and should be referred to for specific depth related values.

Three in-situ permeability/soakaway tests were undertaken revealing soil infiltration rates of between 1.43×10^{-06} m/s and 8.93×10^{-06} m/s.

Six samples of soil collected from the site were tested for a standard suite of contaminants. The soil chemical testing has revealed that the determinants tested were all below relevant guidelines for a commercial/ industrial development.

Based on the results of the WAC testing, the shallow deposits from TP2 @ 0.50m have been classed as inert waste. However, the level of TPH (C10-C40) from TP1 @ 0.30m was slightly above the inert waste limit values.

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SECTION 1 Introduction and Proposed Development

Hampshire County Council is proposing the expansion of the existing teaching facilities at Trosnant Primary School, Havant, Hampshire. The development will consist of a new 4-classroom block to the southwest linked to the main school building by a covered walkway and a new 2-classroom extension of the eastern corner of the school.

Terra Firma (South) has been commissioned by the Geotechnics Group of Hampshire County Council to carry out a ground investigation of the above site.

The main objectives of the ground investigation were to:

- Determine the type, strength and bearing characteristics of the shallow superficial deposits and underlying solid geology.
- Provide recommendations for a suitable and economic foundation/floor slab solution for the development.
- Provide recommendations with regard to any other geo-technical aspects pertaining to the development, such as soakaway and highway design parameters.
- Collect representative samples for laboratory chemical analysis and provide an evaluation of the results.

In order to achieve the above objectives, Terra Firma (South) carried out an assessment programme including a review of existing data, followed by a field investigation to determine the prevailing ground conditions and also to collect and analyse soil samples from selected locations around the site.

It should be noted that the brief was beyond the scope of Terra Firma (South) to undertake a Phased Contamination Risk Assessment of the site. If necessary this can be considered at a later stage following the evaluation of chemical results.

1.1 Limitations and Exceptions of Investigation

Hampshire County Council has requested that a Ground Investigation (GI) be performed in order to establish the ground conditions at the site, determine an appropriate foundation solution for the proposed development and collect representative samples for laboratory analysis.

The GI was conducted and this report has been prepared for the sole internal reliance of Hampshire County Council and their design and construction partners. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Terra Firma (South). If an unauthorised third party comes into possession of this report they rely on it at their peril and the authors owe them no duty of care and skill.

The report represents the findings and opinions of experienced geo-environmental and geo-technical consultants. Terra Firma (South) does not provide legal advice and the advice of lawyers may also be required.

The subsurface geological profiles, any contamination and other plots are generalised by necessity and have been based on the information found at the locations of the exploratory holes and depths sampled and tested.

The site investigation was limited by the following site constraints:

- Underground services and utilities, and
- The presence of the existing buildings and above ground obstructions.

SECTION 2 Review of Existing Data

The following information has been based on a walk-over survey undertaken by Terra Firma (South) and desktop soil investigation undertaken by the Geotechnics Group of Hampshire County Council.

All relevant desktop plans have been included within **Annex A**.

2.1 Physical Setting

The proposed development is located within the property boundaries of Trosnant Primary School, Havant, Hampshire, PO9 3BD.

The site is centred approximately on National Grid Reference (NGR) 471450 107240. The site location is presented in **Drawing 01**.

The school site is irregular in shape with a plan area of approximately 3.65 hectares and sits at between approximately 10m and 13m above ordnance datum (AOD), falling very gently to the west.

The site is bounded by the playing fields of Havant College to the south, residential housing to the east, an open public area to the north and Stockheath Lane to the west.

2.2 Current Use and Site Conditions

The site was visited on the 3rd of May 2016 by a Terra Firma (South) Engineer.

The site currently comprises the existing school buildings, playing fields, hard standing playgrounds, car parking areas and access roads.

The site is accessed from Stockheath Lane to the nwest, which leads directly to the entrance and car park.

No evidence of surface contamination was observed during the walkover survey.

2.3 Geology and Radon

The 1:50 000 scale Geological Map of the area shows the site to be underlain by the London Clay Formation of Palaeogene age.

The London Clay Formation typically comprises bioturbated or poorly laminated, blue-grey or grey-brown, slightly calcareous, silty to very silty clay, clayey silt and sometimes silt, with some layers of sandy clay.

Superficial deposits comprising River Terrace Deposits (Undifferentiated) are shown to overlie the bedrock geology of the area.

Due to the nature and history of the site, a significant thickness of made ground is not expected across the majority of the investigation site.

Radon protection measures are not required at the study site, although a site specific radon report should be obtained to confirm.

2.4 Environmental Information

Site History

Epoch 1 – 1843-1893

The site is shown to be within open fields likely used for agriculture. Stockheath Lane runs along the western boundary of the site.

Epoch 2 – 1891 – 1912

Little or no change from the previous epoch.

Epoch 3 – 1904 – 1939

Little or no change from the previous epoch.

Epoch 4 – 1919 – 1943

Little or no change from the previous epoch.

Hydrology

There is an Environment Agency (EA) designated Main Rivers noted just within the southern boundary of the study site. Following the walk-over survey it was confirmed that it must be culverted.

The study site does not lie within an EA Flood Zone.

Hydrogeology

The River Terrace Deposits beneath the site is designated as a secondary aquifer.

The study site is situated within an Inner Zone 1c (Subsurface activity only) for Groundwater Source Protection.

Landfills

There are no active or historic landfill sites located within 250m of the site.

2.5 Previous Investigations

There is one previous SI report available for the study site undertaken by Structural Soils Ltd in April 1994 (report no. 40360).

The investigation comprised five machine excavated trial pits to depths of up to 3.60mbgl.

The trial pits encountered generally loose orange brown flint gravels to stiff/firm/soft orange brown clays (Coombe Deposits) to between 2.10m and 3.20m over stiff light grey or brown clay to termination. TP4 encountered made ground to termination at 3.50m depth on what appeared to be a slab of concrete.

Slight water seepages were encountered between 1.75m and 3.50m depth.

The soils encountered in the trial pits should not present any special difficulties with regard to excavation.

2.5 Previous Investigations (Continued)

NHBC Standards Chapter 4.2, 1999 indicates that the clay Coombe Deposits have a low shrinkage potential and classes the gravel Coombe Deposits as being non-shrinkable.

The gravels in the trial pits should offer a net presumed bearing value of about 200kPa. However, the Clay Coombe Martin Deposits beneath will only offer net presumed bearing values of between 80 and 150kPa. Care should be taken therefore that footings founded in the gravels do not overstress the underlying clays.

A 1.10m wide strip footing supporting a load of 130kN per m run and founded at 0.80m depth in the vicinity of TP3 would induce about 10mm of consolidation settlement.

Chemical tests indicate that the site falls into Class 1, as defined in BRE Digest 363 and therefore no special precautions need to be taken with regard to concrete in foundations.

SECTION 3 Field Investigation

3.1 Site Works

A ground investigation scoped by Hampshire County Council and comprising five mini percussive boreholes, two machine excavated trial pits, three in-situ soakaway tests, five hand excavated inspection pits, two in-situ CBR tests, laboratory chemical testing of soils and soil property testing was carried out between the 2nd and 3rd of June 2016.

Prior to the site investigation, arrangements were made with the headmaster at the school, in order to outline the schedule of works and arrange necessary safety measures to be implemented. It was requested that site works be completed within half term time to avoid disruption to the schools working day.

The windowless sampling boreholes were bored using a mini percussive drilling rig. The windowless sampling boreholes were used to investigate the shallow ground conditions and undertake in-situ strength tests at regular intervals.

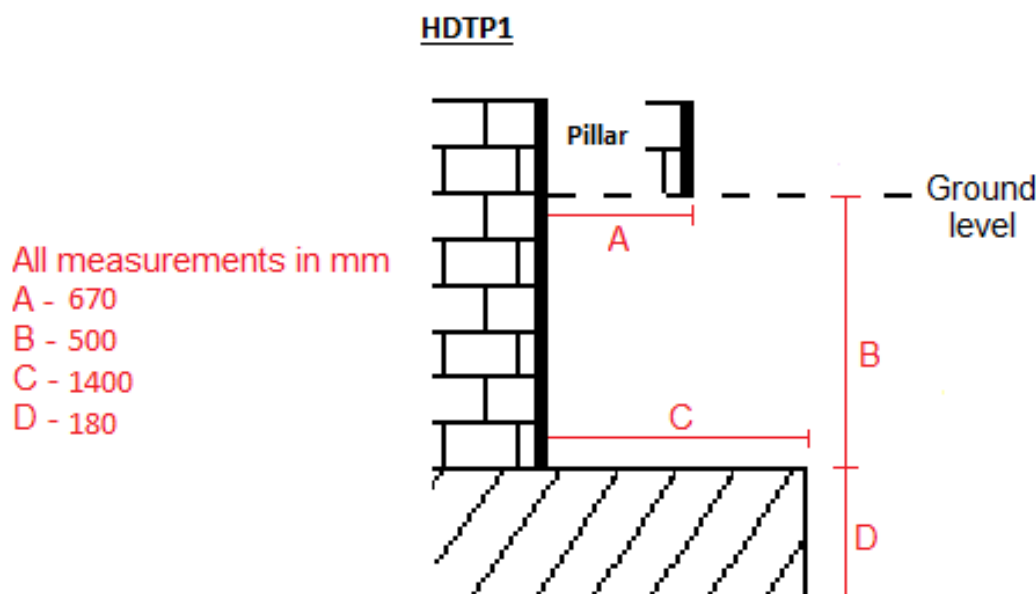
The machine excavated trial pits were excavated using a JCB 3CX wheeled excavator.

