Annexure N – Geotechnical Investigation Report

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Reg No: 2015/304894/07 Est. 2015

GEOTECHNICAL INVESTIGATION: PORTION 453 TOWNLANDS OF LYDENBURG 31JR

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Report No. : MWEM19-22

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July 2019

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1 INTRODUCTION

Masana Waste and Environmental Management (MWEM) was appointed by KHS (PTY) LTD to conduct a geotechnical investigation study for a proposed development of a Pentagon Business and Residential Development on Portion 453 Townlands of Lydenburg 31 JR within the Thaba Chweu Local Municipality, Mpumalanga Province, South Africa. This report presents the preliminary findings of the field investigation.

2 SCOPE OF WORK

The objectives of the geotechnical investigation were to:

- Establish the site stratigraphy and the relevant engineering properties of the encountered sub-surface soils;
- To give general foundation recommendations for the proposed development and;

  To comment on the site water management aspects, particularly pertaining to shallow groundwater or seepage.

It must be noted that the interpretation of the overall subsurface conditions across the site is inferred using professional judgment, from the interpolation and extrapolation of point information assimilated from the various test positions.

Geotechnical conditions at intermediate positions have been inferred by professional judgment. In the unlikely event of significant variations from the inferred conditions becoming apparent during subsequent phases of the project, these conditions must be referred to a geotechnical professional for verification.

3 SITE DESCRIPTION

3.1 SITE LOCATION

The study area is located approximately 3.65 km south west of Lydenburg central business district, within the Thaba Chweu Local Municipality, Mpumalanga. The size of the site is approximately 20 hectares and the centre coordinates of the site are S -25.111877, E 30.434556. The site is currently undeveloped and no services (water, sanitation and electrical) have been installed on the site. The locality map can be viewed in Figure 4-1.

4 GEOLOGY

According to the Geological Map Sheet 2530 Barbeton Map at a scale of 1: 250 000 (Figure 4-2) the site is underlain by surficial deposits comprising alluvium and scree. The deposits are underlain by greenish, fine grained shale and mudstone with tuff, subordinate carbonate layer and hornfels in places which belong to the Silverton Formation. The Silverton Formation forms part of the Pretoria Group.

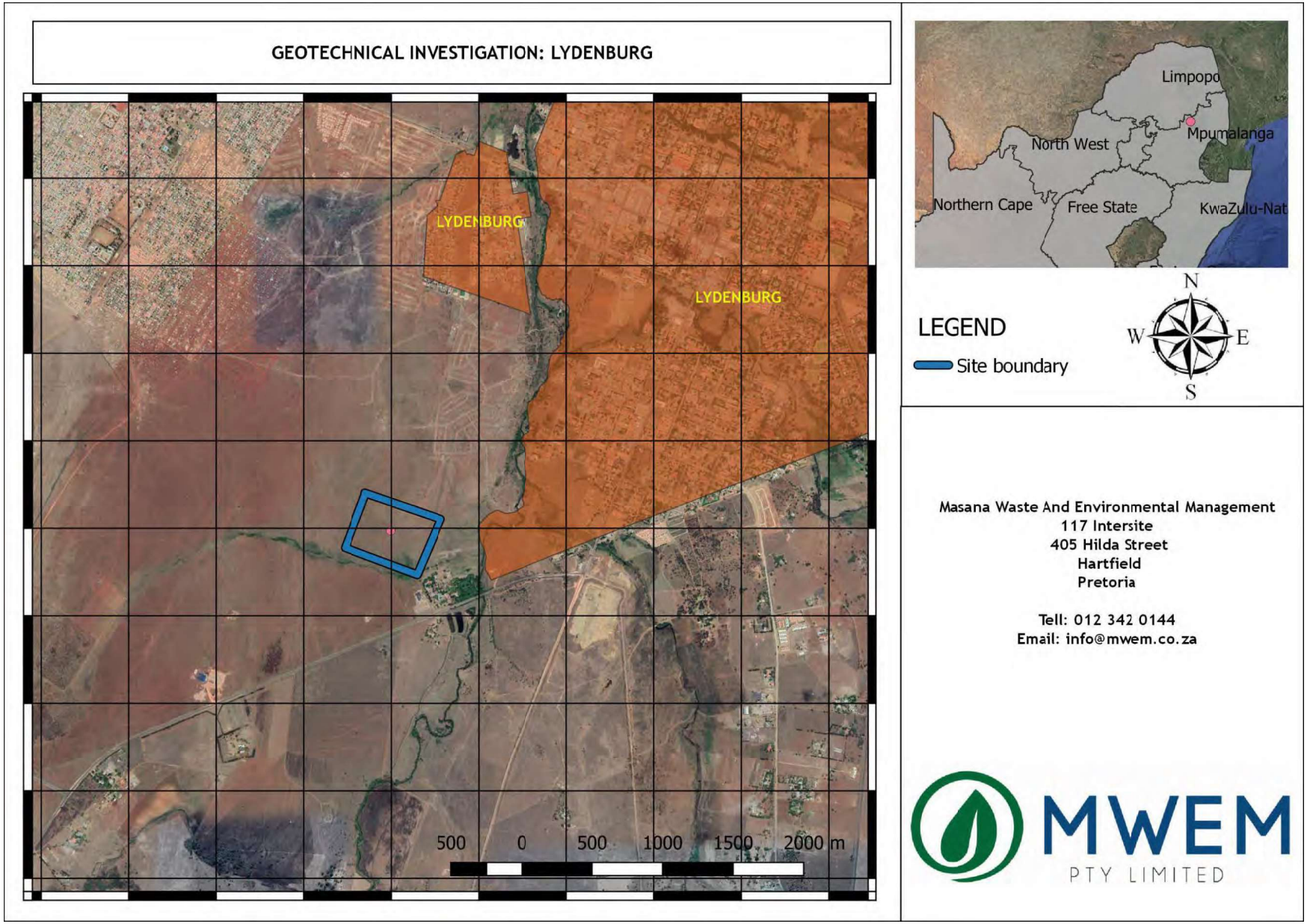


FIGURE 4-1 SITE LOCATION MAP

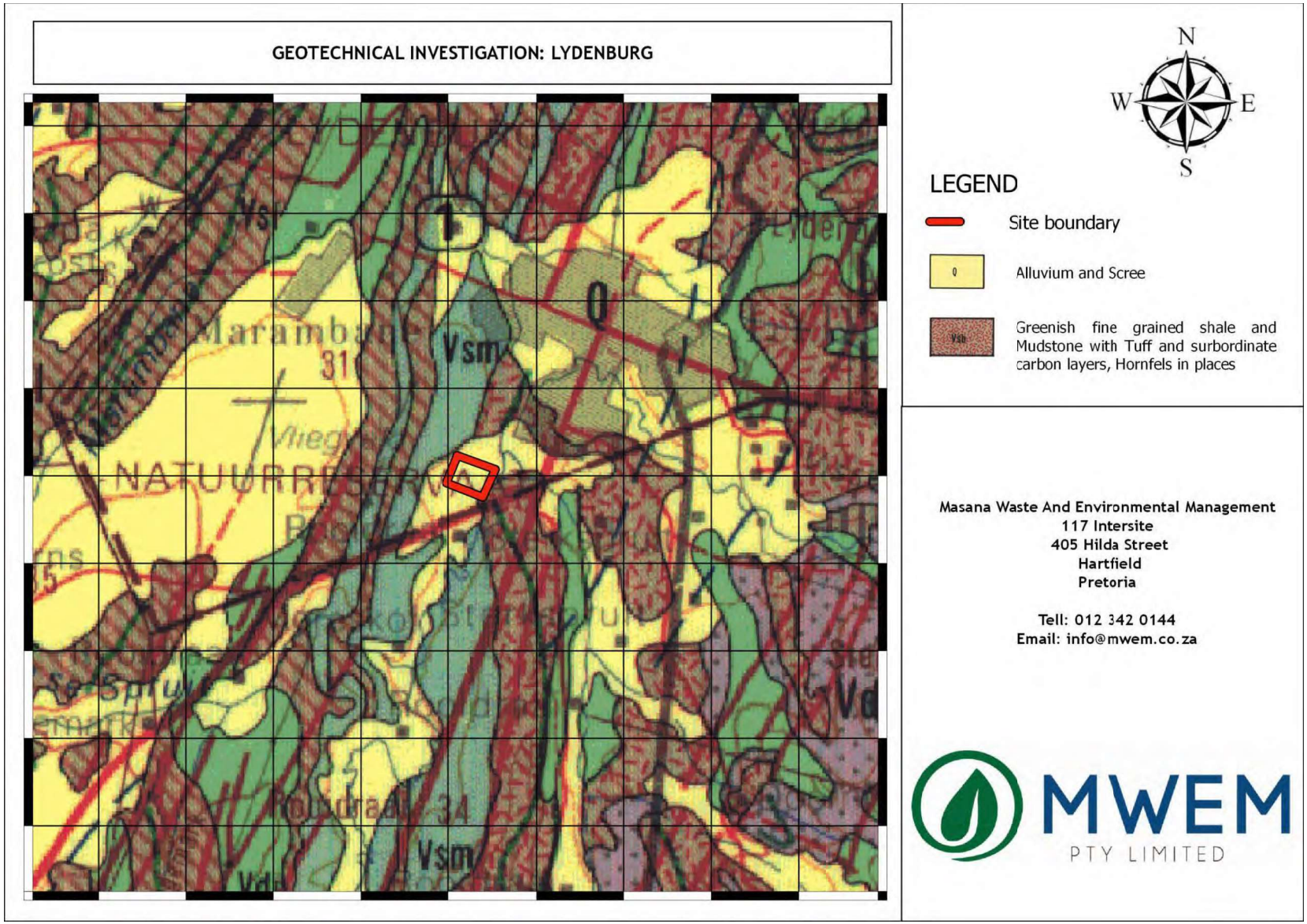


FIGURE 4-2 SITE GEOLOGICAL MAP

5 METHODOLOGY AND WORK PLAN

The work completed for the purposes of compiling a geotechnical report comprised the following:

5.1 DESKTOP STUDY

A complete desk study, entailing the gathering of information from the relevant topographical maps, geological map sheets (1:250 000) was conducted.

