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T. L. P. Ground Investigations Ltd.

Ground Investigation Report

Site: Proposed Residential Development, Lodge Moor Community Centre, Minster Road / Chesterfield Road, Scunthorpe, North Lincolnshire.

Client: Platform Housing Group and Villawood Homes Ltd.

Architects: Sangwin Architects.

Date: 16th December 2020.

Brief

A new residential development is proposed at the site presently occupied Lodge Moor Community Centre, located on Minster Road / Chesterfield Road, Scunthorpe, North Lincolnshire. In order to establish details of the prevailing ground conditions, TLP Ground Investigations Ltd. were requested to undertake a ground investigation at the site which was to include the following:

- The sinking of 1 No. exploratory borehole using percussive cable tool boring techniques.
- The sinking of 4 No. shallow sampling borehole using a track mounted dynamic sampling rig, taking undisturbed soil samples.
- Identification of the prevailing soil and groundwater conditions.
- Performing *in situ* penetration tests as the boreholes were advanced.
- Performing a 'falling head' (variable head) permeability test on one of the completed borehole in order to establish the relative permeability of the near surface stratum *in situ*.
- The provision of a brief report with borehole records and test results.

Site and Geology

The Lodge Moore Community Centre comprises an irregular shaped area of land located at the corner of Minster Road and Chesterfield Road in the western outskirts of the town of Scunthorpe in North Lincolnshire. The proposed development site forms part of the external recreational areas to the Lodge Moor Community Centre / Mister House. The western part of the proposed development site is currently given over to lawn grass and the eastern part of the site currently comprises a macadam surfaced tennis court area with perimeter wire fence. The western and southern boundaries to the site are definded by an approximately 2m high hawthorne hedge the northern and eastern boundaries are defined by pathways and the eastern wire fence to the tennis court. It is the intention to redevelop the site with community / affordable housing.

The British Geological Survey sheet for the area shows the superficial soils overlying the site as being represented by warp clays and silts. At slightly greater depth this rests on deposits of silty sand belonging to the Sutton Sand Formation. The underlying solid geology is represented by mudstones of the Mercia Mudstone Group which is of Early Triassic / Rhaetian age.

Fieldwork

The fieldwork was undertaken on the 9th December 2020 and involved the excavation of 4 No. shallow sampling boreholes which were extended to depths of between 2.35m and 2.45m below the ground surface using a track mounted dynamic sampling rig and the sinking of a deeper percussive cable tool boring to a depth of 15.00m below ground level.

The borings were located in order to provide an overview of the prevailing ground conditions beneath the area of the proposed residential development. These locations have been indicated on the enclosed borehole location plan and details of the strata encountered have been recorded on the enclosed borehole record sheets.

Undisturbed core samples were obtained from the shallow windowless sampling boreholes for subsequent examination and *in situ* tests were performed as the borings were advanced. In the percussive cable tool borehole, disturbed soil samples were obtained and *in situ* tests were performed as the borehole was advanced.

Ground Conditions

Made Up/ Disturbed Ground

2 No. of the shallow sampling boreholes and the deeper percussive cable tool boring were located within the grassed area in the western parts of the site. Here the borings initially encountered superficial deposits of brown, silty, sandy and clayey soil containing occasional fine stone fragments. These deposits extended to depths of between 0.10m and 0.50m beneath the surface. A further 2 No. shallow sampling bores were located within the disused tennis court in the eastern part of the site which is surfaced with tar macadam. Here the borings penetrated a thin skin of tar macadam resting on 'medium dense', fine to medium fragments of grey slag in a matrix of dark grey, gritty, sandy fines.