Deep in-situ permeability tests were undertaken within two trial pit locations, TP1 and TP2, in order to provide conventional soakaway design detail.

A 2000 gallon tanker was used to rapidly fill the excavation with water.

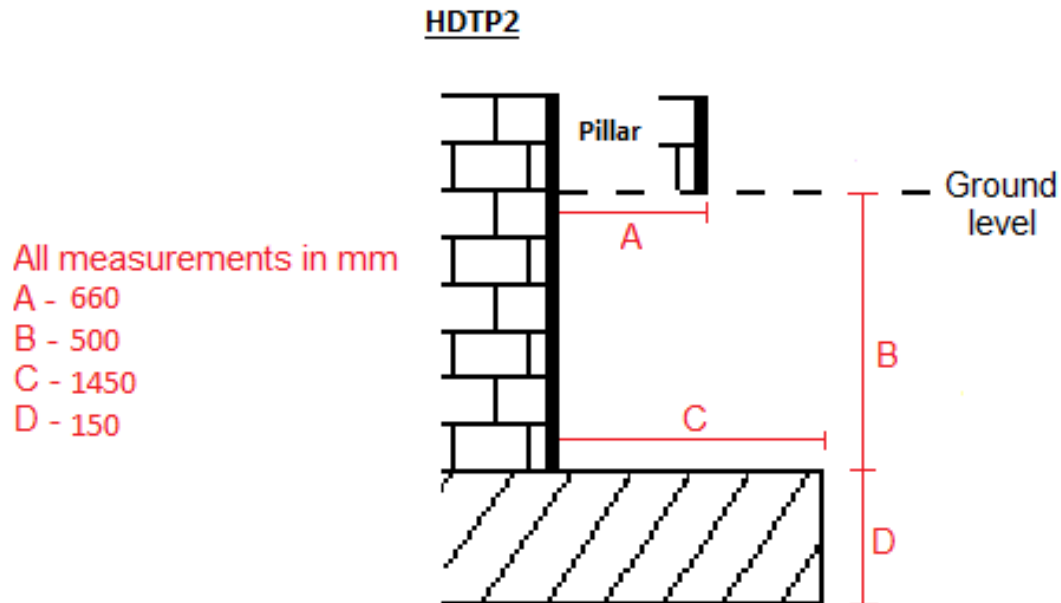
The hand excavated inspection pits were sunk using conventional digging tools. The pits were used to expose existing foundations, obtain in-situ CBR values for the proposed car park area and undertake shallow soakaway testing.

HDTP1 was used excavated to expose the existing foundations of the main school building. A concrete foundation was encountered at 0.50mbgl, stepping out 1.40m from the external wall (0.67m from pillar) and was 0.18m thick. A schematic drawing of the inspection pit is given below:

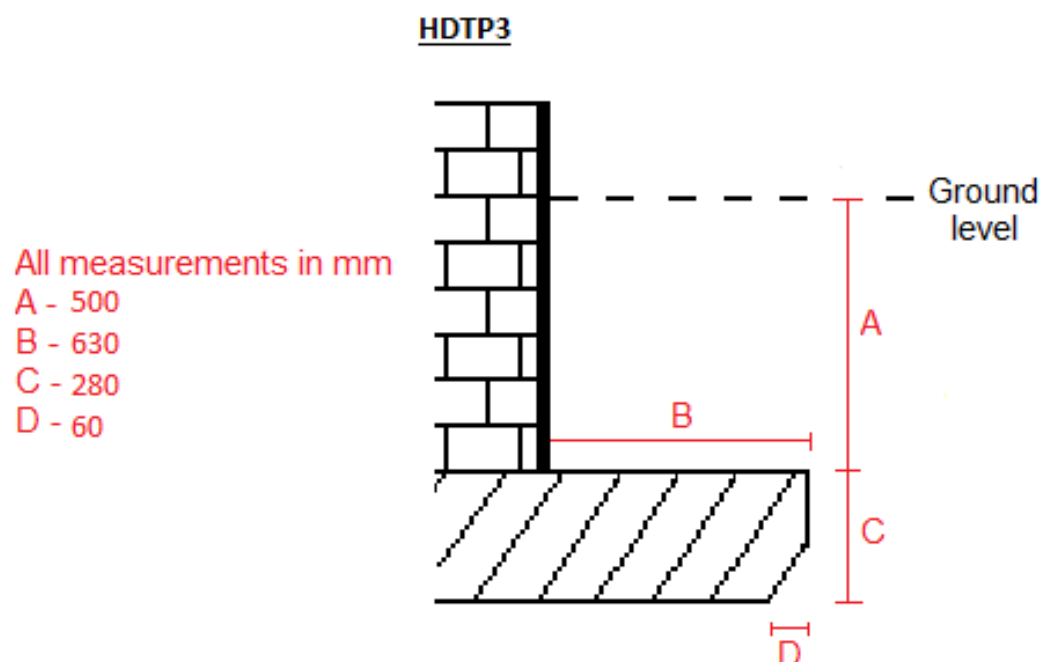


3.1 Site Works (Continued)

HDTP2 was used excavated to expose the existing foundations of the main school building. A concrete foundation was encountered at 0.50mbgl, stepping out 1.45m from the external wall (0.66m from pillar) and was 0.15m thick. A schematic drawing of the inspection pit is given below:



HDTP3 was used excavated to expose the existing foundations of the main school building. A concrete foundation was encountered at 0.50mbgl, stepping out 0.63m from the external wall and was 0.28m thick (undercut 0.06m). A schematic drawing of the inspection pit is given below:



The in-situ CBR tests were carried out using a MEXE probe to a nominal depth of <0.50m.

3.1 Site Works (Continued)

Before any intrusive works commenced a CAT survey was undertaken at all locations to clear them of any services.

The fieldworks were supervised by Terra Firma (South), who also logged the boreholes and trial pits to the requirements of Eurocode 7.

The windowless sampling borehole logs, machine excavated trial pit logs and hand excavated inspection pit logs are presented in **Annex B**, **Annex C** and **Annex D** respectively and are shown on **Drawing 02**.

3.2 Exploratory Strategy

The boreholes, trial pits and hand excavated inspection pits were undertaken at locations provided by Hampshire County Council.

3.3 Sampling Quality Assurance

Care was taken to ensure that sampling quality assurance occurred during site works. This included the following measures:

- The use of nitrile gloves at each sampling point.
- Stainless steel shovels were used to collect soil samples. The tool was cleaned with distilled water between each sample point.
- Soil samples were stored at a temperature below 4 degrees.
- Soil samples were stored within sample containers according to the chemical testing required.
- No head space was left in sample containers.

3.4 Sampling Regime

3.4.1 Soil Chemical Test Sampling

During the intrusive investigation small disturbed soil samples were collected for chemical testing. The sampling regime was conducted in accordance with BS5930: 1999 in order to satisfy the criteria below:

- Identify and confirm suspected sources of contamination
- Determine type and concentration of contamination
- Determine lateral and vertical spread of contaminants
- Ensure representation of the entire site
- Provide sufficient data to determine suitable remedial measures if necessary

The sample locations and depths are illustrated in the table on the following page:

3.4.1 Soil Chemical Test Sampling (Continued)

Table 3.1 Soil Chemical Test Sample Descriptions			
Sample No.		Soil Type	Sample Description
WS1	0.40m	Made Ground	Brown silty very clayey very gravelly SAND
WS2	0.30m	Made Ground	Brown silty sandy gravelly CLAY
WS3	0.25m	Made Ground	Brown silty very sandy gravelly CLAY
WS4	0.30m	River Terrace	Orange brown silty sandy CLAY
WS5	0.40m	River Terrace	Orange brown silty very gravelly CLAY
HDTP5	0.30m	Made Ground	Brown silty sandy gravelly CLAY

In addition, Waste Acceptance Criteria (WAC) testing was undertaken on a representative sample of material due for possible removal from site.

The sample location and depth are illustrated in the following table.

