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REPORT
ON
THE ENGINEERING GEOLOGICAL INVESTIGATION
OF
THE PROPOSED NEW TOWNSHIP
SITUATED
ON
VARIOUS PORTIONS
OF
THE FARM BOSCHKOP 369 JR
FOR
TOWNSHIP ESTABLISHMENT

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Client

TIMPROPS

REPORT ON THE ENGINEERING GEOLOGICAL INVESTIGATION OF THE PROPOSED NEW TOWNSHIP SITUATED ON VARIOUS PORTIONS OF THE FARM BOSCHKOP 369 JR FOR TOWNSHIP ESTABLISHMENT.

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1. INTRODUCTION

Louis Kruger Geotechnics CC was appointed by Timprops to do a Phase 2 engineering geological investigation for the proposed new township situated on Various Portions of the farm Boschkop 369 JR for township establishment. The investigation was undertaken according to the normal requirements for township proclamation to assess the suitability of the site for residential development (Guidelines for Urban Engineering Geological Investigations 1997). The following aspects are addressed in this report:

- Geology and Soil profile
- Geohydrology
- Foundation conditions
- Construction material

2. TERMS OF REFERENCE

The appointment was to do an engineering geological investigation (non-dolomitic) for the proposed new township situated on Various Portions of the farm Boschkop 369 JR. Since large areas of the proposed site will not be developed, Louis Kruger Geotechnics was requested to concentrate the investigation on the proposed stands.

The following aspects were to be addressed:

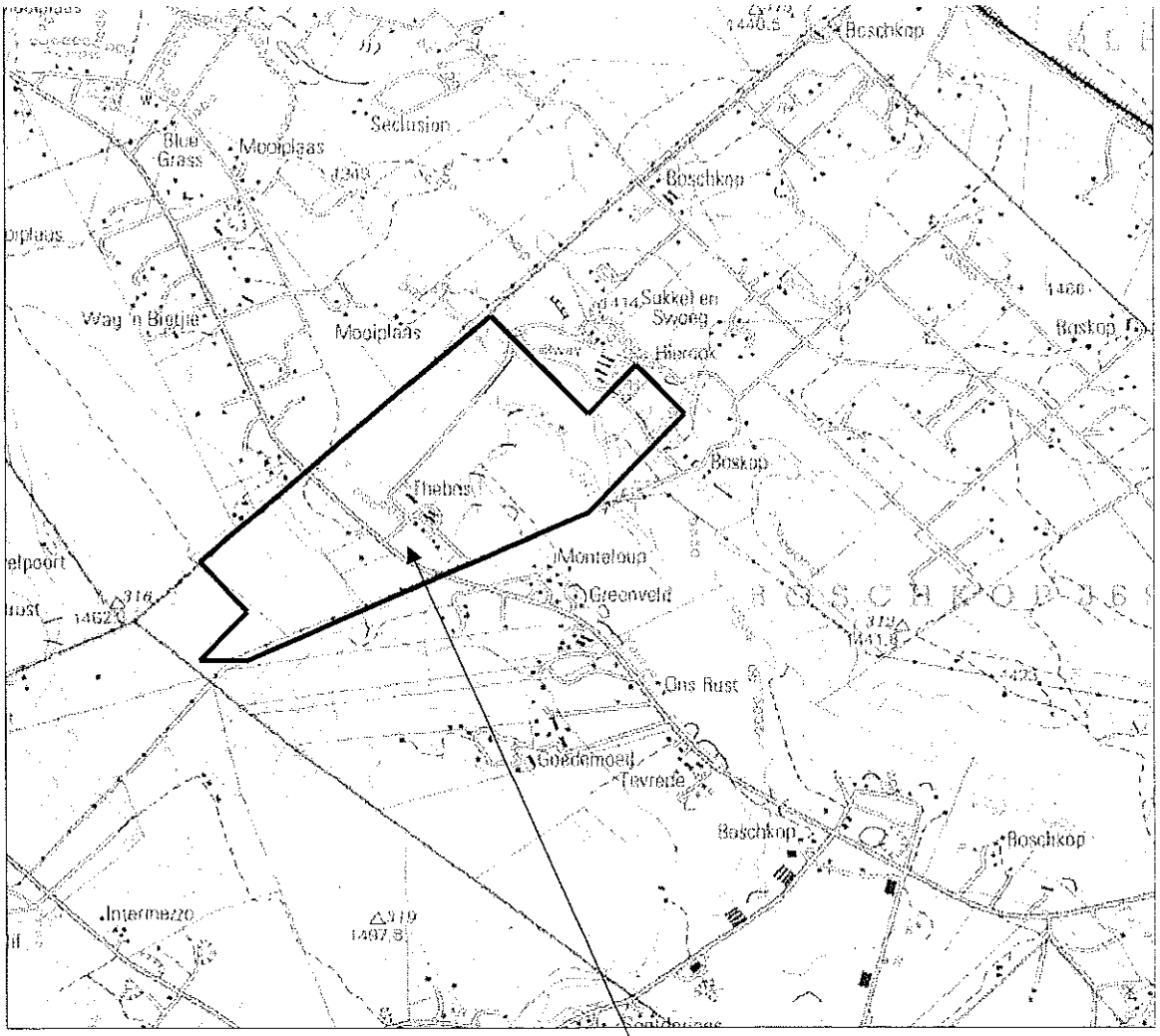
- The geotechnical characteristics of the site
- Geotechnical constraints
- Founding conditions
- NHBRC Zoning