Warp / Sutton Sand Formation

At depths of between 0.10m and 0.68m, each of the borings penetrated deposits of Warp represented by 'firm' quickly becoming 'soft', brown, silty clay. In three of the borings this rested on a layer of 'very loose', **dark brown, fibrous and clayey peat**, which from the borehole data appeared to be distributed mainly across the southern parts of the site. Elsewhere the deposits of peat appeared to be absent. Where present, the deposits of peat varied between 300mm and 500mm in thickness and rested on deposits of **'loose'** becoming 'medium dense, mid brown, silty, fine sand. These deposits of sand quickly became **wet** and in the four shallow windowless sampling boreholes these saturated deposits extended to the full depth of borehole penetration some 2.35m to 2.45m beneath the surface. These deposits of sand are likely to belong to the Sutton Sand Formation.

In the deeper percussive cable tool boring, deposits of saturated, silty sand were encountered to a depth of 13.70m beneath the surface where they rested on weathered deposits of 'dense', pinkish brown, mottled greenish grey, weathered, silty, slightly clayey mudstone (Mercia Mudstone). It was in these competent deposits that the percussive borehole was terminated.

Groundwater

In the shallower windowless sampling boreholes and deeper percussive cable tool boring, ground water seepages were encountered at depths of between 0.90m and 1.20m beneath the surface. On

completion the groundwater levels in the open holes was measured at depths of between 0.62m and 0.93m beneath the surface.

In Situ **Testing - Geotechnical**

Hand vane tests were performed on the more cohesive (clayey) sections of the undisturbed soil cores recovered from the shallow windowless sampling boreholes and the results of the tests have been indicated on the enclosed borehole record sheets. Tests performed on samples recovered from the near surface silty clay (warp), recorded hand vane values quickly reducing from around 85kN/m^2 on samples recovered from the firmer *'crust'* to 22kN/m^2 on samples recovered from the soft, silty deposits at slightly greater depth.

In order to establish the relative compaction / strength of the strata *in situ*, Standard Penetration Tests (SPT's) were performed at regular intervals as the boreholes were advanced. The results of the tests have been interpreted as 'N' values (blows for 300mm penetration) and the results have been noted on the enclosed borehole record sheets. Tests performed within the layer of fibrous and clayey peat, recorded 'N' values ranging between 1 and 2 (uncorrected) indicating a 'very loose' state of compaction for the deposit. Tests performed in the underlying deposits of silty sand recorded values more typically between 6 and 25 were recorded, indicating a range in compaction between 'loose' and 'medium dense' for the deposit. A test performed within the deposits of weathered Mercia Mudstone encountered at a depth of 13.70m beneath the surface recorded an 'N' value of 34, indicative of a **'dense'** state of compaction for the deposit.

In order to establish the relative permeability of the near surface stratum, a 'falling head' (variable head) permeability test was performed within 1 No. completed borehole at the location of BH2. A length of slotted standpipe was inserted into borehole and the annulus around the standpipe was surrounded with well screen gravel in order to prevent the side walls of the boring from collapsing during the test.

At the start of the test, the test hole was quickly filled to the surface with water and then the time taken for the water to dissipate from the hole was subsequently monitored. The results of the tests have been tabulated on the enclosed spread sheet and illustrated on the enclosed percolation graph.

The results of the tests indicate a soil infiltration of 4.95 x 10^{-2}mm/s for the silty which is indicative of a 'moderate' rate of soil infiltration.

A chemical tests performed on representative sample of the near surface soils, recorded a water-soluble sulphate concentration of 0.01g/l (2:1water / soil extract) with pH of 7.4.

Engineering Comments Geotechnical

Ground Conditions

The borings have revealed that beneath a superficial covering of disturbed or made ground, the site of the proposed residential development is underlain by deposits of silty clay (Warp). This initially comprised a 'firm' or 'firm to stiff *'crust'* of silty clay, however, this quickly deteriorated to a soft consistency and in three of the five boreholes was underlain by 'very loose', dark brown, fibrous and clayey peat. The deposits of peat / silty clay were underlain by deposits of **wet**, loose to 'medium dense' silty, medium sand. These deposits of saturated, silty sand were found to extend to a depth of 13.70m depth where they rested on the weathered surface of the underlying 'dense' Mercia Mudstone.