Table 3.2 WAC Test Sample Descriptions			
Sample No.		Soil Type	Description
TP1	0.30m	Made Ground	Brown slightly clayey silty gravelly SAND
TP2	0.50m	Made Ground	Brown silty sandy gravelly CLAY

3.4.2 Soil Property Test Sampling

During the intrusive investigation bulk soil samples were collected for soil property testing.

The sample locations and depths are illustrated in the table on the following page.

Table 3.3 Soil Property Test Sample Descriptions			
Sample No.		Test	Laboratory Description
TP1	1.00m	MC, PI	Brown gravelly (fine-coarse) sandy silty CLAY
TP2	1.00m	MC, PI	Brown clayey silty sandy GRAVEL (fine-coarse)
WS1	1.30m	MC, PI, PSD, BRE	Brown sandy silty clayey GRAVEL (fine-coarse)
WS1	1.80m	MC, PI	Brown silty CLAY
WS2	1.00m	MC, PI, PSD, BRE	Brown sandy silty clayey GRAVEL (fine-coarse)
WS2	2.00m	MC, PI, BRE	Brown silty CLAY
WS3	0.80m	MC, PI, PSD	Brown sandy silty clayey GRAVEL (fine-coarse)
WS3	2.40m	MC, PI	Brown sandy silty CLAY
WS4	1.00m	MC, PI, PSD	Brown sandy silty clayey GRAVEL (fine-coarse)
WS4	3.75m	MC, PI	Brown silty CLAY
WS5	0.90m	MC, PI, PSD, BRE	Brown sandy silty clayey GRAVEL (fine-coarse)
WS5	1.50m	MC, PI	Brown sandy silty CLAY

Notes MC: Moisture Content Test
 PI: Plasticity Index (PI) Test
 PSD: Particle Size Distribution (PSD) Test
 BRE: BRE SD1 Reduced Suite Test

3.5 Ground Conditions

The ground conditions encountered by the boreholes and trial pits varied slightly across the site but can in general be summarised as shown in Table 3.4 on the following page:

3.5 Ground Conditions (Continued)

Table 3.4 Summary of Ground Conditions				
Depth (m)		Thickness (m)	Stratum	
GL	- 0.10/0.25	0.10/0.25	MADE GROUND: Asphalt over pink limestone hard core <i>Or</i> TOPSOIL: Grass over soft dark brown silty sandy gravelly CLAY with frequent rootlets	<i>Made Ground</i>
0.10/0.25	- 0.35/1.20	0.10/1.05	MADE GROUND: Brown, orange brown and grey silty sandy gravelly CLAY / silty very clayey very gravelly SAND. Gravel sub-angular of flint, concrete and brick. Rare roots and ash	
0.20/1.20	- 1.40/2.00	0.50/1.60	Firm to very stiff brown to orange brown and grey silty sandy very gravelly CLAY / Dense to very dense silty very clayey GRAVELS . Gravels are sub-angular of flint.	<i>River Terrace Deposits</i>
1.40/2.00	- >5.00	-	Firm to stiff, locally soft, brown becoming dark grey (below 3.40/3.70m) silty, locally sandy, CLAY	<i>London Clay Formation</i>

Typical SPT strength tests within the River Terrace deposits revealed an average N value of 39.6 (range: 19 to 50).

Typical SPT strength tests within the London Clay Formation revealed an average N value of 9.1 (range: 3 to 14).

The sides of the excavations were typically found to be unstable within the River Terrace Deposits.

3.6 Water Strikes

Perched groundwater strikes were encountered within WS3, WS4 and WS5 at a depth of between 1.60m and 2.70m.

3.7 In-situ Soakaway Testing

During the site investigation, in-situ permeability tests were undertaken within TP1, TP2 and HDTP5 and where possible were carried out to the requirements of BRE Digest 365 and/or BS 5930:1999+A2:2010 (Section 4).

3.7 In-situ Soakaway Testing (Continued)

The appropriate calculation sheets are presented in **Annex E** and the results are discussed in Section 6.6.

3.8 In-situ California Bearing Ratio (CBR) Testing

The in-situ CBR tests (2No) were carried out using a MEXE probe. The probes were typically sunk to a depth of <0.50m below the topsoil level.

The results of the in-situ CBR tests are presented on the relevant hand excavated inspection pit logs in **Annex D** and should be referred to for specific depth related values.

3.9 Laboratory Chemical Testing

During the recent site works six soil samples were taken and despatched to the laboratories of DETS for laboratory chemical testing.

The following standard chemical testing suite for common contaminants was undertaken:

Metals	Semi Metals/Non-Metals	Organic Chemicals
Cadmium	Arsenic	Phenol
Chromium	Selenium	Poly-Aromatic Hydrocarbons (PAH)
Hexavalent Chromium	Boron	Extractable Petroleum Hydrocarbons (EPH)
Lead		
Mercury	Inorganic Chemicals	
Thiocyanate	Cyanide	
Nickel	Sulphate	Others
Zinc	Sulphide	pH (acidity)
Copper	Ammoniacal Nitrogen	Asbestos

In order to assess the aggressiveness of the soil deposits underlying the site, three samples were also tested for the BRE Reduced SD1 Suite and pH and Sulphate Testing.

The results of the above soil chemical tests are presented in **Annex F** and evaluated in Section 4.

3.10 Soil Property Testing

Twelve bulk samples were collected, and dispatched to the laboratories of GSTL for soil property testing. The following soil property tests were undertaken:

3.10.1 Classification Testing

In order to assess classification characteristics underlying the site bulk samples were collected and dispatched to the laboratories of GSTL for Moisture Content, Plasticity Index (PI) tests and Particle Size Distribution (PSD) testing.

In addition, four samples were also tested for the BRE Reduced SD1 Suite and pH and Sulphate Testing.

The test results are presented in **Annex G** and the results are discussed in Section 5.

SECTION 4 Chemical Testing Results

4.1 Evaluation of Analytical Results

The future use of the site i.e. whether it is to be used for residential or commercial has an impact on any risk assessment. In the case of this development the site is to be used for educational development.

Given the working criteria of a school and that development proposals do not include any garden areas, all soil test results have been compared to thresholds for commercial/industrial development.

4.1.1 Soils

A summary of the chemical test results compared with generic regulatory guideline levels are given in Table 4.1 on the following page:

4.1.1 Soils (Continued)**Table 4.1 Summary of Chemical Test Results: General Contaminants**

Substance	SGV/SSV (mg/kg)	Source	Measured Concentrations of Tested Substances (mg/kg)		Number of exceedences	95% UCL ***
			Minimum	Maximum		
Arsenic	640	C4SL	6.5	13	0	-
Cadmium	410	C4SL	<0.1	0.3	0	-
Boron	192000	CIEH	0.5	1.6	0	-
Chromium	5000	CLEA	12	30	0	-
Chromium VI	49	C4SL	<1.0	<1.0	0	-
Lead	1100	C4SL	15	120	0	-
Mercury	3600	CLEA	<0.05	0.18	0	-
Ammoniacal Nitrogen as N	570	GAC	10	13	0	-
Selenium	13000	CLEA	<0.5	<0.5	0	-
Copper	71700	CIEH	12	28	0	-
Nickel	1800	CLEA	8.7	13	0	-
Thiocyanate	170	CLEA	<0.6	1.7	0	-
Zinc	665000	CIEH	35	90	0	-
Total PAH**	-	-	<1.6	290	-	-
Total Cyanide	480	CLEA	<0.1	0.2	0	-
Free Cyanide	-	-	<0.1	<0.1	-	-
Phenols	3200	CLEA	<0.3	0.8	0	-
Sulphate	2400*	BRE	200	2000	See concrete assessment	-
Sulphide	-	-	<10	12	-	-
Sulphur	-	-	<0.01	0.07	-	-
Organic Matter	-	-	0.4	2.2	-	-
pH	6-9	-	8.1	11.3	0	-
EPH (C10–C40)	10000****	CIEH	<10	4900	0	-

Table 4.1 Notes:

- C4SL – Provisional Category 4 Screening Levels for commercial development
- CLEA - Soil guideline values for commercial/industrial development

4.1.1 Soils (Continued)

- CIEH – Chartered Institute of Environmental Health Land Quality Management Generic Assessment Criteria (based upon worse-case 1% SOM content) for commercial development
- GAC – generic assessment criteria calculated using the CLEA model
- PAH – Poly-Aromatic Hydrocarbons
- BRE - Building Research Establishment - Considered in concrete aggressive assessment.
- * - Sulphate considered in assessment of concrete environment.
- ** See speciated PAH results
- *** 95% Upper Confidence Limit (UCL) statistical analysis not undertaken where there are no contaminant exceedences and/or insufficient number of samples
- **** - Based on worse-case CIEH guideline for Aliphatic C₁₀-C₁₂ fraction
- - No comparable target concentration / guideline value
- A total of six representative soil samples were tested for these substances

In addition, Asbestos screening on all six samples revealed NAD (No Asbestos Detected).