5.2 FIELD INVESTIGATION

The site investigation typically includes subsurface exploration through the excavation of trial pits and DCP testing to obtain information on the physical properties of the surficial soils underlying the site

- **Trial test pits** – Test pit profiling is a visual and tactile method of assessing the soil characteristics of a site in order to classify it according to its geotechnical zones so as to give guidance on suitability of the site for the proposed/planned development. This process also provides guidance on the appropriate foundation and structural designs for the engineering structures, appropriate aggregate and compaction material, and suitable pipe bedding material to be used
- **Dynamic Cone Penetrometer (DCP)** – Dynamic Cone Penetration Tests (DCP) provide an in-situ method to determine the strength of the subsurface and design load of the soil. Once the maximum design load of a soil is known, these results can be used to calculate appropriate footings and foundations for sub/superstructures to be placed on or within the soil. This is achieved by measuring the extent of penetration into the ground of a calibrated tip or cone and weight which is dropped from a standardized height.
- **Sample Collection** – Representative disturbed bulk samples were retrieved from representative soil horizons in selected test pits. The samples were submitted to Soil lab for geotechnical laboratory testing. Several tests were conducted on the samples which included the following:
    - Sieve analyses to 0.075 mm (TMH A1);
    - Hydrometer analysis to 0.002 mm (ASTM D422);
    - Atterberg limits tests < 0.425 mm (TMH1 A2, A3, A4) and;
    - California Bearing Ratio (CBR)

6 FIELD INVESTIGATION RESULTS

6.1 TRIAL PITS

The site investigation was conducted on the 27th of June 2019. A total of twelve (12) trial pits were advanced to depths ranging between 1.0 and 1.9 meters below ground level (mbgl). A layout with trial pit locations is shown in Figure 6-1 and a photo log of the trial pits is provided in Table 6-3. Due to erratic GPS satellite signal reception, the coordinates and elevations recorded have an accuracy of only +/- 5 m. The full description of the field logs is presented in Appendix A.

Trial pits excavated across the proposed site revealed that the site can be divided into two separate zones, Zone A and Zone B shown in Table 6-1.

TABLE 6-1: ZONAITON OF TRIAL PITS

Zone A	Zone B
TP 1	TP 6
TP 2	TP 7
TP 3	
TP 4	
TP 5	
TP 9	
TP 10	
TP 11	
TP 12	
TP 8	

6.1.1 ZONE A

Alluvium - A transported soil horizon comprising alluvium was encountered on the site. The alluvium comprises moist, dark brown to black, soft, slightly shattered, clay and silty clay with roots, encountered in ten (10) trial pits at depths between ground level extending to depths between 0.2 and 1.9 mbgl.

Residual Soil - A residual horizon comprising reworked ferruginised residual clay underlies the alluvial horizon. The residual horizon comprises slightly moist, brown and yellow mottled black slightly shattered, gravelly clay with subangular boulders encountered at depths between ground level and 0.2 mbgl extending to depths between 0.4 to 0.6 mbgl. This material was encountered in six (6) trial pits namely TP 3, TP 4, TP 7, TP 9, TP 10 and TP 11. Quartz pebbles were encountered in two trial pits (TP 3 and TP 7) excavated on the site.

Weathered Mudstone - Weathered Mudstone was intersected at the base of one trial pit (TP 8) at a depth of 0.56 mbgl extending to 1.3 mbgl. The weathered mudstone was observed to be greyish black, fine grained, hard and moderately weathered.

6.1.2 ZONE B

Weathered Diabase Hard Rock - Weathered diabase was intersected at the base of two trial pits (TP6 and TP7) excavated. The weathered diabase encountered on the site was observed to be black, fine grained, highly fractured and moderately to highly weathered encountered at depths between 0.4 mbgl extending to 1.7 mbgl.

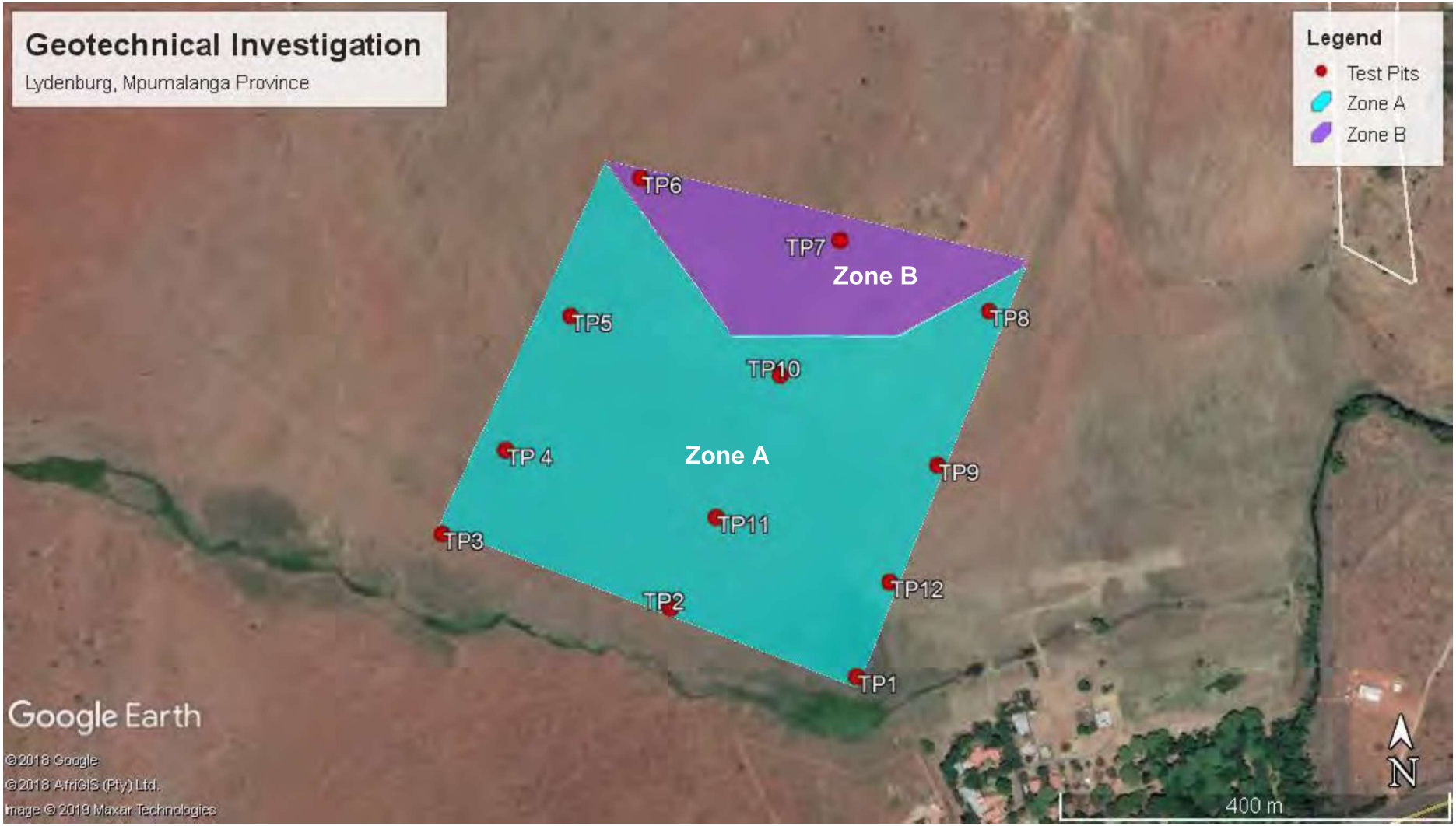


FIGURE 6-1 TEST PIT LOCATION

6.2 DYNAMIC CONE PENETROMETER TEST

A total of four (4) Dynamic Cone Penetrometer (DCP) tests were advanced adjacent to the trial pits to compliment trial pit data. The DCP tests were advanced from surface to depths ranging between 0.46 and 0.86 mbgl.

The DCP penetration rates were used for the evaluation of subsoil consistency and the empirical derivation of the estimated allowable safe bearing pressure (EASBP) and in-situ CBR, according to the methods of Terzaghi & Peck, modified by Meyerhof (Craig, 1997) and Draft TMH 6 (1984) respectively. The DCP test results are summarized in Table 6-2 and presented in Appendix B.

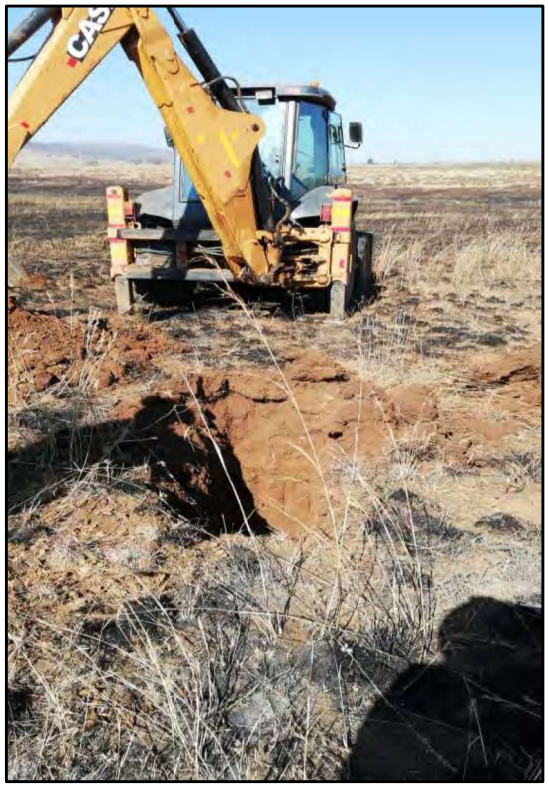
It should be noted that the results of DCP testing is affected by the moisture content of the soil profile, as well as any pebbles or cobbles that may be struck during the testing. A horizon saturated due to heavy rainfall will provide a lower set of results than a similar test in the dry season. Awkwardly oriented pebbles or cobbles struck may give false high readings. Majority of the horizons profiled during the investigation were observed to be moist.