Foundation Recommendations

The presence of soft clays and highly compressible peat at shallow depth beneath the surface make it **unlikely that conventional strip / trench fill or even surface raft foundations would provide a satisfactory bearing solution for the new dwellings intended at this site**. Whilst peaty deposits were not encountered in all of the borings, there is the possibility that pockets of peat may, nevertheless, be present between the borehole locations. The soft clays and peat are underlain by deposits of silty sand and whilst the sand could be considered a potential bearing stratum for shallow foundations, in places it

is initially only loose in compaction and very quickly becomes **saturated**. Excavation to construct foundations within these unstable deposits could therefore be problematical and would certainly require the provision of dewatering facilities and trench supports to ensure that construction can proceed under optimum conditions.

To avoid constructing excavations within wet and unstable deposits, it may be prudent to consider employing piled foundations with the piles generating the required 'carrying capacity' from adequate penetration into the deposits of **medium dense** silty sand, or if higher piles loads, using a fewer number piles is the preferred option, then the piles may need to be extended into the dense mudstone below 14.00m depth. The carrying capacity of piles is fundamentally related to their method of installation and therefore advice should be sought from experienced piling contractors in order to establish the most appropriate type and length of pile to adopt given the prevailing geological conditions. However, bearing in mind the residential location of the site and the weak and compressible nature of the near surface deposits the use of a lighter mini piling rig may be more appropriate than a heavier machine which drives pre-cast concrete piles.

Initial estimates would suggest that a 200mm to 220mm driven and cast in situ, steel cased mini pile, terminated within 'dense' deposits of weathered Mercia Mudstone at a depth of around 15.00m beneath the surface should be capable of generating a safe carrying capacity of at least 200kN. Piles terminated within the overlying 'medium dense' sand may have a lesser carrying capacity, the magnitude of which may be more accurately assessed by installing a number of test piles.

Ground Floor Construction

Given the highly compressible nature of the near surface deposits at this site, the use of a fully suspended ground floor construction will be more appropriate than one which is ground bearing.

Design Sulphate Classification

A chemical tests performed on representative sample of the near surface soils, recorded a water-soluble sulphate concentration of 0.01g/l (2:1water / soil extract) with pH of 7.4. In accordance with the guidelines contained in Part 1 of the Digest and taking into account the geology and specific soil and groundwater conditions the site can be assigned a Design Sulphate Class DS-1 and an ACEC (Aggressive Chemical Environment for Concrete) Class AC-1.

TLP Ground Investigations Ltd

R. L. Trattles B.Sc. M.Sc. Ref. RT/VHL/SA/MRS/12/2020

Borehole Location Plan

Proposed Residential Development, Chesterfield Road, Scunthorpe, North Lincolnshire

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Proposed Residential Development, Chesterfield Road, Scunthorpe, North Lincolnshire

T.L.P. Ground Investigations Ltd.	**Borehole Record** Dynamic Probe / Sampler.	**Location :** Proposed Residential Development, Chesterfield Road, Scunthorpe.	**Borehole No.** BH1.
Carried out For Villawood Homes Ltd.		Ground Level	Co-ordinates	Date : 09.12.20

Description	Reduced Level	Legend	Depth & Thickness	Samples/Tests: Depth	samples: Type	samples: No.	Test	Field Records
Grass over loose, brown, silty, slightly sandy and clayey **Topsoil** containing occasional fine stones.			(0.40)	0.00 - 0.85	U	1	S N7	
Topsoil			0.40					
Mid brown, silty **Clay.**			(0.25)					
Warp			0.65					
Very loose, dark brown, clayey and fibrous **Peat.**			(0.40)	0.85 - 1.95	U	2	S N1	
Very loose, dark brown, organic, slightly clayey **Sand.**			1.05 (0.20)					
Medium dense, mid brown, silty, medium **Sand** containing traces of raw wood and woody peat.			1.25 (0.55)	1.30	D	1	S N10	
Medium dense, mid brown, silty, medium **Sand**.			1.80	1.95	D	2	S N16	
			2.40 **End of Borehole**					

Observations

Groundwater seepages were encountered at a depth of around 1.05m depth. On completion groundwater level subsequently measured at 0.62m beneath the surface.