It should be noted that for contamination concentrations, which are measured to be lower than the detection limits, then the detection limit has been included in the statistical assessment.

In order to accurately assess the risk from Total PAH, further testing comprising speciation was also undertaken on samples where the total concentrations were above detection limits. Speciation splits the total PAH concentration into its sixteen components. It is important to know which components make up the total, as some are relatively harmless in comparison to others.

The speciated Poly-Aromatic Hydrocarbons (PAH) soil chemical test results are shown in Table 4.2 on the following page.

4.1.1 Soils (Continued)

Table 4.2 Summary of Soil Chemical Test Results – Speciated PAH						
Substance	GAC (mg/kg)	Source	Measured Concentrations of Tested Substances (mg/kg)		Number of exceedences	95% UCL *
			Minimum	Maximum		
Naphthalene	200	CIEH	<0.1	0.3	-	0
Acenaphthylene	84000	CIEH	<0.1	0.3	-	0
Acenaphthene	85000	CIEH	<0.1	4.4	-	0
Fluorene	64000	CIEH	<0.1	4.1	-	0
Phenanthrene	22000	CIEH	<0.1	35	-	0
Anthracene	530000	CIEH	<0.1	8.2	-	0
Fluoranthene	23000	CIEH	<0.1	61	-	0
Pyrene	54000	CIEH	<0.1	57	-	0
Benzo(a)anthracene	90	CIEH	<0.1	23	-	0
Chrysene	140	CIEH	<0.1	22	-	0
Benzo(b)fluoranthene	100	CIEH	<0.1	17	-	0
Benzo(k)fluoranthene	140	CIEH	<0.1	9.0	-	0
Benzo(a)pyrene	76	C4SL	<0.1	21	-	0
Dibenzo(a,h)anthracene	13	CIEH	<0.1	1.9	-	0
Benzo(g,h,i)perylene	650	CIEH	<0.1	14	-	0
Indeno(1,2,3-c,d)pyrene	60	CIEH	<0.1	13	-	0

Table 4.2 Notes:

- CIEH – Chartered Institute of Environmental Health Land Quality Management Generic Assessment Criteria (based upon worst-case 1% SOM content)
- C4SL – Provisional Category 4 Screening Levels for commercial development
- * - 95% Upper Confidence Limit (UCL) statistical analysis not undertaken on contaminants with no exceedences and/or insufficient number of samples
- A total of six samples were tested for these substances

4.1.2 Asphalt Testing

Three core samples (WS1, WS2 and WS3) of the asphalt within the site were taken and subjected to Polycyclic Aromatic Hydrocarbon spray testing.

The results of the PAH spray test revealed negligible PAH's present (<150ppm) within all cores of the asphalt at the site.

4.2 Contaminants of Concern in Soils

Contaminants of concern are those whose measured concentrations or 95% Upper Confidence Limit exceeds the relevant Tier 1 CLEA Soil Guideline Value or CIEH Generic Assessment Criteria.

It should be noted that elevated levels of PAH were encountered within WS1 and WS2 which can possibly be attributed to small fragments of asphalt dragged down into the windowless samples as a result of pre-commencement asphalt coring in these specific locations. However, from Tables 4.1 and 4.2 no chemicals are present in unacceptable concentrations for a commercial development and all results were below the Tier 1 guideline values. Therefore the site as a whole can be considered uncontaminated.

It should also be noted that as a precaution, it is recommended that no garden areas or vegetable plots should be considered within the localised area of WS1 and WS2.

4.3 Waste Acceptance Procedure

Any materials to be removed from site should be subject to the Waste Acceptance Procedure (WAP) in order to appropriately classify the waste for the correct type of landfill.

Based on the results of the WAC testing, the shallow deposits from TP2 @ 0.50m have been classed as inert waste. However, the level of TPH (C10-C40) from TP1 @ 0.30m was slightly above the inert waste limit values.

In addition, TPH levels taken from samples at WS1 and WS2 and PAH levels from WS2 were elevated above the guidelines for inert waste and material from these areas would be classed as hazardous.

It is recommended that all results are sent to the receiving landfill for confirmation before haulage.

The results of the WAC testing have been included in **Annex E**.

SECTION 5 Geotechnical Laboratory Testing

5.1 Classification Testing

A summary of the plasticity and moisture content results is presented below. The laboratory test results are presented in **Annex G**.

Table 5.1 Plasticity and Moisture Content Test Results							
Sample No.		Stratum	Plasticity Index (%)	% <0.425mm	Modified PI (%)	Moisture Content (%)	Shrinkage Potential
TP1	1.00m	River Terrace	19	82	15.58	8.4	Low
TP2	1.00m	River Terrace	NP	31	-	6.1	None
WS1	1.30m	River Terrace	NP	19	-	19	None
WS1	1.80m	London Clay	46	100	46	27	High
WS2	1.00m	River Terrace	21	34	7.14	22	None
WS2	2.00m	London Clay	21	100	21	21	Medium
WS3	0.80m	River Terrace	NP	13	-	8.4	None
WS3	2.40m	London Clay	16	100	16	22	Medium
WS4	1.00m	River Terrace	NP	18	-	10	None
WS4	3.75m	London Clay	47	100	47	31	High
WS5	0.90m	River Terrace	NP	20	-	11	None
WS5	1.50m	London Clay	37	100	37	34	Medium

Table 5.1 Notes:

- NP – Non-Plastic

The results of the plasticity testing reveal that the underlying River Terrace deposits exhibit typically no to low plasticity and moisture content of between 6.1% and 22%. The underlying London Clay Formation exhibits typically medium to high plasticity and a moisture content of between 21% and 34%.

A summary of the particle size distribution test results is presented below. The laboratory test results are presented in **Annex G**.

Table 5.2 Particle Size Distribution Test Results						
Sample No.		Stratum	Soil Fraction (Total %)			
			Cobbles	Gravel	Sand	Silt/Clay
WS1	1.30m	River Terrace	0	73	13	14
WS2	1.00m	River Terrace	0	60	9	31
WS3	0.80m	River Terrace	0	83	7	10
WS4	1.00m	River Terrace	0	78	7	15
WS5	0.90m	River Terrace	0	76	7	17

5.1 Classification Testing (Continued)

Table 5.2 Notes:

- For full % Passing results see Annex G

The results show that the underlying River Terrace deposits comprise cobble fractions of zero, gravel fractions of between 60% and 83%, sand fractions of between 7% and 13% and silt/clay fractions of between 10% and 31%.

A summary of the BRE SD1 Suite test results is presented below. The laboratory test results are also presented in **Annex G**.

Table 5.3 BRE SD1 Suite Test Results					
Sample No.		Stratum	Water Soluble Sulphate as SO₄ (mg/l)	Total Sulphur (%)	pH Value
WS1	1.30m	River Terrace	20	0.05	9.06
WS2	1.00m	River Terrace	30	0.12	7.86
WS2	2.00m	London Clay	30	0.11	7.95
WS5	0.90m	River Terrace	30	0.06	8.03

The results of the BRE SD1 Suite testing reveal that the underlying River Terrace deposits comprises of Water Soluble Sulphate as SO₄ values of between 20 and 30mg/l and between 0.05 and 0.12% Total Sulphur. The pH values varied between 7.86 and 9.06. The underlying London Clay Formation comprises of Water Soluble Sulphate as SO₄ values of 30mg/l and 0.11% Total Sulphur. The pH value was 7.95.

SECTION 6 Engineering Recommendations

6.1 Preparation of Site

Prior to the main site works, any buildings to be demolished should be subject to a full asbestos survey.

A structural survey should be undertaken of any existing buildings and structures (road and pavement structures,) including pictorial records. This should be updated throughout the site development phases.

Any existing buildings, foundations, floor slabs, concrete/tarmac hard standings beneath the proposed buildings should be broken up and removed from site and disposed of at a suitable landfill facility. Alternatively, the crushed site won materials may be re-used as structural fill, subject to laboratory chemical testing.

Significant allowances should be made for dealing with any historic foundations, floor slabs, basement structures and other buried obstructions.

The existing grass and scrub vegetation, including all roots and any trees to be removed (and not subject to preservation orders) should be grubbed up and removed from beneath the proposed buildings and roadways.

The reduced levels should be brought up to the required levels with well, compacted imported granular materials. Department of Transport (DoT) Type 2 sub-base or similar may be used and should be compacted in layers, in accordance with the Specification for Highway Works. Alternatively, appropriate selected inert imported fill could be used.

Allowances should be made for removing any 'soft spots/area' and their replacement with well compacted granular materials as previously described. The excavated materials will be unacceptable as structural fill and should be removed from site and taken to an appropriately licensed tip.

All materials to be removed from site should be subject to the appropriate Waste Acceptance Protocol (WAP) and taken to an appropriately licensed tip.