The DCP test results indicate CBR values ranging between 6 % and 62 % with lower values typically observed at trial pits TP 4 and 12. Furthermore, the derived Estimated Allowable Safe Bearing Pressure (EASBP) ranges between 37 kPa and 285 kPa indicating poor to moderate bearing pressure of the underlying soil horizons

TABLE 6-2: DCP RESULTS

DCP 1				DCP2			DCP3			DCP 4		
TP4				TP5			TP11			TP12		
No. of Blows	Depth (mm)	CBR %	EASBP (KPa)	Depth (mm)	CBR %	EASBP (KPa)	Depth (mm)	CBR %	EASBP (KPa)	Depth (mm)	CBR %	EASBP (KPa)
0	20	0	0	20	0	0	10	0	0	10	0	0
5	104	11	64	89	15	80	100	10	59	62	21	109
10	173	15	80	128	30	150	165	16	85	130	15	81
15	240	15	82	175	24	122	208	27	135	214	11	64
20	355	8	45	210	35	170	240	39	188	290	13	71
25	420	16	85	249	30	150	272	39	188	400	8	47
30	480	17	93	287	31	155	300	46	218	510	8	47
35	605	7	41	326	30	150	322	62	285	625	8	45
40	742	6	37	370	26	131	351	44	209	705	12	67
45	862	7	43	413	27	135	399	23	119	770	16	85
50				450	32,3	160	430	40,4	194			
55				492	27	138	460	42	202			
60				532	29	146						
65				578	24	125						
				638	17	93						
				705	15	82						
				754	23	117						
				783	44	209						

TABLE 6-3: LYDENBURG PHOTOLOG - TEST PITTING

Photo Logs: Lydenburg Geotechnical Investigation	
	
PLATE 1: Soil profile of trial pits	**PLATE 2:** Excavating of Trial Pits

7 LABORATORY TESTING

Laboratory testing included grading analysis, Atterberg Limit determinations and Mod/CBR compaction tests were conducted and the results are summarized in Table 7-1 and Table 7-2. Detailed laboratory test results are presented in Appendix B.

A total of nine (9) disturbed bulk samples were submitted for geotechnical laboratory for testing. The laboratory tests are divided into two separate zones as indicated in the field investigation, shown in Figure 6-1.

Zone A Laboratory results indicates the following:

- Zone A is typically underlain by alluvium comprising clayey sand and subordinate mudstone in places classified as ML (inorganic silt), SM (Silty sand).) and MH (inorganic silts). The Liquid Limit of the samples collected from the alluvial horizon (TP01, TP02, TP03, TP04, TP05, TP08, TP09, TP10, TP11 and TP12) varies between 40 % and 61 % with the Linear Shrinkage ranging between 6.5 % and 12 %. The samples indicate a medium to high plasticity with the Plasticity Index of the samples ranging between 13 % and 22 %. The clay content and the Plasticity Index indicate that the samples exhibit low potential expansiveness (Van der Merwe, 1964).

Zone B Laboratory results indicates the following:

- Zone B (TP07) has one sample that was collected and submitted for grading analysis and Atterberg Limit determinations. It is typically underlain by alluvium comprising clayey sand classified as ML (inorganic silt). The Liquid Limit of the sample collected is 40 % with the Linear Shrinkage ranging between 6.5 %. The sample indicates a medium plasticity with the Plasticity Index of 13 %. The clay content and the Plasticity Index indicate that the sample exhibits low potential expansiveness (Van der Merwe, 1964).

TABLE 7-1: SUMMARY OF LABORATORY RESUILTS

ZONE A											
Sample No.	Depth (m)	Grading (%)				Atterberg Limits (%)			AASHTO Class.	Pot. Exp.	USCS Class.
		Gravel	Sand	Silt	Clay	LL	LS	PI			
TP 01	0.5 - 1.0	4	27	17	52	53	12	22	A-7-5 (18)	Low	MH
TP 02	0.2 - 0.6	28	30	13	29	55	10.5	20	A-7-5 (6)	Low	SM
TP 03	0.6 - 1.0	19	27	16	38	53	11	22	A-7-5 (11)	Low	MH
TP 04	0.5 -1.0	4	27	17	52	53	12	22	A-7-5 (18)	Low	MH
TP 05	0.2 - 0.6	28	30	13	29	55	10.5	20	A-7-5 (6)	Low	SM
TP 07	0.56- 1.3	10	59	19	12	40	6.5	13	A-6 (8)	Low	ML
TP 11	0.6- 1.0	19	27	16	38	53	11	22	A-7-5 (11)	Low	MH
TP12	0.53- 1.53	1	23	22	50	61	10	21	A-7-5 (21)	Low	MH

ZONE B											
Sample No.	Depth (m)	Grading (%)				Atterberg Limits (%)			AASHTO Class.	Pot. Exp.	USCS Class.
		Gravel	Sand	Silt	Clay	LL	LS	PI			
TP 07	0.56- 1.3	10	59	19	12	40	6.5	13	A-6 (8)	Low	ML

LS = Linear Shrinkage LL = Liquid Limit PI = Plasticity Index Pot. Exp. = Potential Expansiveness (vd Merwe Classification) USCS = Unified Soil Classification System AASHTO – American Association for State Highways and Transport Officials

TABLE 7-2 COMPACTION PROPERTIES

ZONE A												
Sample No.	Depth (m)	Lab Ref. No.	CBR @					PI	GM	OMC (%)	Max. Dry Density (kg/m^3)	COLTO Class
			90%	93%	95%	98%	100%					
TP 04	0.5 - 1.0	S19-1182-01	1	2	2	4	6	22	0.43	19.6	1599	**>G9**
TP 11	0.6 - 1.1	S19-1182-04	2	3	4	7	10	22	0.96	15.6	1798	**>G9**
TP 12	0.53 - 1.53	S19-1182-05	1	2	2	3	5	21	0.30	21.3	1615	**>G9**

CBR = California Beari3ng Ratio OMC = Optimum Moisture content PI = Plasticity Index

8 GEOTECHNICAL APPRAISAL

It is also the purpose of this investigation to consider various geotechnical factors at the site which may have an influence on the proposed developments and associated infrastructure.

8.1 GEOTECHNICAL CHALLENGES

Typical problems that may occur with the soils identified during the geotechnical investigation and considering the laboratory results received of geotechnical investigations are as follows:

- Transported Soils:
  - Alluvium: Collapsible grain structure, heave and high compressibility.

These are typical problems associated with the type of soil encountered on site and these problems may not necessarily occur. However, if encountered suggested remedial action to address them is detailed below:

- Collapsible grain structure: This material can either be removed and re-compacted or compacted using an impact roller depending on the depth of the material and its relation to specific structures.
- Heave and high compressibility: This will affect concrete structures around the site. It is recommended that during construction, should clay be encountered alongside or below any structures, it should be removed and replaced with suitable material with no heave or high compressibility potential.
- Dispersity and erosion: The following measures can be taken to address should dispersive materials be encountered:
  - Erosion of dispersive soils can be controlled by properly designed filters.
  - Proper compaction of the soil.
  - Dispersive material should not be used especially underneath the structures, footings and foundations.
- Poor compaction and workability: will need to be removed and replaced with suitable material particularly if the structure footprint extents encroach these locations. Civil Engineering designs and construction methods must provide corrective measures to the challenges discussed above.

8.2 EXISTENCE OF COLLAPSIBLE/COMPRESSIBLE PROFILE

The soils encountered on the site typically comprise soft to very stiff silty clay, gravelly clay and clay with no visual open-textured structure such as pinholes which indicate collapse potential. Due to the crumbly nature of the soils on site, undisturbed soil samples could not be retrieved for collapse potential testing. From the site observations it is anticipated that the site will exhibit low collapse potential. Compressible soils typically comprise fine grained soils such as clay and silty clay with low to medium plasticity and therefore problems associated with compressible soils such as differential settlement are anticipated on the site.

8.3 THE EXISTENCE OF EXPANSIVE SOILS

The site is mainly underlain by silty clay and the laboratory results of all the samples indicate that the samples will exhibit low potential expansiveness. Therefore, problems associated with expansive soils such as differential volume change of the soil (heaving and shrinking) are anticipated on the site.

8.4 ERODIBILITY OF THE SOIL PROFILE

During the site investigation, minor visible signs of surface soil erosion were identified mainly confined to Zone A, in the form of erosion gullies and rills to indicate that the material could be erodible. The site must be shaped to improve stormwater runoff and extensive stormwater management must be considered. All drainage boundaries near the south areas or drainage lines and floodlines must be confirmed by the relevant Competent Person (floodline specialist)

8.5 EXCAVATION CLASSIFICATION

Excavations for the proposed development are expected to utilise a range of excavation techniques. Soft excavation techniques can be used to remove alluvial material mainly confined to Zone A. Intermediate and hard techniques will be required for the removal shallow bedrock encountered in Zone B. It is recommended that all required earthworks be carried out in accordance with guidelines provided by SANS 1200 (latest edition).

According to the COLTO classes of excavation,

a**) <u>Soft excavation</u>**

1) Soft excavation, other than in restricted excavation, shall be excavation in material that can be efficiently removed or loaded without prior ripping by any of the following plant:

- i) a bulldozer of mass (including the mass of a ripper if fitted) 22 t and flywheel power approximately 145 kW; or
- ii) a tractor-scraper unit of total mass approximately 28 t and flywheel power approximately 245 kw, pushed during loading by a bulldozer equivalent to that specified in (b) below; or
- iii) a track-type front-end loader of mass approximately 22 t and flywheel power approximately 145 kw.

2) In the case of restricted excavation, soft excavation shall be excavation in material that can be efficiently removed by a back-acting excavator of flywheel power approximately 0,10 kW for each millimetre of tined-bucket width, without the assistance of pneumatic tools such as paving breakers.

b) <u>Intermediate excavation</u>

1) Intermediate excavation, other than in restricted excavation, shall be excavation (excluding Soft excavation) in material that can be efficiently ripped by a bulldozer of mass approximately 35 t fitted with a single-tine ripper suitable for heavy ripping, and of flywheel power approximately 220 kw

2) In the case of restricted excavation, intermediate excavation shall be excavation (excluding Soft excavation) in material that requires a back-acting excavator of flywheel power exceeding 0,io kW for each millimetre of tined-bucket width or the use of pneumatic tools before the material can be removed by equipment equivalent to that specified in (a)(2) above.

c) Hard rock excavation.