S.P.T. : Where full penetration has not been achieved the number of blows for the quoted penetration is given (Not 'N' value)

Depths: All depths and reduce levels in metres. Thickness given in brackets in depth column.

Samples/Test Key.

D Disturbed Sample
B Bulk Sample
W Water Sample
U Undisturbed Core sample
S Standard Penetration Test
V Vane Test

Remarks

Logged by S. P. T. / J. T.

Scale 1 : 25

Fig.

T.L.P. Ground Investigations Ltd.	**Borehole Record** Dynamic Probe / Sampler.	**Location :** Proposed Residential Development, Chesterfield Road, Scunthorpe.	**Borehole No.** BH2.
Carried out For Villawood Homes Ltd.		Ground Level	Co-ordinates	Date : 09.12.20

Description	Reduced Level	Legend	Depth & Thickness	Samples/Tests: Depth	samples: Type	samples: No.	Test	Field Records
Grass over loose, brown, silty, slightly sandy and clayey **Topsoil** containing occasional fine stones.			(0.10)	0.00 - 0.75	U	1	S N8	
Topsoil			0.10					
Firm to stiff, quickly becoming soft, brown, silty **Clay.**			(0.85)	0.50			Vane	85kN/m²
Warp				0.75 - 1.90	U	2	S N9	
				0.90			Vane	22kN/m²
Loose becoming medium dense, mid brown, silty, medium **Sand**.			0.95					
				1.90	D	2	S N18	
			2.35					
			End of Borehole					

Observations

Groundwater seepages were encountered at a depth of around 1.00m depth. On completion groundwater subsequently measured at 0.93m beneath the surface.

In order to establish the relative permeability of the near surface stratum in situ, a 'falling head' (variable head) permeability test was performed. The results of the tests are tabulated on the enclosed data sheets and presented on the enclosed percolation graphs.

S.P.T. : Where full penetration has not been achieved the number of blows for the quoted penetration is given (Not 'N' value)

Depths: All depths and reduce levels in metres. Thickness given in brackets in depth column.

Samples/Test Key.

D Disturbed Sample
B Bulk Sample
W Water Sample
U Undisturbed Core sample
S Standard Penetration Test
V Vane Test

Remarks

Logged by S. P. T. / J. T.

Scale 1 : 25

Fig.

T.L.P. Ground Investigations Ltd.	**Borehole Record** Dynamic Probe / Sampler.	**Location :** Proposed Residential Development, Chesterfield Road, Scunthorpe.	**Borehole No.** BH3.
Carried out For Villawood Homes Ltd.		Ground Level	Co-ordinates	Date : 09.12.20

Description	Reduced Level	Legend	Depth & Thickness	Samples/Tests: Depth	samples: Type	samples: No.	Test	Field Records
Thin layer of tar macadam over medium dense, fine to medium fragments of grey slag in a matrix of dark grey, gritty sandy fines.			(0.28)	0.00 - 0.80	U	1	S N12	
Made Up / Disturbed Ground			0.28					
Firm, greyish brown, silty clay containing occasional fine fragments of grey slag.			(0.22)					
			0.50	0.50			Vane	68kN/m²
Mid brown, silty **Clay.**			(0.35)					
			0.85	0.80 - 1.90	U	2	S N2	38kN/m²
Very loose, dark brown, clayey and fibrous **Peat.**			(0.30)					
			1.15					
Warp				1.25	D	1	S N13	
Medium dense, mid brown, silty, medium **Sand**.								
				1.90	D	2	S N22	
			2.35					
Observations			**End of Borehole**					
Groundwater seepages were encountered at a depth of around 0.90m. On completion groundwater level subsequently measured at 0.80m beneath the surface.								