The locality of the site is shown on Figure 1.

3. AVAILABLE INFORMATION

The following information was available:

- 1 : 50 000 Geological Map, Rietvleidam 2528 CD
- Locality plan
- Contour plan and aerial photographs
- "Report on the Reconnaissance Engineering Geological Investigation for the Proposed New Township Situated on the Farm Boschkop 369 JR", Louis Kruger Geotechnics, December 2004.



LOCALITY	FIGURE 1 SCALE: 1 : 50 000

4. LOCALITY

The proposed site is situated is situated east of Pretoria on the farm Boschkop. It is bounded by undeveloped property on all the sides. The proposed site is divided into two by the Provincial Road K631. The locality of the site is shown on Figure 1.

5. TOPOGRAPHY AND DRAINAGE

The main topographical features on the site are the northern slopes of the Bronberg, south of the K631, the pediment north of the road, a steep ridge north of the dam and varying slopes north of the ridge. On the southern part of the site, the side slope of the Bronberg is characterized by a series of ridges and knolls, broken by localized pediments, the average slope of this part of the site is 7%. The pediment north of the road (K631) slopes at an average of 3% towards the dam in the Pienaars River. Directly north of the dam a near vertical slope form the third topographical unit, and north of the ridge the site slopes towards the south-west and south east at average slopes varying between 3% and 7%, the slopes increases considerably on the northern boundary of the site.

The site is drained by the Pienaars River and a tributary of it, a large dam is present in the Pienaars River on the site. The site drains by means of sheet wash to the river and the tributary. The topography of the site and the 1 : 100 year flood lines of the streams are shown on Figure 2.

6. METHOD OF INVESTIGATION

The layout of the proposed development was available at the time of the investigation and Louis Kruger Geotechnics was instructed by the client to concentrate the investigation on the proposed stands. The proposed layout is shown on Figure 3. Fifty test pits were dug at predetermined positions on the site and the soil profiles were described according to the standard method proposed by Jennings, Brink and Williams (1973). Due to the steep ridges and large boulders on the slopes south of the K631, access to all the stands on this part of the site was limited. Disturbed samples of the most prominent soil horizons were taken and submitted to a soils laboratory for foundation indicator tests. Due to the clay- and gravel content of the materials encountered on the site, no undisturbed samples were taken.