Hard rock excavation shall be excavation (excluding boulder excavation) in material that cannot be efficiently ripped by a bulldozer equivalent to that specified in (b)(1) above. Such excavation generally includes material such as formations of unweathered rock that can be removed only after blasting.

8.6 GROUNDWATER CONDITIONS

Groundwater seepage was not encountered in any of the trial pits excavated during site investigation. However, during periods of prolonged rainfall, an increase in the occurrence and magnitude of groundwater seepage flow may be anticipated. Perched groundwater flows at the soil / rock interface.

9 FOUNDATION RECOMMENDATIONS

According to the desktop study, field investigation as well as laboratory testing the following can be concluded:

The laboratory tests indicate that material underlying the site are classified as clays which exhibit low potential expansiveness and low to medium plasticity. The development potential has been broadly classified in terms of three Geotechnical Sub-Areas based on field observations/investigation and laboratory soil testing of soil samples, the site can be classified as **Zone A: 2/H1/C/S1**, **Zone B: 2/R**. Recommendations on foundation options area indicated in Table 9-1**Error! Reference source not found.**Table 9-1 Foundation design, building procedures and precautionary measures for single-storey type 1 buildings founded on soil horizons subject to both consolidation and collapse settlemenT

TABLE 9-1 FOUNDATION DESIGN, BUILDING PROCEDURES AND PRECAUTIONARY MEASURES FOR SINGLE-STOREY TYPE 1 BUILDINGS FOUNDED ON SOIL HORIZONS SUBJECT TO BOTH CONSOLIDATION AND COLLAPSE SETTLEMENT

Geotechnical Zone	Site Class	Estimated total settlement (mm)	Construction Type	Foundation design and building procedures
Zone A	**2/H1/C/S1**	2.5 – 7.5	Soil Raft	• Remove all or part of the in-situ expansive material to 1,0 m beyond the perimeter of the building to a depth of 1,5 times the widest foundation or to a competent soil horizon (shale bedrock) and replace with material compacted to 93 % MOD AASHTO density at -1 % to +2 % of optimum moisture content.
Zone B	**2/R**	<0.5	Strip Footing	• Excavate material to expose shale bedrock; • Foundations to be founded on shale bedrock; • Normal construction; • Foundations to SABS 0400 Part H.

10 CONCLUSION

- A geotechnical investigation was conducted in on Portion 453 Townlands of Lydenburg 31 JR within the Thaba Chweu Local Municipality, Mpumalanga Province
- A total of twelve (12) trial pits were excavated on the site
- The geological map indicates that the investigated area is at depth underlain by shale and mudstone.
- The trial pits excavated across the site indicate that the site may be subdivided into two zones namely: Zone A and Zone B.
- The trial pits indicate that are divided into two zones: Zone A and Zone B.
- Zone A is characterized by the presence of a transported horizon comprising alluvial material overlying residual clay with subordinate mudstone in places classified as ML (inorganic silt), SM (Silty sand).) and MH (inorganic silts). Laboratory results indicate that the material encountered within this zone exhibits low to moderate collapse potential and medium to high compressibility based on the LL.
- Zone B is characterized by shallow and outcropping diabase bedrock with clay matrix in places. The laboratory results indicate that the material encountered within this zone exhibits low potential expansiveness along with medium compressibility based on the LL.
- No groundwater or groundwater seepage was encountered in all the test pits encountered on the site. Pedogenic material in the form of ferruginised residual clay was encountered, indicating the presence of a fluctuating seasonal or perched water table.
- The site is sub-divided into two geotechnical zones: **Zone A: 2/H1/C/S1, Zone B: 2/R.** Recommendations foundation options area indicated in **Error! Reference source not found.**

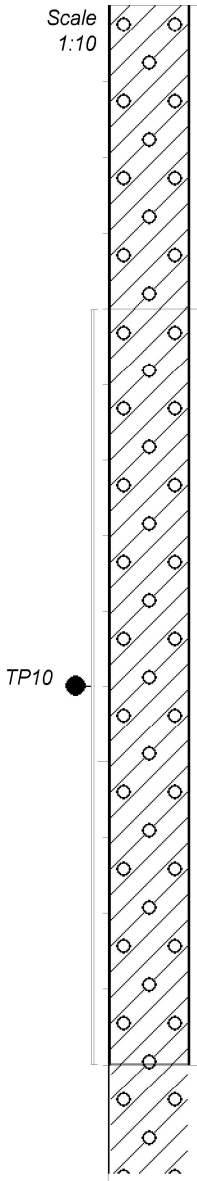
APPENDIX A: TRIAL PIT PROFILES

KSH (PTY) LTD
Lydenburg Geotechnical Investigation

HOLE No: **TP10**
Sheet 1 of 1

JOB NUMBER: **MWEM 19-22**

Scale 1:10



0.00 "Moist, brown and yellow mottled black, slightly shattered, gravelly CLAY with minor gravels. FERRUGINISED RESIDUAL"

0.40 "Moist, brown mottled black, very stiff, intact, gravelly CLAY. RESIDUAL"

1.40 "End of hole, continues as above."

NOTES

1) No water Seepage.
2) Disturbed sample TP10 taken at 0.4--1.4 m.
3) Stable side walls.

CONTRACTOR :
MACHINE : CAT 428
DRILLED BY :
PROFILED BY : G. Manganyi

TYPE SET BY : G. Mogashoa
SETUP FILE : KKK.SET

INCLINATION :
DIAM : 0.7m trench
DATE : 27/06/2019
DATE : 27/06/2019

DATE : 15/07/2019 20:38
TEXT : ..n\2019\Lydenburglogs.txt

ELEVATION :
X-COORD : -25.111335
Y-COORD : 30.434845

HOLE No: **TP10**

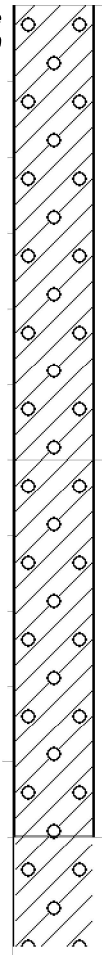
dotPLOT 7022

KSH (PTY) LTD
Lydenburg Geotechnical Investigation

HOLE No: **TP11**
Sheet 1 of 1

JOB NUMBER: **MWEM 19-22**

Scale 1:10



0.00 "Moist, brown and yellow mottled black, slightly shattered, gravelly CLAY with minor gravels, FERRUGINISED RESIDUAL"

0.60 "Moist, brown mottled black, very stiff, intact, gravelly CLAY. RESIDUAL "

1.10 "End of hole, continues as above"

NOTES

1) No water Seepage.
2) No sample taken.
3) Stable side walls.

CONTRACTOR :
MACHINE : CAT 428
DRILLED BY :
PROFILED BY : G. Manganyi

TYPE SET BY : G. Mogashoa
SETUP FILE : KKK.SET

INCLINATION :
DIAM : 0.7m trench
DATE : 27/06/2019
DATE : 27/06/2019

DATE : 15/07/2019 20:38
TEXT : ..n\2019\Lydenburglogs.txt

ELEVATION :
X-COORD : -25.112678
Y-COORD : 30.434182

HOLE No: **TP11**

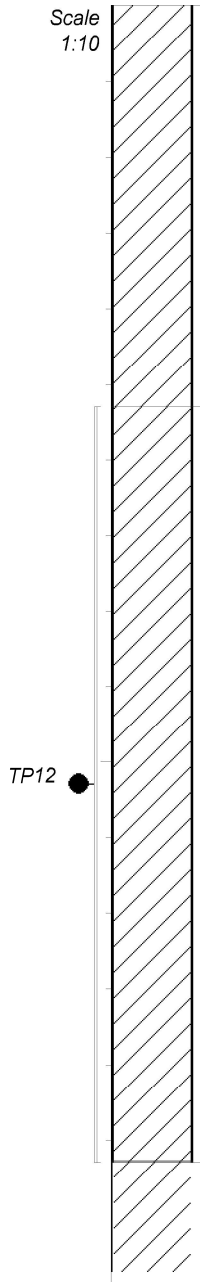
MWEM PTY LIMITED
MASANA WASTE & ENVIRONMENTAL MANAGEMENT

KSH (PTY) LTD
Lydenburg Geotechnical Investigation

HOLE No: **TP12**
Sheet 1 of 1

JOB NUMBER: **MWEM 19-22**

Scale 1:10



0.00 "Moist, dark brown to black, very stiff, slickensided, slightly shattered, CLAY. TRANSPORTED"

0.53 "Moist, dark brown mottled red, very stiff, intact, CLAY. RESIDUAL"

1.53 "End of hole, continues as above."

NOTES

1) No water Seepage.
2) Disturbed sample TP12 at 0.53--1.53 m.
3) Stable side walls.

CONTRACTOR :
MACHINE : CAT 428
DRILLED BY :
PROFILED BY : G. Manganyi

TYPE SET BY : G. Mogashoa
SETUP FILE : KKK.SET

INCLINATION :
DIAM : 0.7m trench
DATE : 27/06/2019
DATE : 27/06/2019

DATE : 15/07/2019 20:38
TEXT : ..n\2019\Lydenburglogs.txt

ELEVATION :
X-COORD : -25.113273
Y-COORD : 30.435963

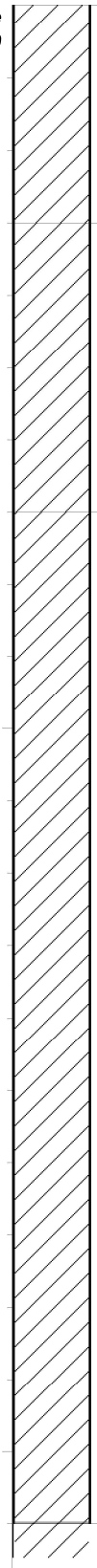
HOLE No: **TP12**

KSH (PTY) LTD
Lydenburg Geotechnical Investigation

HOLE No: **TP1**
Sheet 1 of 1

JOB NUMBER: **MWEM 19-22**

Scale 1:10



0.00 "Moist, dark brown to black, soft, slightly shattered, CLAY with roots in places. TRANSPORTED"

0.30 "Moist, dark brown to black, very stiff, slickenside, slightly shattered, CLAY. TRANSPORTED"

0.70 "Moist, dark brown mottled red, very stiff, intact, CLAY. RESIDUAL"

2.10 "End of hole, continues as above."