Significant contingencies should be made for the protection/diversion of any underground services present beneath the site brought about as a result of the proposed works.

Contingencies should also be made for the protection and any necessary temporary/permanent support of nearby walls.

6.2 Foundation and Floor Slab Solution

The soil sequence beneath the proposed development consisted of made ground, comprising either asphalt and sub-base, or grass over brown, orange brown and grey silty sandy gravelly clay to a depth of between 0.20m and 1.20m. The made ground was underlain by River Terrace deposits typically comprising dense to very dense silty very clayey gravels of flint to a depth of between 1.40m and 2.00m. The River Terrace deposits were underlain by the London Clay Formation comprising firm to stiff, locally soft, brown becoming dark grey silty, locally sandy clay to the maximum investigated depth of 5.00m.

The underlying made ground is variable in respect to their geotechnical properties and if foundations were extended into this stratum it would lead to unacceptable levels of differential settlement.

6.2 Foundation and Floor Slab Solution (Continued)

Therefore, we recommend that mass concrete strip/trench foundations be extended into the underlying River Terrace deposits comprising typically dense to very dense silty very clayey gravels of flint.

The depth to the above in-situ founding horizons is likely to vary between typically 0.20m and 1.20m below the existing ground level.

For the above foundations founded within the River Terrace deposits, an allowable bearing pressure of 100kN/m² may be used for design purposes. This value is considered conservative in order to minimise the risk of overstressing the underlying London Clay Formation which was found to be locally soft. However, it is recommended that the foundations be founded as shallow as possible.

It should be noted that the founding horizon for each block construction should be solely within the River Terrace deposits and not span across a change in ground conditions.

For the given foundation solution and bearing pressure, maximum total settlements of 25mm should result, with differential movements (δ/l) of the superstructure not exceeding 1:750 where δ is the differential settlement between two points of a foundation and l is the distance between these points.

Plasticity tests, summarised in Section 5.1, show the shallow cohesive residual deposits beneath the site exhibit typically no shrinkage potential. Therefore, given the foundation solution recommended above, to avoid damage from frost heave and or thermal shrinkage, the base of the foundations should lie at least 450mm below final ground level, or sit on non-frost susceptible material extending to this depth.

Minimum founding depths for building foundations within chalk will need to be 450 mm below finished ground level as a precaution against frost action in accordance with the current building regulations.

It is also recommended that the foundations achieve a minimum penetration of 200mm into the above in-situ materials.

In addition, it should be noted that deeper foundation depths than those quoted above may be required close to the tree root system of the trees located around the site.

If design loads of the floor slabs are less than or equal to typically 5kN/m² (imposed load), floor slabs can be designed as ground bearing provided the following recommendations are adhered to:

- Floor slab is designed of adequate strength and durability,
- Uses concrete mixed and reinforced as necessary to support floor loads safely and resist chemical and frost action,
- Is a minimum of 100mm thick, and
- All soft spots/areas are removed from the formations and replaced with well compacted granular materials.

Alternatively, the floor slabs can be designed as suspended.

Allowances should be made for the removal of any 'soft spots' and their replacement with a suitable concrete mix or well-compacted granular material in layers to the specification for Highway Works.

6.2 Foundation and Floor Slab Solution (Continued)

All foundation formations should be inspected by a suitably qualified Engineer before being concreted.

6.3 Excavations and Formations

Most shallow excavations should be possible with normal soil excavating machinery, although significant allowances should be made for a hydraulic breaker when excavating out any historic foundations, concrete floor slabs and other buried obstructions.

Perched groundwater strikes were encountered within WS3, WS4 and WS5 at a depth of between 1.60m and 2.70m. Therefore, excavations may encounter groundwater inflows. The slow inflows should be dealt with by conventional pumping techniques.

It should also be noted that during times of high rainfall a higher groundwater table may be encountered.

The sides of any excavations deeper than 1.00m, especially within any granular deposits, should be supported by planking and strutting or other proprietary means.

The sub-formations/formations will be susceptible to loosening, softening and deterioration by exposure to weather (rain, frost and drying conditions), the action of water (flood water or removal of groundwater) and site traffic. As a minimum the formation/base of excavations must be protected by concrete blinding or a minimum thickness of 200mm of hard-core immediately after exposure.

Formations should never be left unprotected and continuously exposed to rain causing degradation, or left exposed/uncovered overnight, unless permitted by a qualified engineer.

Construction plant and other vehicular traffic should not be operated on unprotected formations.

As a minimum the formation/excavation surfaces must be protected by a minimum thickness of 200mm of hard cover immediately after exposure.

Allowances should be made for trimming, re-trimming and re-compaction if necessary and for the removal of soft spots and their replacement with well compacted granular materials.

It is also recommended that if concerns still remain then a number of plate loading tests are carried out at formation level to confirm the suitability of the formations.

Allowances should be made for special precautions to prevent formation deterioration in addition to the above.

It is recommended that approval be gained from a qualified engineer of the formation condition before covering them with any subsequent construction.

6.4 Earthworks

As summarised in Section 5.1 soil property testing comprising Particle Size Distribution (PSD) and Plasticity (PI) testing was undertaken on natural samples across the site.

Based on the above testing and due to the varying nature of the underlying deposits, two classes should be adopted for any proposed earthworks:

6.4 Earthworks (Continued)

Cohesive 'Natural' Deposits

- Class 2B (General Cohesive Fill)

Granular 'Natural' Deposits

The particle distribution curves showed that the shallow granular deposits will conform to the following classes as defined in the Specification of Highways Works (1992):

- Class 1B (General Granular Fill)

It is likely that the in-situ materials can be used as structural fill. This material should be placed at or close to its optimum moisture content/maximum dry density and compacted in layers as per the requirements of the Specification for Highway Works, Table 6/4 Method 3 for granular material and Table 6/4 Method 2 for cohesive material. These requirements should be followed by the appointed groundwork's contractor.

In order to reduce the risk of structural failure it is recommended that the roller compaction plant should not transfer any load onto the adjacent foundations. An exclusion zone extending from a 45° angle from the base of the foundations should be used.

Where the roller compaction plant is unable to compact the fill due to this exclusion zone a vibrating plate compactor or vibro-tamper should be used.

6.5 New Access Road and Car Parking Areas

The in-situ CBR tests (2No) were carried out using a MEXE probe. The probes were typically sunk to a depth of 0.50m from below the topsoil level.

The in-situ CBR test results are presented on the relevant hand excavated inspection pit logs in **Annex D** and should be referred to for specific depth related values.

Allowances should be made for the removal of any soft spots and their replacement with well-compacted imported granular materials as previously described.

6.6 Storm Drainage

Three in-situ permeability/soakaway test was undertaken, in accordance with the requirements of BRE 365 and/or BS 5930:1999+A2:2010 (Section 4). The infiltration rates are as follows:

Table 6.1 Permeability Test Results			
Soak away Test	Depth (m)	Soil Type	Soil Permeability (m/s)
TP1	1.60	River Terrace	8.93×10^{-06}
TP2	1.80	River Terrace	1.43×10^{-06}
HDTP5	0.50	Made Ground	3.20×10^{-06} (1st Fill)
			2.89×10^{-06} (2nd Fill)

The shallow ground conditions encountered across the site typically comprised silty clayey gravels over silty sandy clay, both with specific bulk properties. Therefore, during drainage design, consideration should be given to the variability encountered across the site.