7. GEOLOGY AND SOIL PROFILE

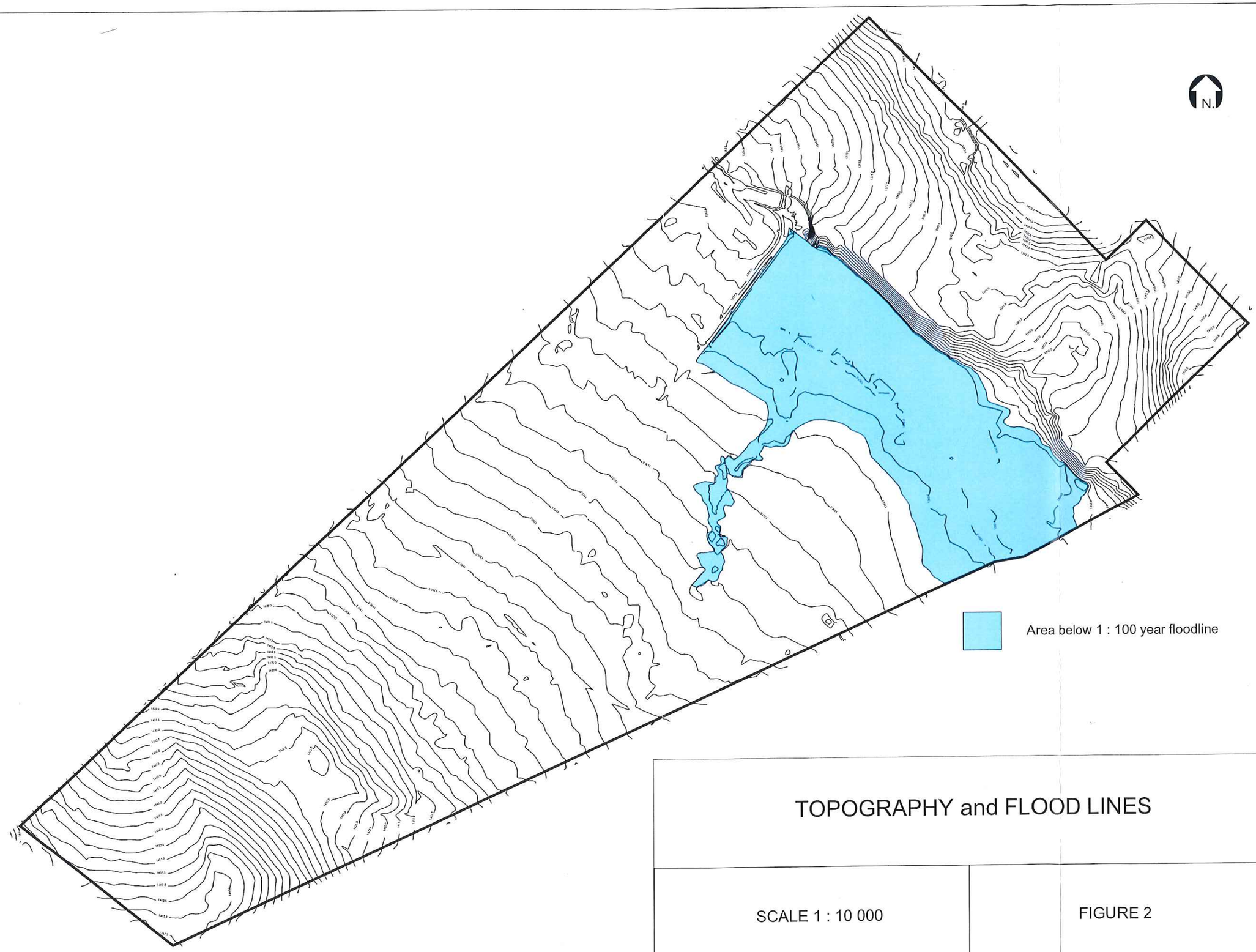
7.1 Geology

According to the 1 : 50 000 scale geological map the site is underlain by shale of the Transvaal Sequence and by diabase- and syenite intrusions. The geology and the topography of the site are closely related. The terraces and ridges on the northern slopes of the Bronberg is formed by diabase, the pediment by shale, the steep ridge north of the dam by diabase and the flatter area north of the ridge is underlain by shale. The higher lying area on the northern boundary is formed by diabase.

The geology as shown on the geological map was confirmed during the investigation, diabase was encountered south of the road, on the central part of the site, on the ridge and north of the ridge. Shale was encountered on the remainder of the site. The presence of the syenite dyke was not confirmed since the part of the site where it occurs was not investigated.