NOTES

1) No water Seepage.
2) No sample taken.
3) Stable side walls.

CONTRACTOR :
MACHINE : CAT 428
DRILLED BY :
PROFILED BY : G. Manganyi

TYPE SET BY : G. Mogashoa
SETUP FILE : KKK.SET

INCLINATION :
DIAM : 0.7m trench
DATE : 27/06/2019
DATE : 27/06/2019

DATE : 15/07/2019 20:38
TEXT : ..n\2019\Lydenburglogs.txt

ELEVATION :
X-COORD : -25.114163
Y-COORD : 30.435628

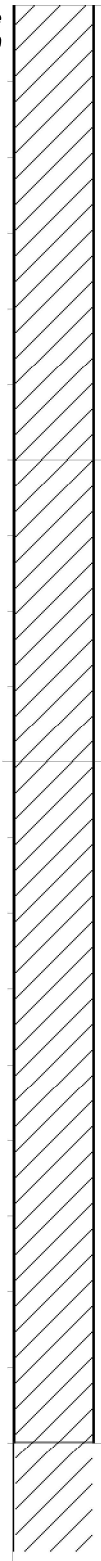
HOLE No: **TP1**

KSH (PTY) LTD
Lydenburg Geotechnical Investigation

HOLE No: **TP2**
Sheet 1 of 1

JOB NUMBER: **MWEM 19-22**

Scale 1:10



0.00 "Moist, dark brown, soft, highly shattered, CLAY. TRANSPORTED"

0.60 "Moist, brown, very stiff, highly shattered, CLAY. TRANSPORTED"

1.00 "Moist, light brown, very stiff, intact, CLAY. TRANSPORTED"

1.90 "End of hole, continues as above."

NOTES

1) No water Seepage.
2) No sample taken.
3) Stable side walls.

CONTRACTOR :
MACHINE : CAT 428
DRILLED BY :
PROFILED BY : G. Manganyi

TYPE SET BY : G. Mogashoa
SETUP FILE : KKK.SET

INCLINATION :
DIAM : 0.7m trench
DATE : 27/06/2019
DATE : 27/06/2019

DATE : 15/07/2019 20:38
TEXT : ..n\2019\Lydenburglogs.txt

ELEVATION :
X-COORD : -25.113631
Y-COORD : 30.4337

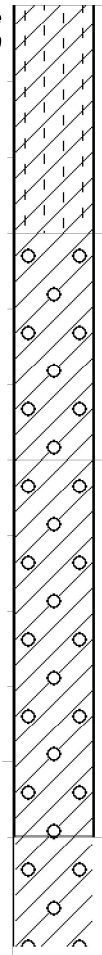
HOLE No: **TP2**

KSH (PTY) LTD
Lydenburg Geotechnical Investigation

HOLE No: **TP3**
Sheet 1 of 1

JOB NUMBER: **MWEM 19-22**

Scale 1:10



0.00	"Slightly moist, brown, soft, intact, silty CLAY. TRANSPORTED"
0.30	"Moist, brown and yellow mottled black, slightly shattered, gravelly CLAY with subangular boulders, quartz pebbles and minor gravels, FERRUGINISED RESIDUAL"
0.60	"Moist, brown mottled black, very stiff, intact, gravelly CLAY. RESIDUAL "
1.10	"End of hole, continues as above."

NOTES

1) No water Seepage.
2) No sample taken.
3) Stable side walls.

CONTRACTOR :
MACHINE : CAT 428
DRILLED BY :
PROFILED BY : G. Manganyi

TYPE SET BY : G. Mogashoa
SETUP FILE : KKK.SET

INCLINATION :
DIAM : 0.7m trench
DATE : 27/06/2019
DATE : 27/06/2019

DATE : 15/07/2019 20:49
TEXT : ..n\2019\Lydenburglogs.txt

ELEVATION :
X-COORD : -25.112918
Y-COORD : 30.431361

HOLE No: **TP3**

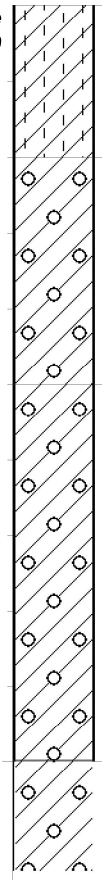
dotPLOT 7022

KSH (PTY) LTD
Lydenburg Geotechnical Investigation

HOLE No: **TP4**
Sheet 1 of 1

JOB NUMBER: **MWEM 19-22**

Scale 1:10



0.00	"Slightly moist, brown, soft, intact, silty CLAY. TRANSPORTED"
0.20	"Moist, brown and yellow mottled black, slightly shattered, gravelly CLAY with subangular boulders and minor gravels. FERRUGINISED RESIDUAL"
0.50	"Moist, brown mottled black, very stiff, intact, gravelly CLAY. RESIDUAL"
1.00	"End of hole, continues as above."

NOTES

1) No water Seepage.
2) No sample taken.
3) Stable side walls.

CONTRACTOR :
MACHINE : CAT 428
DRILLED BY :
PROFILED BY : G. Manganyi

TYPE SET BY : G. Mogashoa
SETUP FILE : KKK.SET

INCLINATION :
DIAM : 0.7m trench
DATE : 27/06/2019
DATE : 27/06/2019

DATE : 15/07/2019 20:38
TEXT : ..n\2019\Lydenburglogs.txt

ELEVATION :
X-COORD : -25.111995
Y-COORD : 30.432016

HOLE No: **TP4**

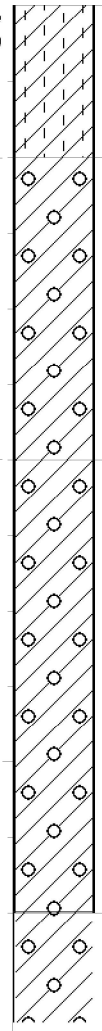
MWEM PTY LIMITED
MASANA WASTE & ENVIRONMENTAL MANAGEMENT

KSH (PTY) LTD
Lydenburg Geotechnical Investigation

HOLE No: **TP5**
Sheet 1 of 1

JOB NUMBER: **MWEM 19-22**

Scale 1:10



0.00	"Slightly moist, brown, soft, intact, silty CLAY. TRANSPORTED"
0.20	"Moist, brown, soft to slightly stiff, shattered, gravelly CLAY. TRANSPORTED"
0.60	"Moist, brown mottled black, very stiff, intact, gravelly CLAY. RESIDUAL"
1.20	"End of hole, continues as above"

NOTES

1) No water Seepage.
2) Disturbed sample TP5 at 0.2--0.6 m.
3) Stable side walls.

CONTRACTOR :
MACHINE : CAT 428
DRILLED BY :
PROFILED BY : G. Manganyi

TYPE SET BY : G. Mogashoa
SETUP FILE : KKK.SET

INCLINATION :
DIAM : 0.7m trench
DATE : 27/06/2019
DATE : 27/06/2019

DATE : 15/07/2019 21:28
TEXT : ..n\2019\Lydenburglogs.txt

ELEVATION :
X-COORD : -25.110734
Y-COORD : 30.432707

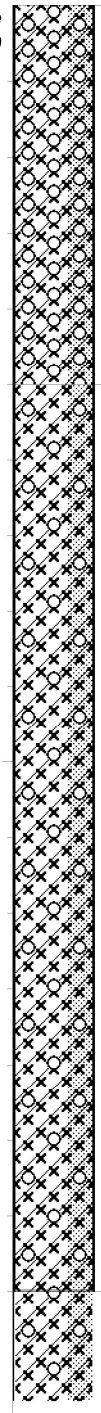
HOLE No: **TP5**

KSH (PTY) LTD
Lydenburg Geotechnical Investigation

HOLE No: **TP6**
Sheet 1 of 1

JOB NUMBER: **MWEM 19-22**

Scale 1:10



0.00 "Moist, brown, stiff, intact, gravelly CLAY with diabase gravels and minor roots. WEATHERED DIABASE "

0.50 "Moist, yellow, stiff, intact, gravelly CLAY with diabase in places. HIHGLY WEATHERED DIABASE"

1.70 "End of hole, continues as above."

NOTES

1) No water Seepage.
2) No sample taken.
3) Stable side walls.

CONTRACTOR :
MACHINE : CAT 428
DRILLED BY :
PROFILED BY : G. Manganyi

TYPE SET BY : G. Mogashoa
SETUP FILE : KKK.SET

INCLINATION :
DIAM : 0.7m trench
DATE : 27/06/2019
DATE : 27/06/2019

DATE : 15/07/2019 20:38
TEXT : ..n\2019\Lydenburglogs.txt

ELEVATION :
X-COORD : -25.109515
Y-COORD : 30.433447

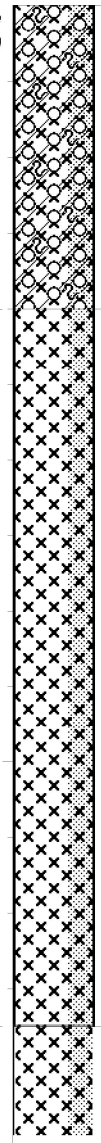
HOLE No: **TP6**

KSH (PTY) LTD
Lydenburg Geotechnical Investigation

HOLE No: **TP7**
Sheet 1 of 1

JOB NUMBER: **MWEM 19-22**

Scale 1:10



TP7

0.00 "Moist, brown, stiff, intact, gravelly CLAY with diabase gravels and minor roots. WEATHERED DIABASE"

0.40 "Black, moderately weathered, fine grained, hard, HIGHLY FRACTURED DIABASE ROCK"

1.35 "End of hole, continues as above."