6.6 Storm Drainage (Continued)

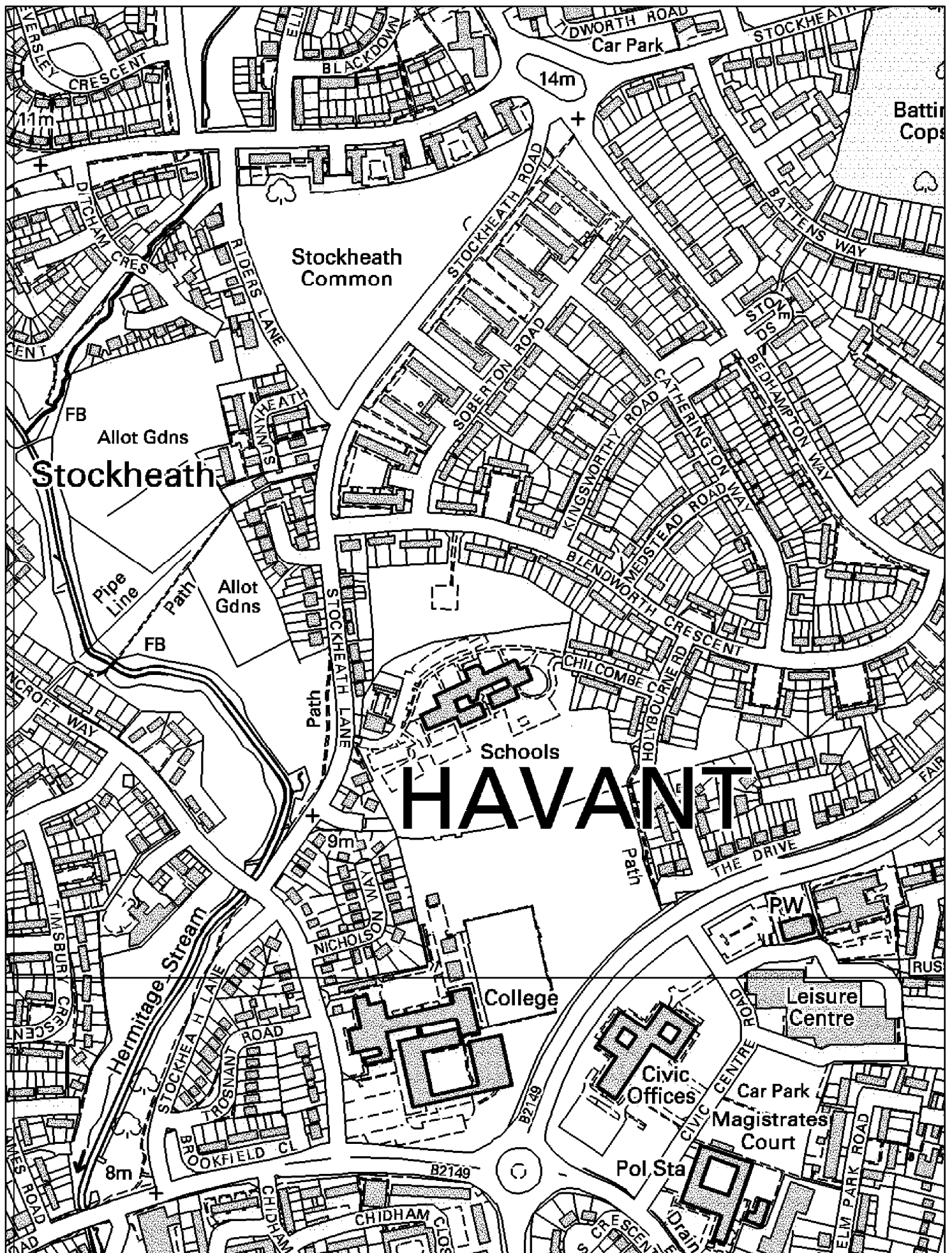
It should also be noted that relatively shallow groundwater levels were encountered across the site, as detailed in Section 3.6 and therefore soakaways would only be effective above this depth.

6.7 Protection of Buried Concrete

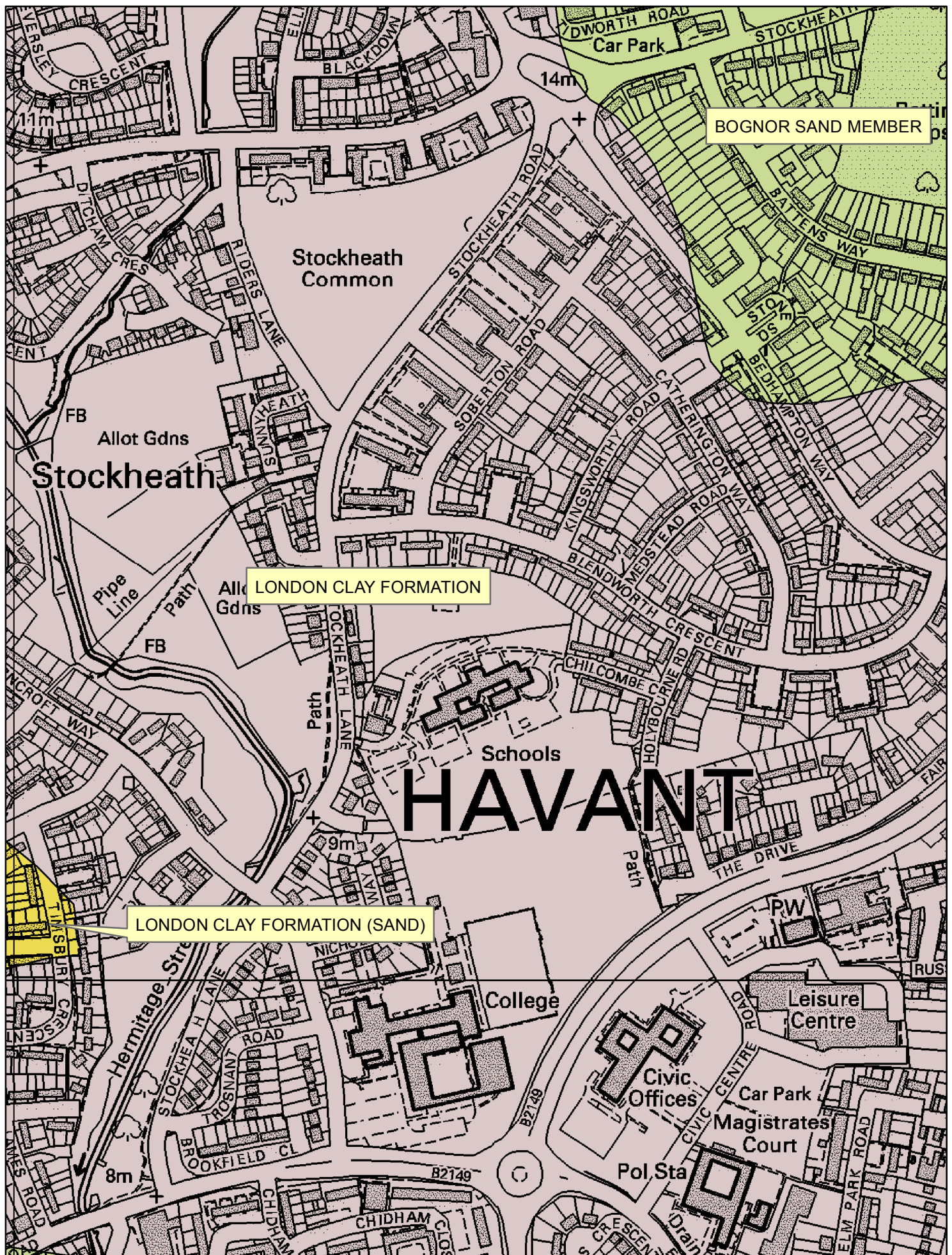
The laboratory chemical tests revealed total sulphate contents within the shallow deposits of between <10mg/l and 140mg/l, and pH values variable between 7.86 and 11.3.

Therefore, all buried concrete should, as a minimum, conform to Class AC-1 of BRE Special Digest 1 (2005).