7.2 Soil Profile

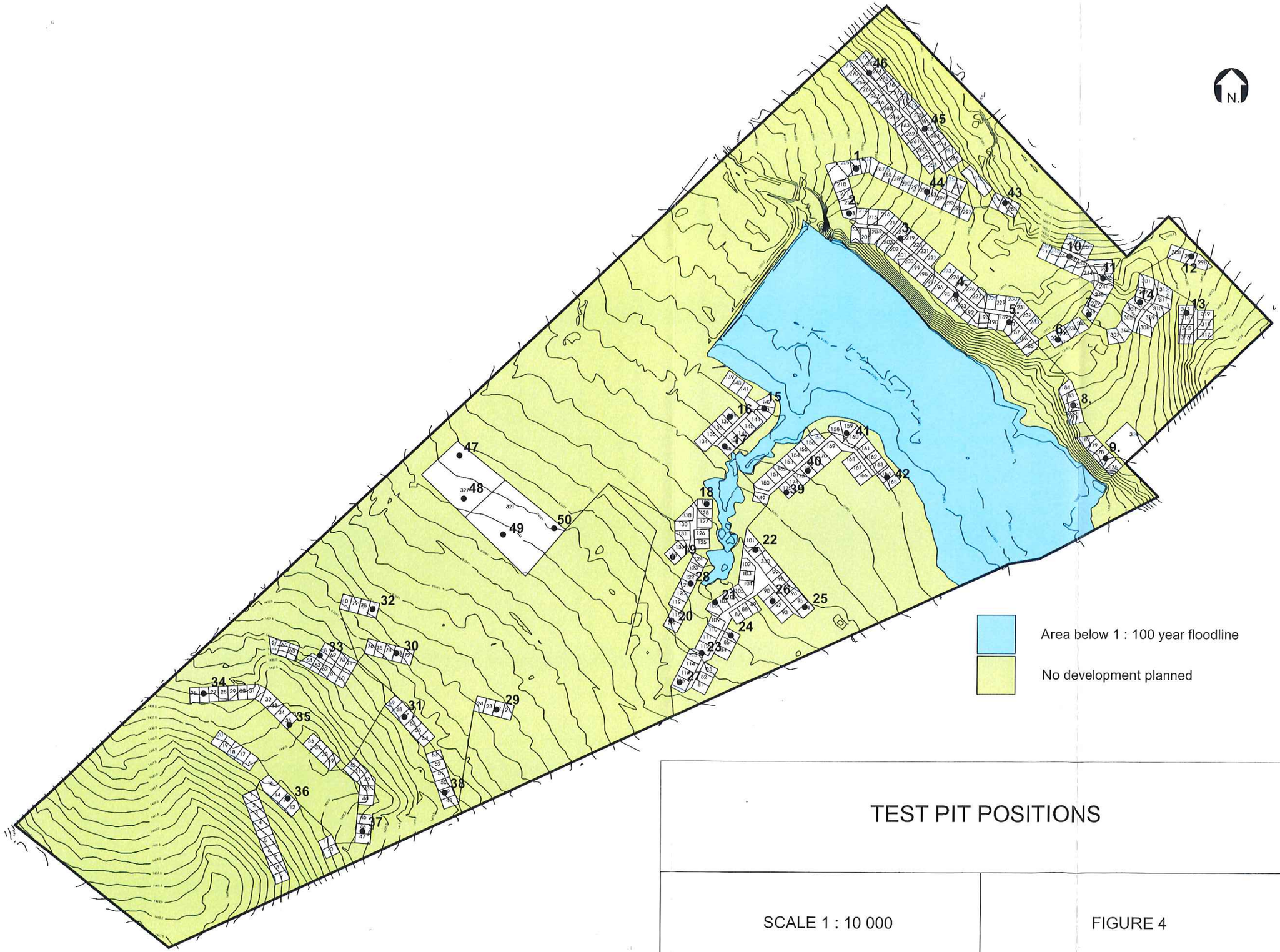
The test pit positions are shown on Figure 4, and the soil profiles are included as Appendix A. The following materials were encountered on the site:



TOPOGRAPHY and FLOOD LINES

SCALE 1 : 10 000

FIGURE 2



TEST PIT POSITIONS

SCALE 1 : 10 000

FIGURE 4

7.2.1 Hillwash

Two types of hillwash were identified on the site:

- Hillwash encountered on the slopes of the Bronberg, south of the road
- Hillwash encountered on the slopes north of the dam and ridge

Hillwash encountered on the slopes of the Bronberg, south of the road.

Slightly moist, dark brown, loose, microshattered, clayey gravely sand with diabase cobbles and plant roots was encountered in ten test pits from surface up to an average depth of 0,5 meters.

Hillwash encountered on the slopes north of the dam and ridge

Slightly moist, brown, loose, slightly slickensided, shattered, gravely, silty sand with abundant shale was encountered in sixteen test pits from surface up to an average depth of 0,3 meters. This material covers the southern and central part of the site.

7.2.2 Colluvium

Slightly moist, red brown, soft, microshattered, slightly slickensided gravely clay with shale fragments was encountered in five test pits from surface up to an average depth of 0,6 meters. This material predominantly occurs on the central part of the site, north of the road.