S.P.T. : Where full penetration has not been achieved the number of blows for the quoted penetration is given (Not 'N' value)

Depths: All depths and reduce levels in metres. Thickness given in brackets in depth column.

Samples/Test Key.

D Disturbed Sample
B Bulk Sample
W Water Sample
U Undisturbed Core sample
S Standard Penetration Test
V Vane Test

Remarks

Logged by S. P. T. / J. T.

Scale 1 : 25

Fig.

T.L.P. Ground Investigations Ltd.	**Borehole Record** Dynamic Probe / Sampler.	**Location :** Proposed Residential Development, Chesterfield Road, Scunthorpe.	**Borehole No.** BH4.
Carried out For Villawood Homes Ltd.		Ground Level	Co-ordinates	Date : 09.12.20

Description	Reduced Level	Legend	Depth & Thickness	Samples/Tests: Depth	samples: Type	samples: No.	Test	Field Records
Tar macadam over medium fragments of grey slag in a matrix of dark grey, gritty, sandy fines.				0.00 - 0.75	U	1	S N21	
Made / disturbed Ground			(0.35)					
Firm, mixed greyish brown, silty clay containing occasional fine fragments of stones.			0.35					
			(0.33)					
			0.68	0.65			S	55kN/m²
Soft, brown, very silty **Clay.**				0.70 - 1.90	U	2	N10	
			(0.27)					
			0.95					
Medium dense, greyish brown, silty, medium **Sand**.			(0.43)					
Warp			1.38					
Medium dense, rust brown, silty, medium **Sand**.				2.00	D	2	S N13	
			2.45					
			End of Borehole					

Observations

Groundwater seepages were encountered at a depth of around 1.00m depth. On completion groundwater level subsequently measured at 0.79m beneath the surface.

S.P.T. : Where full penetration has not been achieved the number of blows for the quoted penetration is given (Not 'N' value)

Depths: All depths and reduce levels in metres. Thickness given in brackets in depth column.

Samples/Test Key.

D Disturbed Sample
B Bulk Sample
W Water Sample
U Undisturbed Core sample
S Standard Penetration Test
V Vane Test

Remarks

Logged by S. P. T. / J. T.

Scale 1 : 25

Fig.

T.L.P. Ground Investigations Ltd.	**Borehole Record** Cable Tool Boring 150mm. dia. to base .	**Location :** Proposed Residential Development 45 Minster Road, Scunthorpe	**Borehole No.** SA1.
Carried out For Villawood Homes Ltd		Ground Level	Co-ordinates	Date : 07.12.20.

Description	Reduced Level	Legend	Depth & Thickness	Samples/Tests: Depth	samples Type	samples No.	Test	Field Records
Mixed, brown, silty, slightly sandy clay containing occasional fine to medium stone fragments. **Made Up / Disturbed Ground**			(0.50) 0.50	0.50	D	1	S N2	
Loose, dark brown, clayey and fibrous **Peat.**			(0.40) 0.90	1.00	D	2	S N10	
Medium dense becoming loose, mid brown, silty, medium **Sand.**				2.00	D	3	S N13	
			(4.60)	3.00	D	4	S N13	
Sutton Sand Formation				4.00	D	5	S N6	
				5.00	D	6	S N7	
Loose becoming medium dense, mid grey, silty, medium **Sand.**			5.50	6.00	D	7	S N6	
			(1.50) 7.00	7.00	D	8	S N14	
Medium dense, mid brown, silty, medium **Sand.**			(2.00)	8.00	D	9	S N20	
			9.00	9.00	D	10	S N13	
Medium dense, mid brown, silty, medium **Sand.**			(4.70)	10.00	D	11	S N16	

S.P.T. : Where full penetration has not been achieved the number of blows for the quoted penetration is given (Not 'N' value)

Depths: All depths and reduce levels in metres. Thickness given in brackets in depth column.