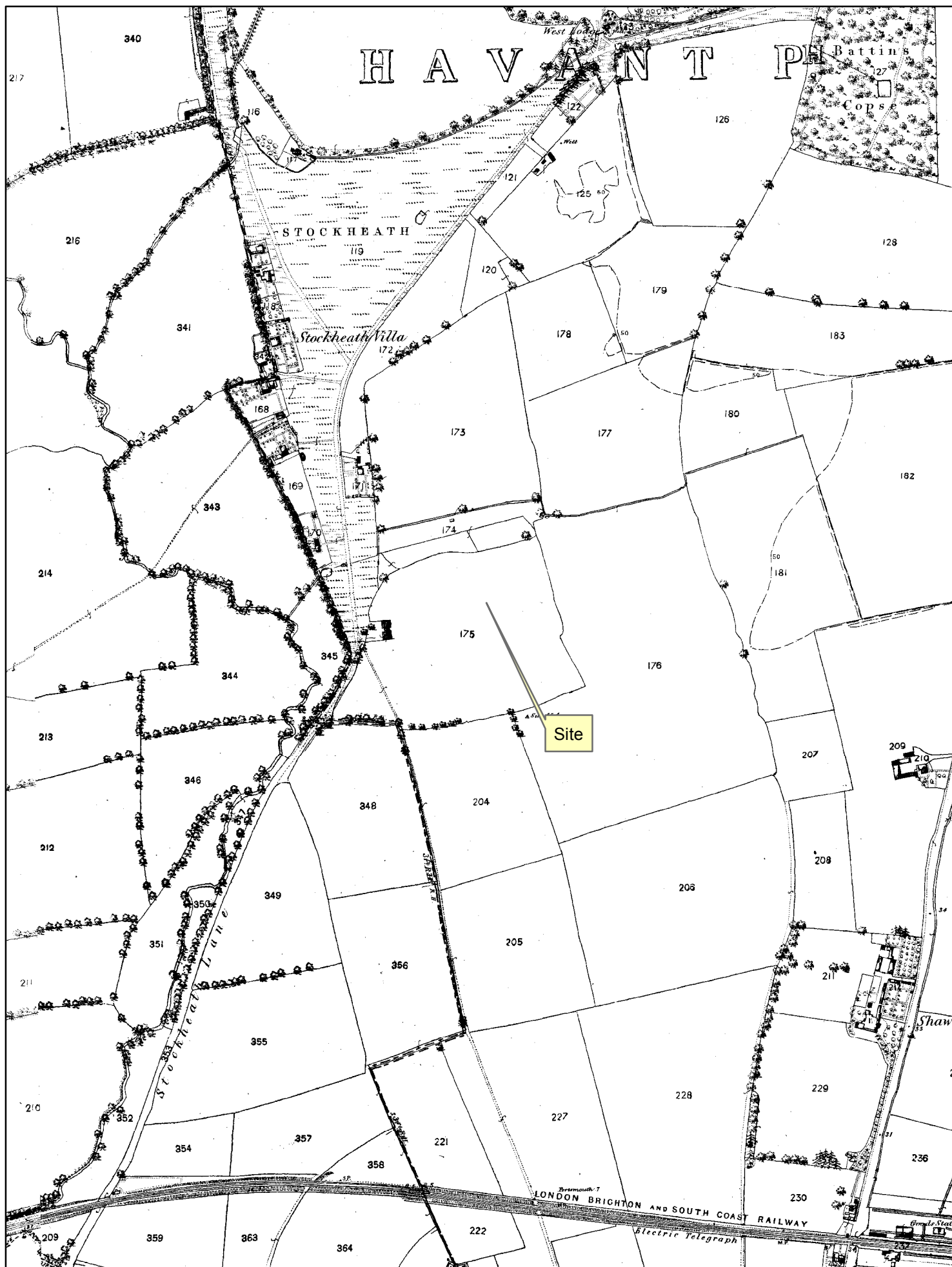
ANNEX A
Desktop Plans



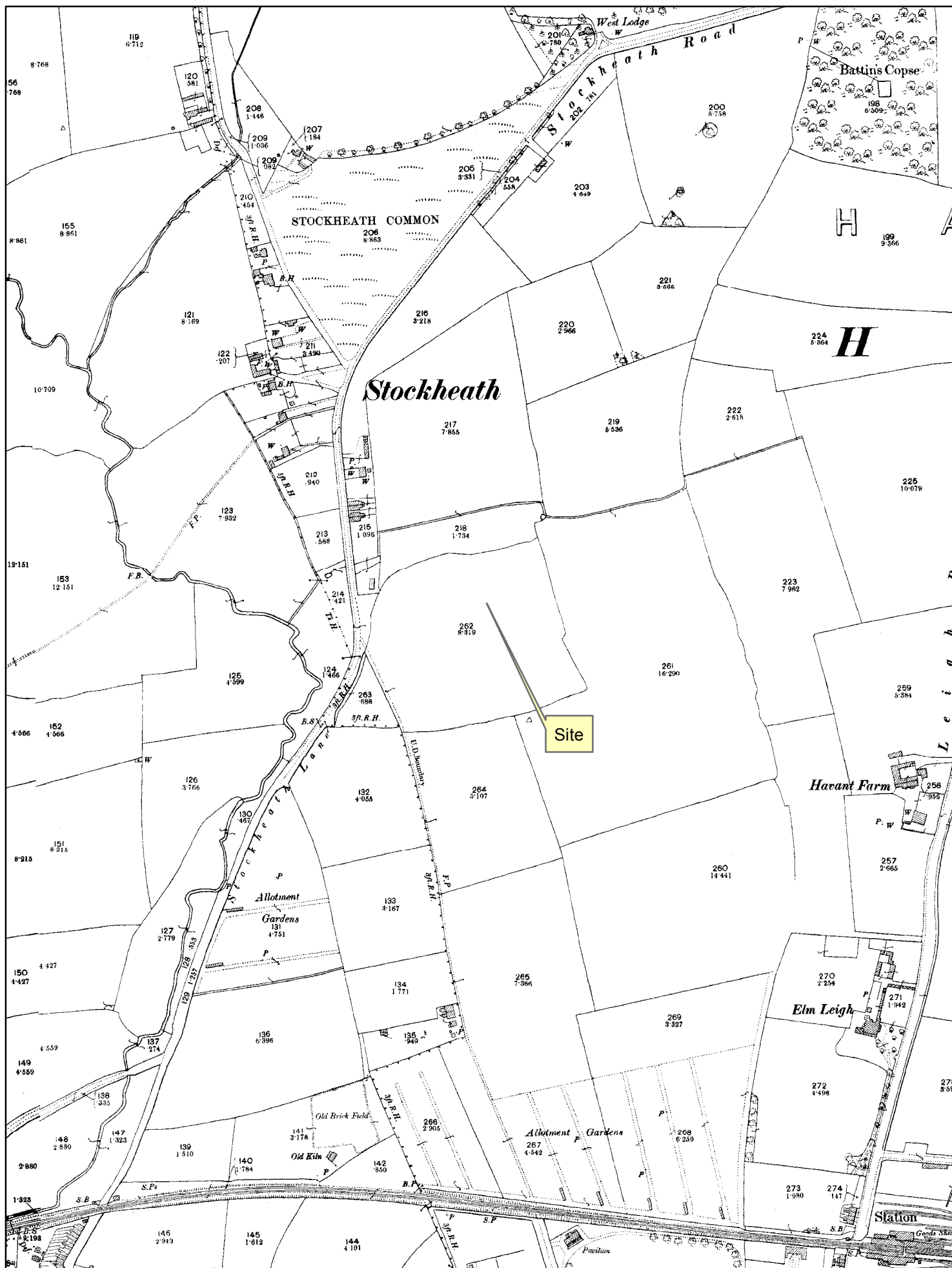
Trosnant Infant and Junior School
Site Location



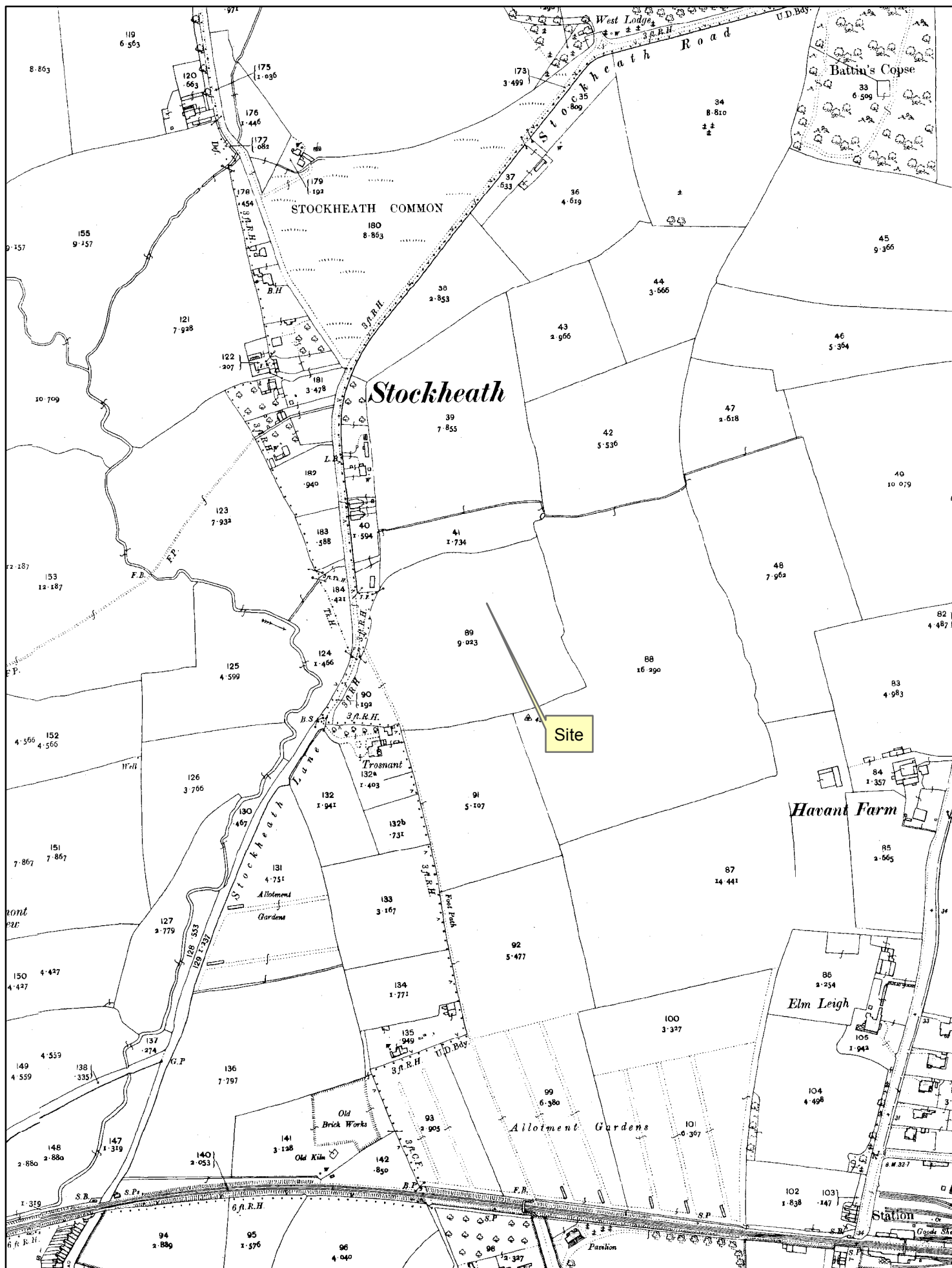
Trosnant Infant and Junior School Bedrock Geology