7.2.3 Alluvium

Slightly moist, black, firm to stiff, fissured, slickensided, sandy clay with calcrete nodules and plant roots was encountered in seventeen test pits from surface up to an average depth of 1,7 meters. The alluvium exceeds two meters on the part of the site to the west and south-east of the tributary of the Pienaars River and on the western part of the site, north of the K631.

7.2.4 Residual shale

Slightly moist, reddish orange brown mottled white, firm to stiff, intact, sandy clay with ferricrete nodules was encountered below the transported materials in twelve test pits, from an average depth of 1,2 meters up to an average depth of 2,0 meters. This material predominantly occurs on the central part of the site, north of the road.

7.2.5 Shale bedrock

Soft and medium hard rock shale (slate) was encountered north of the road (K631). North of the dam shale is present at an average depth of 0,3 meters. South of the dam and west of the tributary the average depth to the shale bedrock is 1,3 meters and east of the tributary shale bedrock is present at depths exceeding three meters.

7.2.6 Residual diabase

Two types of residual diabase were identified on the site:

- A top layer of red brown residual diabase
- A bottom layer of yellowish brown residual diabase

Red brown residual diabase

Slightly moist, bright red brown, soft to firm, fissured, slickensided, silty clay with ferricrete nodules and with occasional small diabase corestones was encountered in five test pits north of the K631, from an average depth of 1,0 meters up to an average depth of 2,0 meters.

Yellowish brown residual diabase

Slightly moist, yellowish brown with black stained joints, firm to stiff, intact, slightly slickensided, clayey silt with small to medium hard rock slightly slickensided, clayey silt with small to medium hard rock diabase was encountered in twelve test pits from an average depth of 1,3 meters up to an average depth of 2,1 meters.

7.2.7 Diabase bedrock

Diabase bedrock was encountered in ten test pits. South of the road (K631) bedrock was encountered at an average depth of 0,5 meters and north of the road the depth to the diabase bedrock exceeds two meters. On the southern part of the site, the depth to bedrock could not be determined accurately due to the presence of medium and large diabase boulders, six test pits refused on diabase boulders at an average depth of 0,4 meters.

7.2.8 Conclusions

From the above it is concluded that:

- The test pits confirms the geology as shown by the 1: 50 000 scale geological map.
- Colluvium was encountered on the pediment, and hillwash on the steeper slopes on the northern- and southern parts of the site.
- Due to the poor drainage on the pediment, the bedrock on the pediment is more deeply weathered than on the steeper slopes.
- The variable weathering of diabase bedrock is well documented; the intermittent outcrops on the site and the variation in the depths to diabase bedrock encountered in the test pits confirm this phenomenon.

8. GEOHYDROLOGY

No groundwater was encountered during the investigation. Shale is notorious for the presence of a perched water table, water drains through the permeable subsoil, due to the low permeability of the shale bedrock the water drains along the bedrock. This perched water table normally follows the topography and drains towards streams and other drainage features. The presence of a shallow perched water table, that is expected to be present during and after periods of high rainfall, is confirmed by the presence of the ferricrete in the soil profiles and the shallow bedrock encountered on the site.

9. LABORATORY TEST RESULTS

9.1 Indicator test results

The laboratory test results are attached as Appendix B and are summarized in the following table:

MATERIAL	TP	DEPTH (m)	PI	% Clay	% Silt	% Sand	% Gravel
Hillwash south	31	0.4	26	21	11	37	30
Hillwash north	5	0.3	24	22	31	26	21
Colluvium	27	0.5	27	34	17	22	27
Alluvium	24	1	41	48	23	25	4
Alluvium	28	0.6	24	34	26	21	19
Alluvium	48	0.8	27	31	28	30	11
Residual shale	19	1	32	35	15	36	15
Residual shale	15	1	28	19	12	57	12
Red brown res diabase	14	1.2	29	40	35	20	6
Yellow res diabase	7	1.8	24	31	36	29	4
Yellow res diabase	29	1	24	34	34	28	4

The predominantly gravely nature of the hillwash and colluvium is clearly reflected by the high sand- and gravel content of the samples. The difference between the colluvium and hillwash is shown by the higher clay content of the colluvium. The difference between the hillwash, colluvium and alluvium is shown by the higher silt- and clay content of the alluvium. The difference between the transported- and residual materials is shown by the lower gravel- and higher clay content of the residual materials. The difference between the red brown residual diabase and the yellowish brown diabase is reflected by the higher sand- and lower clay content of the yellowish brown residual diabase.