NOTES

1) No water Seepage.
2) Disturbed sample TP7 at 0.4--1.35 m.
3) Stable side walls.

CONTRACTOR :
MACHINE : CAT 428
DRILLED BY :
PROFILED BY : G. Manganyi

TYPE SET BY : G. Mogashoa
SETUP FILE : KKK.SET

INCLINATION :
DIAM : 0.7m trench
DATE : 27/06/2019
DATE : 27/06/2019

DATE : 16/07/2019 08:51
TEXT : ..n\2019\Lydenburglogs.txt

ELEVATION :
X-COORD : -25.11076
Y-COORD : 30.437018

HOLE No: **TP7**

IN DEMO MODE!

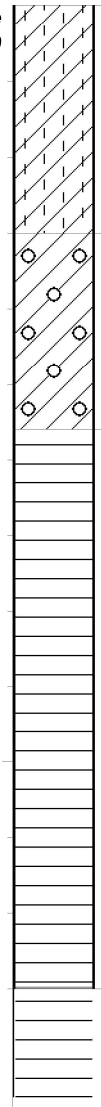
dotPLOT 7022

KSH (PTY) LTD
Lydenburg Geotechnical Investigation

HOLE No: **TP8**
Sheet 1 of 1

JOB NUMBER: **MWEM 19-22**

Scale 1:10



0.00	"Slightly moist, brown, soft, intact, silty CLAY with quartz pebbles. TRANSPORTED"
0.30	"Moist, brown and yellow mottled black, slightly shattered, gravelly CLAY with subangular boulders and quartz pebbles and minor gravels. FERRUGINISED RESIDUAL"
0.56	"Greyish black, moderately weathered, fine grained, hard. MUDSTONE ROCK."
1.30	"End of hole, continues as above."

NOTES

1) No water Seepage.
2) No sample taken.
3) Stable side walls.

CONTRACTOR :
MACHINE : CAT 428
DRILLED BY :
PROFILED BY : G. Manganyi

TYPE SET BY : G. Mogashoa
SETUP FILE : KKK.SET

INCLINATION :
DIAM : 0.7m trench
DATE : 27/06/2019
DATE : 27/06/2019

DATE : 16/07/2019 08:51
TEXT : ..n\2019\Lydenburglogs.txt

ELEVATION :
X-COORD : -25.110153
Y-COORD : 30.435479

HOLE No: **TP8**

dotPLOT 7022

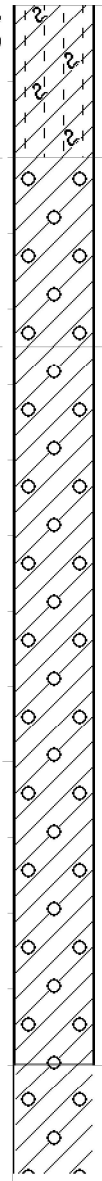
MWEM PTY LIMITED
MASANA WASTE & ENVIRONMENTAL MANAGEMENT

KSH (PTY) LTD
Lydenburg Geotechnical Investigation

HOLE No: **TP9**
Sheet 1 of 1

JOB NUMBER: **MWEM 19-22**

Scale 1:10



TP9

0.00	"Slightly moist, brown, soft, intact, silty CLAY with roots in places. TRANSPORTED "
0.20	"Moist, brown and yellow mottled black, slightly shattered, gravelly CLAY with minor gravels. FERRUGINISED RESIDUAL"
0.45	"Moist, brown mottled black, very stiff, intact, gravelly CLAY. RESIDUAL"
1.40	"End of hole, continues as above"

NOTES

1) No water Seepage.
2) Disturbed sample TP9 at 0.2--0.45 m.
3) Stable side walls.

CONTRACTOR :
MACHINE : CAT 428
DRILLED BY :
PROFILED BY : G. Manganyi

TYPE SET BY : G. Mogashoa
SETUP FILE : KKK.SET

INCLINATION :
DIAM : 0.7m trench
DATE : 27/06/2019
DATE : 27/06/2019

DATE : 15/07/2019 20:38
TEXT : ..n\2019\Lydenburglogs.txt

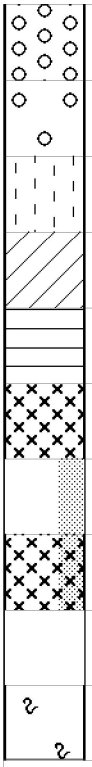
ELEVATION :
X-COORD : -25.112096
Y-COORD : 30.436522

HOLE No: **TP9**

KSH (PTY) LTD
Lydenburg Geotechnical Investigation

LEGEND
Sheet 1 of 1

JOB NUMBER: **MWEM 19-22**



GRAVELS	{SA02}
GRAVELLY	{SA03}
SILTY	{SA07}
CLAY	{SA08}
MUDSTONE	{SA12}
HYPABYSSAL/anorthosite/syenite aplite	{SA18}
DIORITE FAMILY	{SA41}
DIABASE	{SA18}{SA41}
DISTURBED SAMPLE	{SA38}
ROOTS	{SA40}

Name

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : G. Mogashoa
SETUP FILE : KKK.SET

DATE : 15/07/2019 20:38
TEXT : ..n\2019\Lydenburglogs.txt

LEGEND
SUMMARY OF SYMBOLS

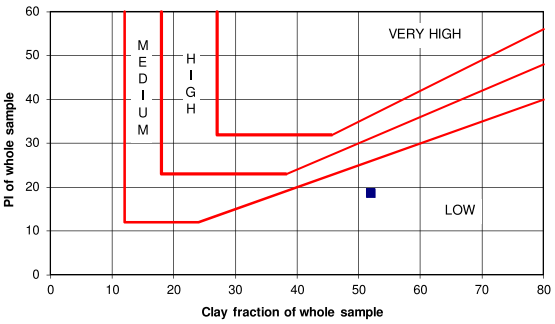
dotPLOT 7022

PARTICLE SIZE ANALYSIS

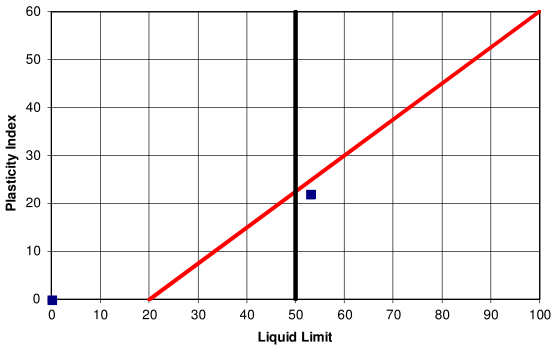
Sample No.	1
Soillab Sample No.	S19-1182-01
Depth (m)	0.5 - 1.0
Position	TP 04
Material Description	LIGHT OLIVE FERRICRETE SANDY CLAY
Relative density on < 2 mm **(SANS 5844)**	2.479
Organic Material	
Moisture (%) / Dispersion (%)	
SCREEN ANALYSIS (% PASSING) **(SANS 3001:GR1)**	
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	100
5.0 mm	99
2.00 mm	96
0.425 mm	85
0.075 mm	76
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
53 µm	69
31 µm	65
13 µm	56
6 µm	52
2 µm	49
% Clay	52
% Silt	17
% Sand	27
% Gravel	4
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	53
Plasticity Index	22
Linear Shrinkage (%)	12.0
Grading Modulus	0.43
Classification	A-7-5 (18)
Unified Classification	MH
Chart Reference	

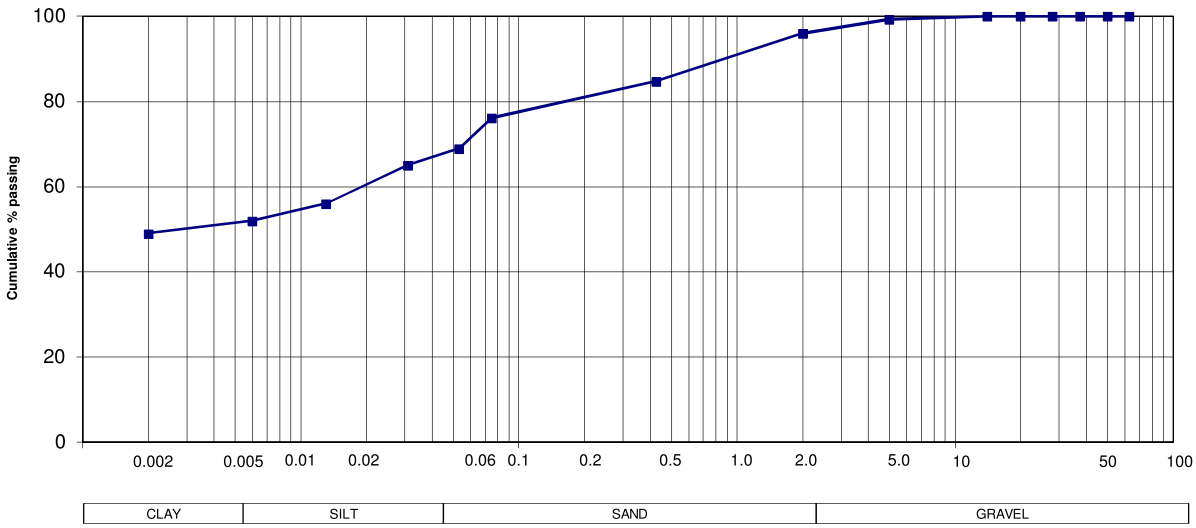
PROJECT : MWEM-19-22 LYNDENBURG GEOTECHNICAL INVESTIGATION
JOB No. : S19-1182
DATE : 2019-07-12