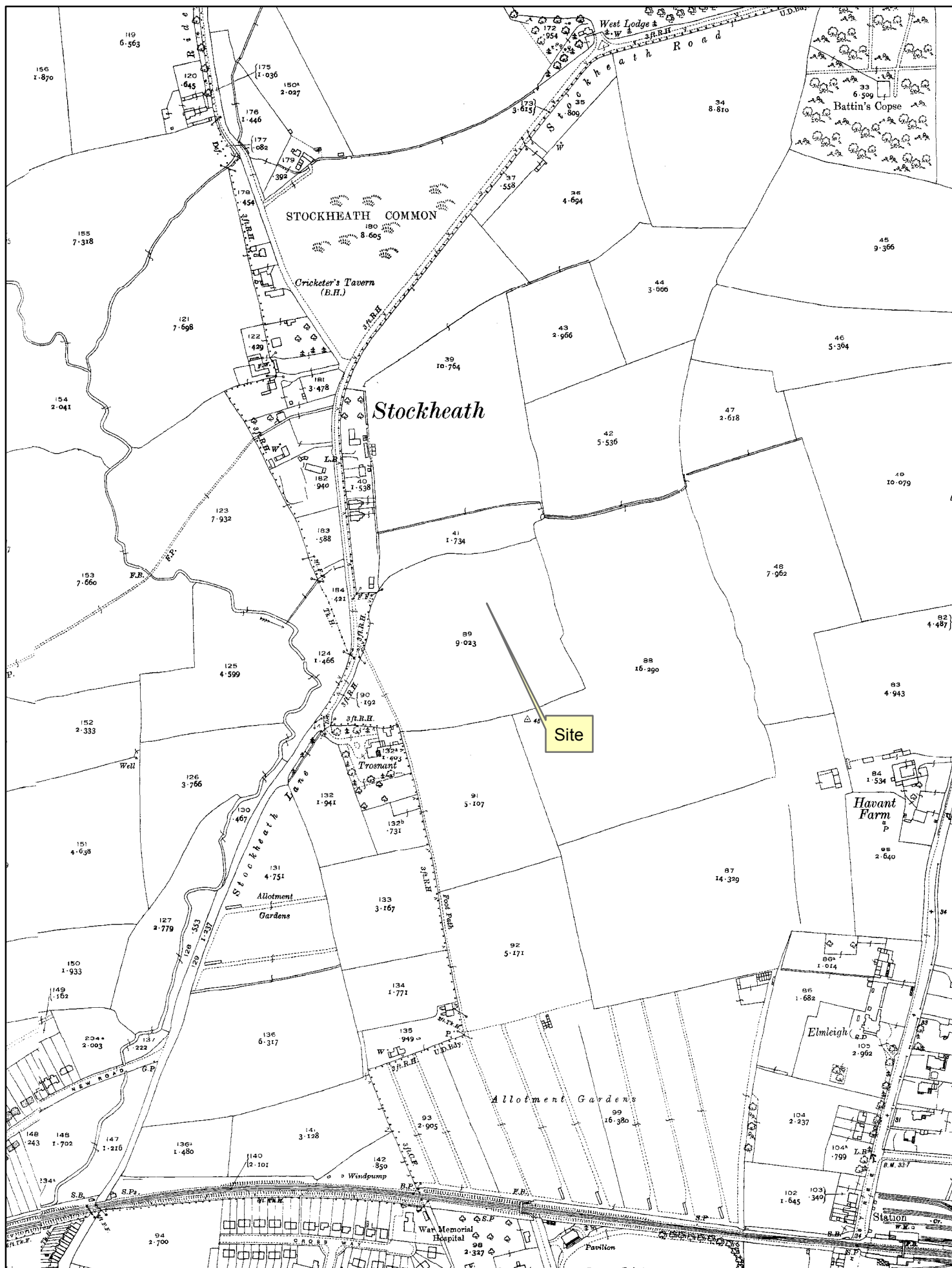
Trosnant Infant and Junior School
Epoch 1 1843 - 1893



Trosnant Infant and Junior School Epoch 2 1891 - 1912



Trosnant Infant and Junior School Epoch 3 1904 - 1939



Trosnant Infant and Junior School Epoch 4 1919 - 1943

ANNEX B
Mini Percussive Borehole Logs



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Borehole No.

WS1

Sheet 1 of 1

Project Name: Trosnant Primary School

Project No.
5715

Co-ords:

Hole Type
WLS

Location: Havant, Hampshire

Level:

Scale
1:50

Client: Hampshire County Council

Dates: 02/06/2016

Logged By

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.40	ES		0.10 0.15			MADE GROUND: Asphalt MADE GROUND: Brown to pink limestone hardcore MADE GROUND: Medium dense brown to orange brown with black inclusions silty very clayey very gravelly SAND. Gravel is of sub-angular flint. Occasional concrete and ash	
		1.00	SPT	N=36 (1,1/8,11,9,8)	1.05 1.20			MADE GROUND: Soft dark grey silty CLAY Dense to very dense brown to orange brown silty very clayey GRAVELS. Gravels are sub-angular of flint.	1
		1.30	B						
		1.80	B		1.70				
		2.00	SPT	N=16 (2,3/4,4,4,4)				Firm to stiff brown becoming grey (below 3.6m) silty CLAY	2
		3.00	SPT	N=6 (1,1/2,2,1,1)					3
		4.00	SPT	N=9 (1,1/2,2,2,3)					4
		5.00	SPT	N=12 (1,1/2,2,2,6)	5.00			End of Borehole at 5.00m	5
									6
									7
									8
									9
									10

Remarks

PAK Test = Negative



Project Name:	Trosnant Primary School	Project No.	5715	Co-ords:		Hole Type	WLS
Location:	Havant, Hampshire	Level:		Scale	1:50	Logged By	
Client:	Hampshire County Council	Dates:	02/06/2016				

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.30	ES		0.10 0.25			MADE GROUND: Asphalt	
								MADE GROUND: Light brown and yellow SAND	
								MADE GROUND: Soft brown silty sandy gravelly CLAY. Gravels are sub-angular of flint and brick	
		1.00 1.00	B SPT	N=43 (4,6/10,11,12,10)	0.70			Very stiff brown, orange brown and grey silty sandy very gravelly CLAY. Gravels are sub-angular of flint.	1
		2.00 2.00	B SPT	N=15 (1,2/3,2,5,5)	1.70			Firm to stiff brown becoming grey (below 3.4m) silty CLAY	2
		3.00	SPT	N=11 (1,2/2,3,3,3)					3
		4.00	SPT	N=14 (2,2/3,3,4,4)					4
		5.00	SPT	11 (1,2/3,3,5,)	5.00				5
								End of Borehole at 5.00m	
									6
									7
									8
									9
									10

Remarks
PAK Test = Negative



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Borehole No.

WS3

Sheet 1 of 1

Project Name: Trosnant Primary School

Project No.
5715

Co-ords:

Hole Type
WLS

Location: Havant, Hampshire

Level:

Scale
1:50

Client: Hampshire County Council

Dates: 02/06/2016

Logged By

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.25	ES		0.10			MADE GROUND: Asphalt	
					0.40			MADE GROUND: Brown silty very sandy gravelly CLAY. Gravel is of sub-angular flint and ash	
		0.80	B					Very dense brown to orange brown silty very clayey GRAVELS / very stiff silty very gravelly CLAY. Gravels are angular of flint.	1
		1.00	SPT	N=50 (9,14/15,14,12,9)					
		2.00	SPT	N=8 (4,4/2,2,2,2)	2.00			Firm to locally soft brown to orange brown silty very sandy CLAY	2
		2.40	B						
		3.00	SPT	N=9 (2,2/2,2,2,3)					3
					3.60			Firm to stiff dark grey silty CLAY	4
		4.00	SPT	N=8 (1,2/2,2,2,2)					
		5.00	SPT	N=9 (2,2/2,2,2,3)	5.00			End of Borehole at 5.00m	5
									6
									7
									8
									9
									10

Remarks

PAK Test = Negative