9.2 Potential expansiveness

The potential expansiveness of the materials encountered on the site was calculated according to the method proposed by Van der Merwe (1964). The following material characteristics are considered when applying this method:

- Plasticity index
- Clay fraction (< 0,002 mm)
- Thickness of expansive material
- Thickness of non - expansive material

Assuming the laboratory test results typify the material encountered on the site, the application of the method of Van der Merwe shows that:

- The alluvium encountered on the western part of the site and west of the tributary classify as "Medium"
- The alluvium encountered east of the tributary classifies as "Very high"
- The colluvium and both types of hillwash classify as "Medium"
- The residual shale classifies as "Medium"
- The top layer of red brown residual diabase classifies as "High"
- The bottom layer of yellowish brown residual diabase classifies as "Medium"

Assuming the laboratory test results typify the material encountered on the site, the results of the application of the method of Van der Merwe are as follows:

Test Pit	Calculated heave (mm)
1	<7,5
2	<7,5
3	<7,5
4	<7,5
5	<7,5
6	<7,5
7	>30
8	<7,5
9	<7,5
10	<7,5
11	7,5-15
12	<7,5
13	<7,5
14	>30
15	>30
16	>30
17	>30

Test Pit	Calculated heave (mm)
18	>30
19	15-30
20	>30
21	>30
22	>30
23	>30
24	>30
25	>30
26	>30
27	>30
28	>30
29	15-30
30	<7,5
31	15-30
32	<7,5
33	<7,5
34	15-30

Test Pit	Calculated heave (mm)
35	7,5-15
36	7,5-15
37	15-30
38	7,5-15
39	>30
40	>30
41	>30
42	>30
43	<7,5
44	15-30
45	<7,5
46	<7,5
47	>30
48	>30
49	>30
50	15-30

From the table it is clear that the calculated heave of the test pits situated on the diabase south of the K631 is highly variable, this is due to the irregular weathering of the bedrock and the presence of diabase boulders (discussed in previous sections).

9.3 Undisturbed samples

Due to the high gravel- and clay content of the materials encountered on the site, no undisturbed samples were taken.

10. ENGINEERING GEOLOGICAL ZONING

Based on the soil profiles and laboratory test results, six engineering geological zones were identified:

Zone 1: Hillwash underlain by shale bedrock, calculated heave less than 7,5 mm

Zone 2: Hillwash and colluvium underlain by residual shale, calculated heave between 15 mm and 30 mm.

Zone 3: Hillwash underlain by residual diabase and diabase boulders, calculated heave variable, average heave between 15mm and 30 mm.

Zone 4: Alluvium underlain by residual shale and residual diabase and colluvium and hillwash underlain by residual diabase, calculated heave more than 30 mm