POTENTIAL EXPANSIVENESS



PLASTICITY CHART



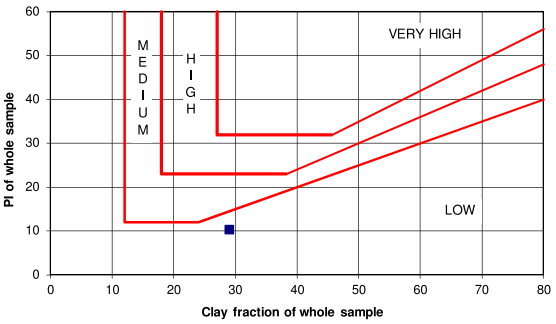


PARTICLE SIZE ANALYSIS

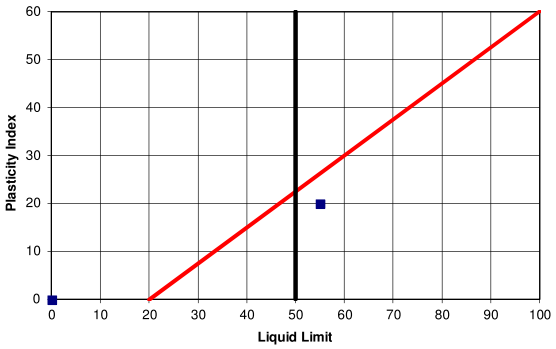
Sample No.	2
Soillab Sample No.	S19-1182-02
Depth (m)	0.2 - 0.6
Position	TP 05
Material Description	DARK BROWN FERRICRETE CLAYEY SAND
Relative density on < 2 mm **(SANS 5844)**	2.568
Organic Material	
Moisture (%) / Dispersion (%)	
SCREEN ANALYSIS (% PASSING) **(SANS 3001:GR1)**	
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	98
20.0 mm	96
14.0 mm	95
5.0 mm	91
2.00 mm	72
0.425 mm	52
0.075 mm	45
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
51 µm	42
30 µm	38
13 µm	32
6 µm	29
2 µm	27
% Clay	29
% Silt	13
% Sand	30
% Gravel	28
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	55
Plasticity Index	20
Linear Shrinkage (%)	10.5
Grading Modulus	1.32
Classification	A-7-5 (6)
Unified Classification	SM
Chart Reference	

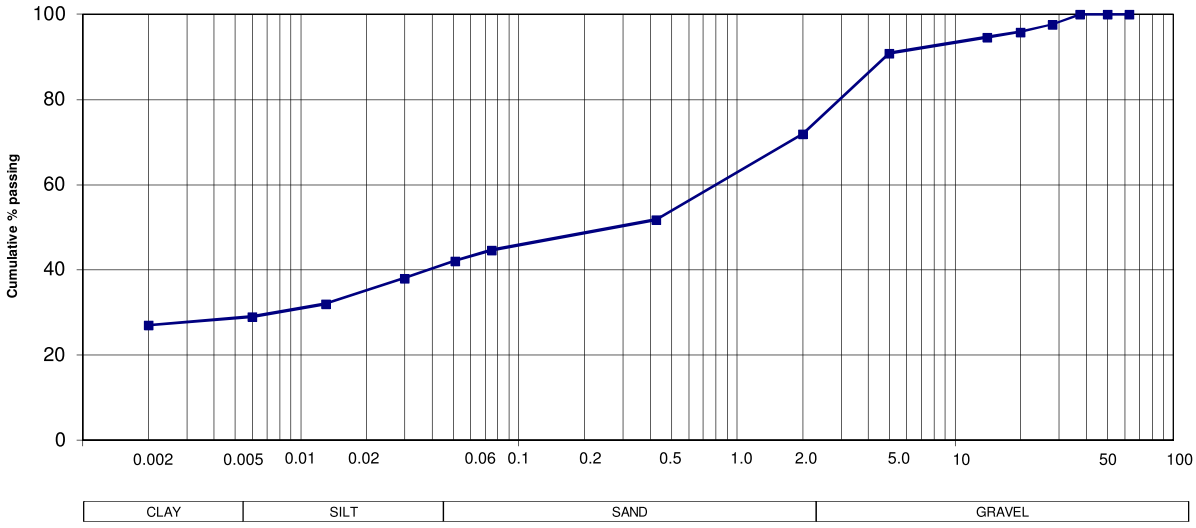
MWEM-19-22 LYNDENBURG GEOTECHNICAL
PROJECT : INVESTIGATION
JOB No. : S19-1182
DATE : 2019-07-12

POTENTIAL EXPANSIVENESS



PLASTICITY CHART



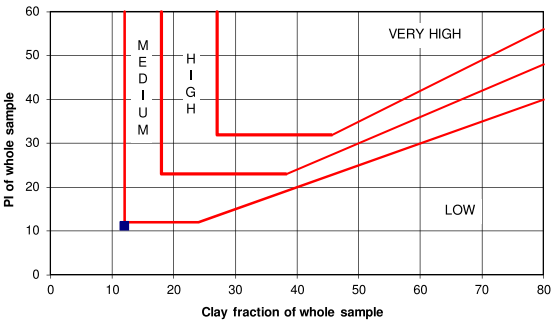


PARTICLE SIZE ANALYSIS

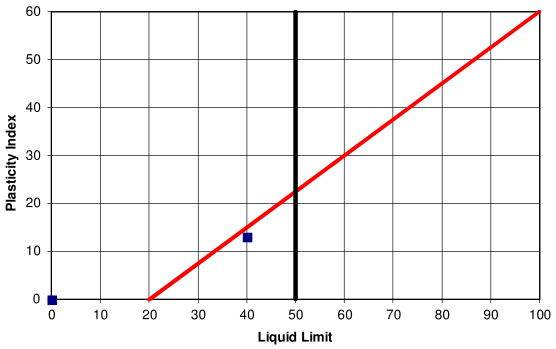
Sample No.	3
Soillab Sample No.	S19-1182-03
Depth (m)	0.56 - 1.3
Position	TP 07
Material Description	DARK OLIVE FERRICRETE SILTY SAND
Relative density on < 2 mm **(SANS 5844)**	2.602
Organic Material	
Moisture (%) / Dispersion (%)	
SCREEN ANALYSIS (% PASSING) **(SANS 3001:GR1)**	
63.0 mm	100
50.0 mm	100
37.5 mm	98
28.0 mm	92
20.0 mm	92
14.0 mm	92
5.0 mm	91
2.00 mm	90
0.425 mm	86
0.075 mm	66
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
60 µm	31
35 µm	26
15 µm	15
6 µm	12
2 µm	7
% Clay	12
% Silt	19
% Sand	59
% Gravel	10
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	40
Plasticity Index	13
Linear Shrinkage (%)	6.5
Grading Modulus	0.59
Classification	A-6 (8)
Unified Classification	ML
Chart Reference	

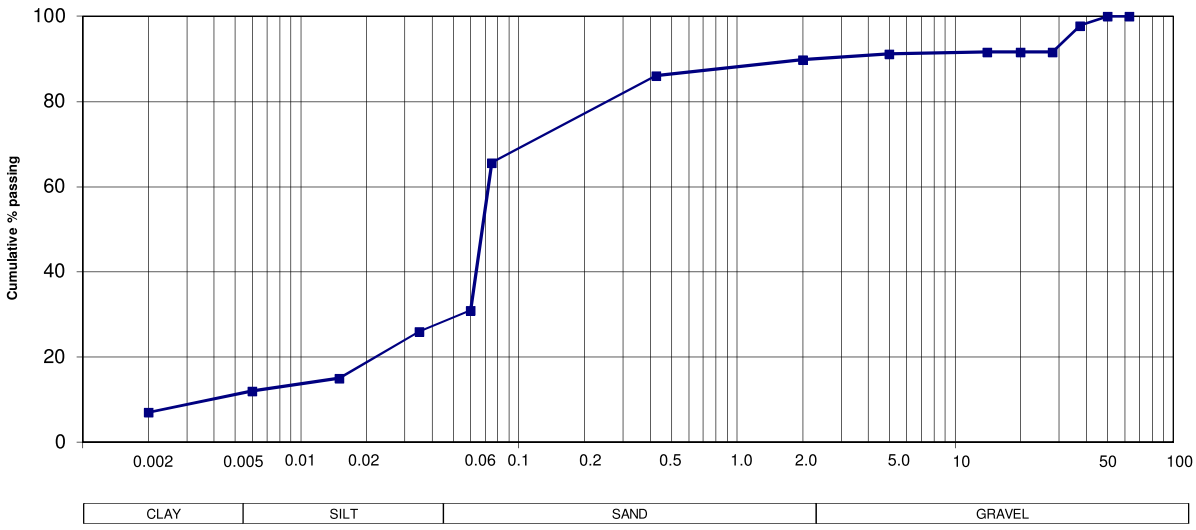
MWEM-19-22 LYNDENBURG GEOTECHNICAL
PROJECT : INVESTIGATION
JOB No. : S19-1182
DATE : 2019-07-12

POTENTIAL EXPANSIVENESS



PLASTICITY CHART



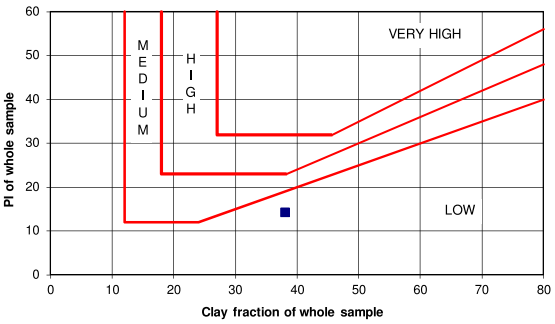


PARTICLE SIZE ANALYSIS

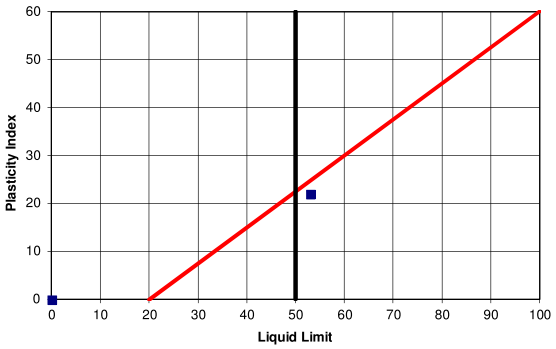
Sample No.	4
Soillab Sample No.	S19-1182-04
Depth (m)	0.6 - 1.0
Position	TP 11
Material Description	DARK BROWN FERRICRETE SANDY CLAY
Relative density on < 2 mm **(SANS 5844)**	2.505
Organic Material	
Moisture (%) / Dispersion (%)	
SCREEN ANALYSIS (% PASSING) **(SANS 3001:GR1)**	
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	100
5.0 mm	97
2.00 mm	81
0.425 mm	65
0.075 mm	58
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
52 µm	54
31 µm	50
13 µm	41
6 µm	38
2 µm	36
% Clay	38
% Silt	16
% Sand	27
% Gravel	19
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	53
Plasticity Index	22
Linear Shrinkage (%)	11.0
Grading Modulus	0.96
Classification	A-7-5 (11)
Unified Classification	MH
Chart Reference	