Samples/Test Key.

D Disturbed Sample
B Bulk Sample
W Water Sample
U Undisturbed Core sample
S Standard Penetration Test
V Vane Test

Remarks

Logged by S. P. T. / J. T.

Scale 1 : 50

Fig.

T.L.P. Ground Investigations Ltd.	**Borehole Record** Cable Tool Boring 150mm. dia. to base .	**Location :** Proposed Residential Chesterfield Road, Scunthorpe.	**Borehole No.** SA1.
Carried out For Villawood Homes Ltd.		Ground Level	Co-ordinates	Date : 09.12.20.

Description	Reduced Level	Legend	Depth & Thickness	Samples/Tests: Depth	samples: Type	samples: No.	Test	Field Records
Medium dense, mid brown, silty, medium **Sand** containing occasional thin partings of greyish brown, silty clay.				11.00	D	12	S N18	
Sutton Sand Formation			(4.60)	12.00	D	13	S N19	
				13.00	D	14	S N25	
Dense pinkish brown, mottled greenish grey, silty and clayey **Mudstone.**			13.70	14.00	D	15	S N34	
Mercia Mudstone Group			15.00					
Observations Groundwater seepages were encountered at a depth of 1.20m beneath the surface. On completion groundwater level measured at 0.80m beneath the surface with the borehole casing withdrawn.		**End of Borehole**						

S.P.T. : Where full penetration has not been achieved the number of blows for the quoted penetration is given (Not 'N' value)

Depths: All depths and reduce levels in metres. Thickness given in brackets in depth column.

Samples/Test Key.

D Disturbed Sample
B Bulk Sample
W Water Sample
U Undisturbed Core sample
S Standard Penetration Test
V Vane Test

Remarks

Logged by S. P. T. / J. T.