Zone 5: The part of the site that falls below the 1 : 100 year flood line

Zone 6: Parts of the site that were not considered for development

ZONE 1: Hillwash underlain by shale bedrock, calculated heave less than 7,5 mm

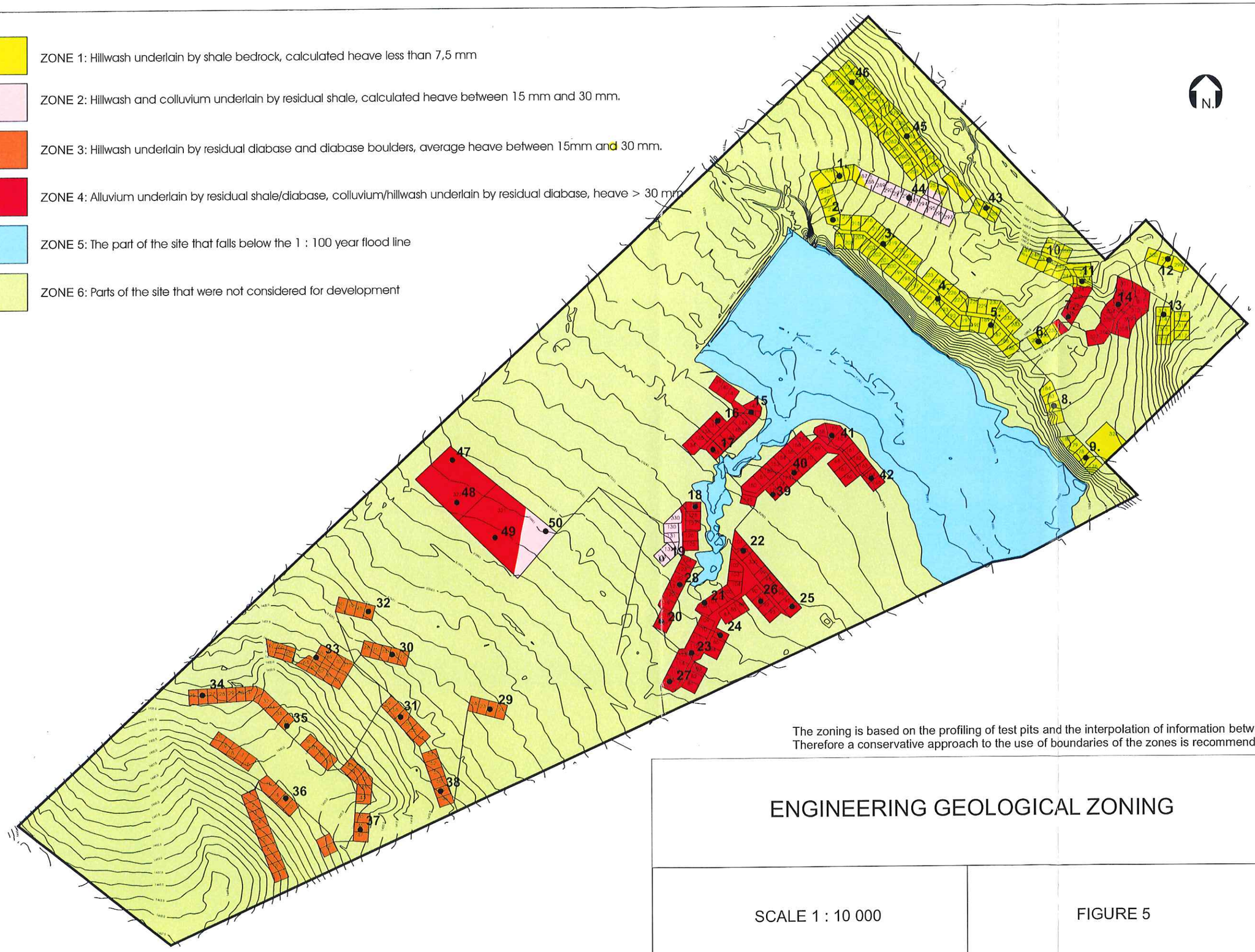
ZONE 2: Hillwash and colluvium underlain by residual shale, calculated heave between 15 mm and 30 mm.

ZONE 3: Hillwash underlain by residual diabase and diabase boulders, average heave between 15mm and 30 mm.

ZONE 4: Alluvium underlain by residual shale/diabase, colluvium/hillwash underlain by residual diabase, heave > 30 mm

ZONE 5: The part of the site that falls below the 1 : 100 year flood line

ZONE 6: Parts of the site that were not considered for development



The zoning is based on the profiling of test pits and the interpolation of information between test pits. Therefore a conservative approach to the use of boundaries of the zones is recommended.

ENGINEERING GEOLOGICAL ZONING

SCALE 1 : 10 000

FIGURE 5

The zoning is shown on Figure 5. The boundaries between the different zones are based on field observations and the interpolation of information between test pits. Therefore a conservative approach to the use of the engineering geological boundaries is recommended.

11. GEOTECHNICAL CONSIDERATIONS

The following geotechnical considerations, which could influence the proposed development, were identified:

11.1 Founding of structures

11.1.1 Engineering geological zone 1

- The hillwash is potentially expansive is potentially expansive, and classifies as "Medium" expansive. Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures
- The calculated heave is less than 7,5 mm
- The shale bedrock is considered suitable for the founding of light structures.

11.1.2 Engineering geological zone 2

- The hillwash, colluvium and residual shale are potentially expansive is potentially expansive, and classifies as "Medium" expansive. Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures
- The calculated heave in is between 15 mm and 30 mm.

11.1.3 Engineering geological zone 3

- The hillwash is potentially expansive, and classifies as "Medium" expansive. Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures
- The yellow residual diabase is potentially expansive and classifies as "Medium" expansive. Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures
- The variable weathering depth of the diabase over short distances and the presence of corestones are well documented; the abundant boulders and the variation in the bedrock depth on the site confirm this. Founding unadapted structures partly on boulders and partly on the residual material may result in unacceptable differential, vertical movements in structures, with resultant cracking of structures.