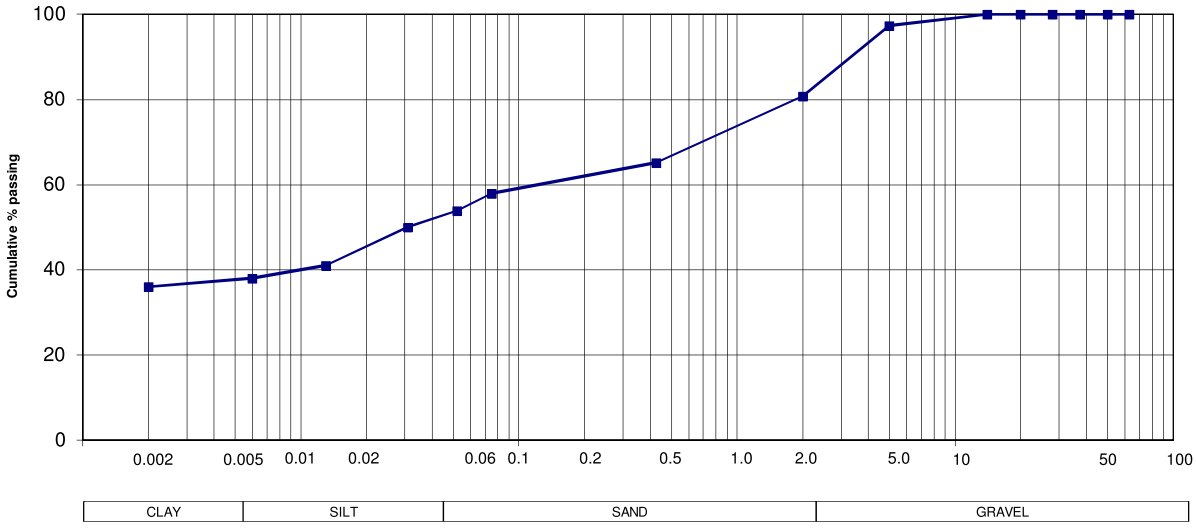
PROJECT : MWEM-19-22 LYNDENBURG GEOTECHNICAL INVESTIGATION
JOB No. : S19-1182
DATE : 2019-07-12

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





PARTICLE SIZE ANALYSIS

Sample No.	5
Soillab Sample No.	S19-1182-05
Depth (m)	0.53 - 1.53
Position	TP 12
Material Description	DARK OLIVE SANDY CLAY
Relative density on < 2 mm **(SANS 5844)**	2.491
Organic Material	
Moisture (%) / Dispersion (%)	
SCREEN ANALYSIS (% PASSING) **(SANS 3001:GR1)**	
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	100
5.0 mm	100
2.00 mm	99
0.425 mm	91
0.075 mm	80
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
53 µm	76
31 µm	70
13 µm	58
6 µm	54
2 µm	48
% Clay	54
% Silt	22
% Sand	23
% Gravel	1
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	61
Plasticity Index	21
Linear Shrinkage (%)	10.0
Grading Modulus	0.30
Classification	A-7-5 (21)
Unified Classification	MH
Chart Reference	

PROJECT : MWEM-19-22 LYNDENBURG GEOTECHNICAL INVESTIGATION
JOB No. : S19-1182
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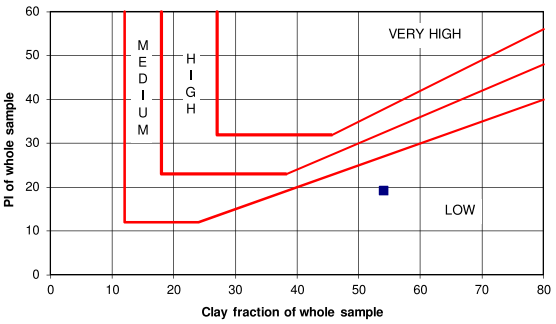
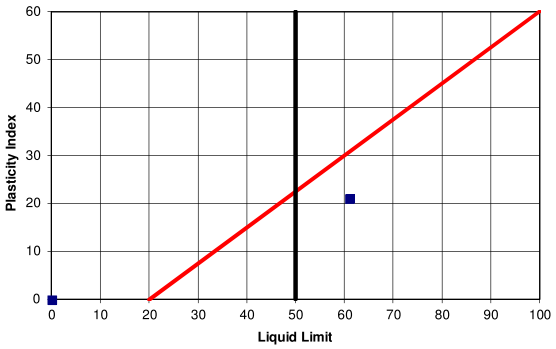
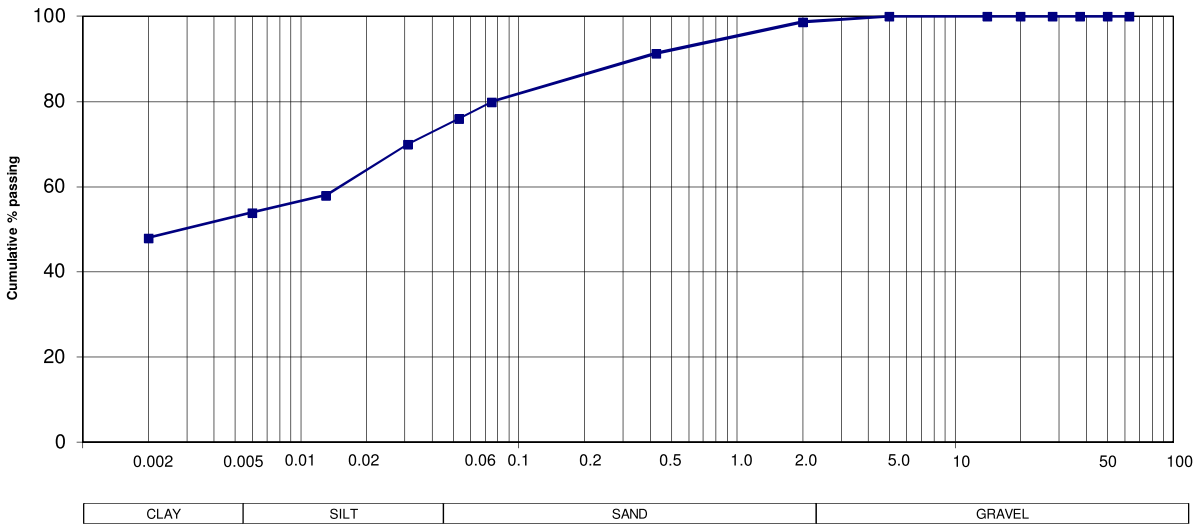
POTENTIAL EXPANSIVENESS



PLASTICITY CHART





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Project Description

Client:	MWEM	Soillab Job No.:	S19-1182
Job Description:	MWEM-19-22 LYDENBURG GEOTECHNICAL INVESTIGATION	Contract Number:	
Date:	2019-07-17	Reference Number:	

Sample Description

Soillab Sample No.:	S19-1182-01	S19-1182-04	S19-1182-05	
Sample Description:	TP 04	TP 11	TP 12	
Sample Depth:	0.5 - 1.0	0.6 -1.1	0.53 - 1.53	
Material Description:	LIGHT OLIVE FERRICRETE	DARK BROWN FERRICRETE	DARK OLIVE	

Screen Analysis (% Passing) - SANS 3001-GR1

75,00 mm	100	100	100	
63,00 mm	100	100	100	
50,00 mm	100	100	100	
37,50 mm	100	100	100	
28,00 mm	100	100	100	
20,00 mm	100	100	100	
14,00 mm	100	100	100	
5,00 mm	99	97	100	
2,000 mm	96	81	99	
0,425 mm	85	65	91	
0,075 mm	76	58	80	

Soil-mortar percentages - SANS 3001-PR5

Coarse Sand	2.000-0.425mm	12	19	8	
Coarse Fine Sand	0.425-0.250mm	2	2	3	
Medium Fine Sand	0.250-0.150mm	3	3	4	
Fine Fine Sand	0.150-0.075mm	4	4	5	
Silt and clay	<0.075mm	79	72	81	

Constants

Grading Modulus	SANS 3001-PR5	0.43	0.96	0.30	
Liquid Limit		53	53	61	
Plasticity Index	SANS 3001-GR10	22	22	21	
Linear Shrinkage		12.0	11.0	10.0	

MOD AASHTO - SANS 3001-GR30

Max Dry Density (kg/m³)	1599	1798	1615	
Optimum Moisture Content (%)	19.6	15.6	21.3	

CBR - SANS 3001-GR40

MOD AASHTO				
Moulding Moisture Content (%)	19.7	15.6	21.4	
Dry Density (kg/m³)	1584	1802	1618	
% of Max Dry Density	99.0	100.2	100.2	
100% MOD CBR (%)	5	10	5	
% Swell	0.1	1.2	2.2	
NRB				
Dry Density (kg/m³)	1516	1716	1550	
% of Max Dry Density	94.8	95.5	96.0	
100% NRB CBR (%)	2	4	2	
% Swell	0.2	1.5	4.6	
PROCTOR				
Dry Density (kg/m³)	1449	1637	1457	
% of Max Dry Density	90.6	91.0	90.2	
100% PROCTOR CBR (%)	1	2	1	
% Swell	0.3	2.6	6.4	
CBR (%)				
100% Mod AASHTO	6	10	5	
98% Mod AASHTO	4	7	3	
97% Mod AASHTO	4	6	3	
95% Mod AASHTO	2	4	2	
93% Mod AASHTO	2	3	2	
90% Mod AASHTO	1	2	1	
COLTO Classification:	**>G9**	**>G9**	**>G9**	