Scale 1 : 50

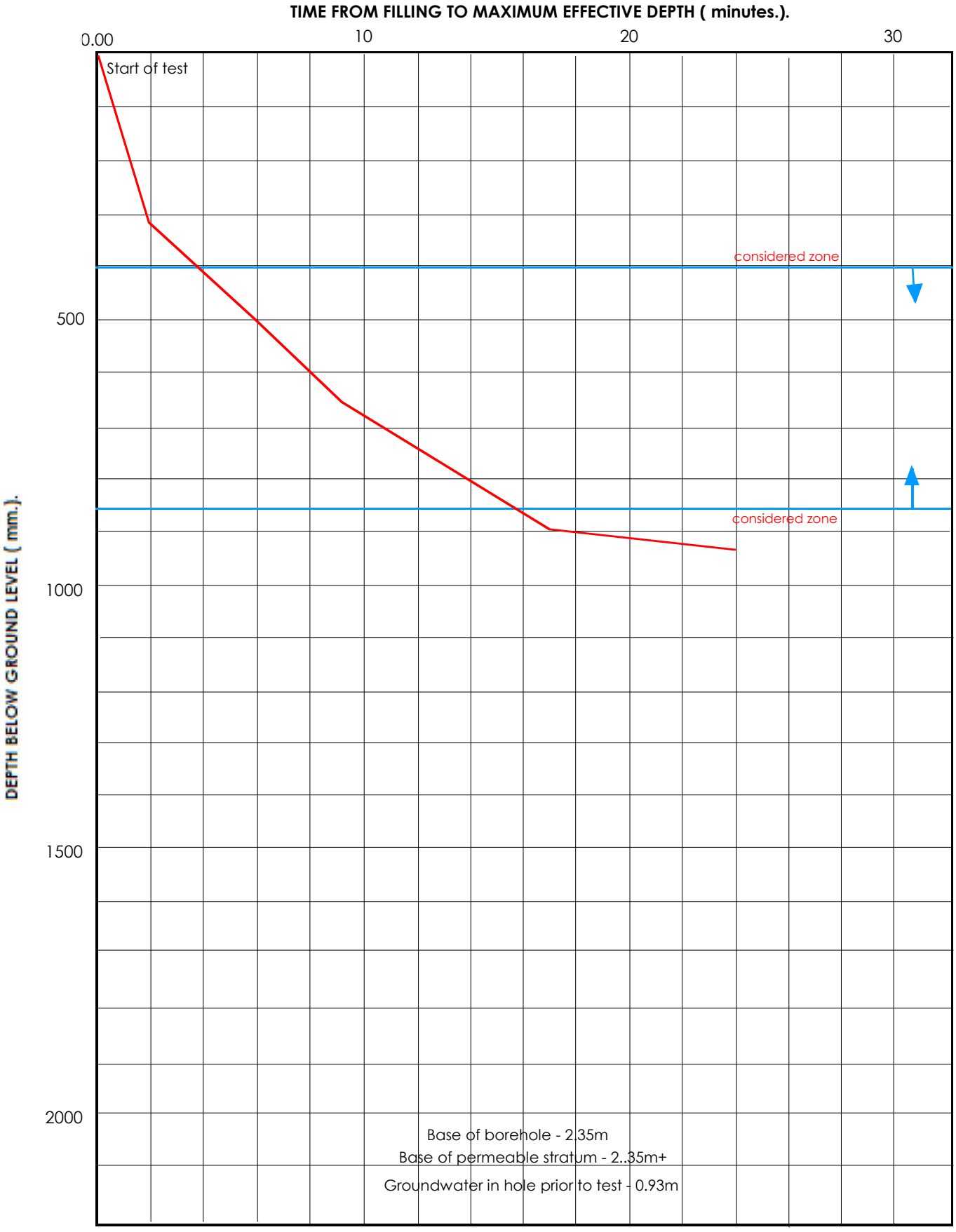
Fig.

Percolation Graph

Falling Head Test

Soak BH2

Project Location : **Minster Road, Scunthorpe.**
Client : **Villawood Homes Ltd.**
Date of SI : **17.12.2020**



Calculation of Soil Infiltration Rate
Minster Road, Scunthorpe

Parameter	BH2						
diameter of borehole	0.105						
Height of water at start of considered zone (m) H1	0.53						
Height of water at end of considered zone (m) H2	0.08						
Considered depth change (m) = H1 - H2	0.45						
Volume out flowing within considered depth	0.003896557						
Mean effective depth during outflow	0.305						
Mean surface area during outflow	0.109268521						
Time of considered outflow (mins)	12						
Soil infiltration rate m/s	4.95E-05						
Soil infiltration rate mm/s	4.95E-02						
Soil infiltration rate m/hour	0.1783						

Calculations from BRE 365 1991

Typical Percolation Values	Value mm/s
Gravels	>10
Sands	1 to 1 x 10E-2
Fine Sands / Coarse Silts	1x10E-2 to 1 x 10E-4
Silts	1x10E-4 to 1 x 10E-6
Clays	< 1 x 10E-6

Table from - Elements of Soil Mechanics for Civil & Mining Engineers (G .N. Smith 1974)

Summary of Laboratory Test Data

Client : Villawood Homes Ltd.
Location : Proposed Residentail Dev, Minster Road / Chesterfield Road, Scunthorpe.

Sample Details			Classification				Chemical		Density		Strength		
No. Type	Depth m.	Description	w %	LL %	PL %	PI %	SO_4 g/l	pH	Bulk Density Mg/m^3	Dry Density Mg/m^3	Type	c kN/m^2	o Deg.
BH1													
	0.80	Sand					0.01 (2:1)	7.4					

Notes
U Undisturbed
B Bulk
D Disturbed
NP Non Plastic
T Triaxial Compression test