- The calculated heave in the test pits varies from less than 7,5 mm to more than 15 mm. Due to the variable weathering, presence of boulders and variable expansiveness a conservative approach is recommended. Therefore it is assumed that the calculated heave is between 15 mm and 30 mm.

11.1.4 Engineering geological zone 4

- The hillwash and colluvium are potentially expansive, and classifies as "Medium" expansive. Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures

- The alluvium is potentially expansive, and classifies as "Medium" to "Very high" expansive. Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures

- The residual shale is potentially expansive and classifies as "Medium" expansive. Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures

- The red brown residual diabase is potentially expansive, and classifies as "High" expansive. Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures

- The yellow residual diabase is potentially expansive and classifies as "Medium" expansive. Therefore, it is not considered suitable founding material. If unadapted structures are founded on this material, and the moisture condition of the insitu material should vary, unacceptable differential movements, with resultant cracking may occur in structures

- The calculated heave exceeds 30 mm.

11.1.5 Engineering geological zone 5

Since this part of the site is below the 1 : 100 year flood line, the founding of structures is not considered relevant.

11.1.6 Engineering geological zone 6

Since these parts of the site will not be developed and was therefore not investigated, the founding of structures is not considered relevant.

11.2 Excavatability

The average refusal depth in the different engineering geological zones is as follows:

- Zone 1: 1,0 meters
- Zone 2: 1,8 meters (variable and boulders are present)
- Zone 3: 0,8 meters (variable and boulders are present)
- Zone 4: 2,5 meters
- Zone 5: Not applicable
- Zone 6: Not applicable

11.3 Construction material

With the exception of the one sample of residual shale that classifies as A -2 – 7, all the materials on the site classify as A – 7 – 6 and A – 7 - 5.

11.4 Groundwater

A shallow perched water table, which could cause the flooding of excavations, is expected to be present on the site during and after high rainfall. This is confirmed by the presence of the shallow bedrock and the pedogenic material encountered in the test pits.

11.5 Stability of excavations

Instability occurred in the sidewalls of the test pits.

12. GEOTECHNICAL CLASSIFICATION

The site was classified according to the Geotechnical Classification for Urban Development (after Partridge, Wood and Brink 1993). The criteria for the classification are as follows:

GEOTECHNICAL CLASSIFICATION FOR URBAN DEVELOPMENT (after Partridge, Wood and Brink 1993)

	CONSTRAINT	MOST FAVOURABLE (1)	INTERMEDIATE (2)	LEAST FAVOURABLE (3)
A	Collapsible soil	Any collapsible horizon or consecutive horizons totalling a depth of less than 750 mm in thickness	Any collapsible horizon or consecutive horizons totalling a depth of more than 750 mm in thickness	A least favourable situation for this constraint does not occur
B	Seepage	Permanent or perched water table more than 1,5 meters below surface	Permanent or perched water table less than 1,5 meters below surface	Swamps or marshes
C	Active soil	Low soil heave predicted	Moderate soil heave predicted	High soil heave predicted
D	Highly compressible soil	Low soil compressibility expected	Moderate soil compressibility expected	High soil compressibility expected
E	Erodibility of soil	Low	Intermediate	High
F	Difficulty of excavation to 1,5 m depth	Scattered or occasional boulders less than 10% of the total volume	Rock or hardpan pedocretes between 10 and 40% of the total volume	Rock or hardpan pedocretes more than 40% of total volume
G	Undermined ground	Undermining at a depth greater than 100 m below surface (except where total extraction mining has not occurred)	Old undermined areas to a depth of 100 m below surface where stope closure has ceased	Mining within less than 100 m of surface or where total extraction mining has taken place
H	Instability in areas of soluble rock	Possibly unstable	Probably unstable	Known sinkholes and dolines
I	Steep slopes	Between 2 and 6 degrees (all regions)	Slopes between 6 and 18 degrees and less 2 degrees (Natal and Western Cape) Slopes between 6 and 12 degrees and less 2 degrees (all other regions)	More than 18 degrees (Natal and western Cape) More than 12 degrees (all other regions)
J	Areas of unstable	Low risk	Intermediate risk	High risk (especially in

	CONSTRAINT	MOST FAVOURABLE (1)	INTERMEDIATE (2)	LEAST FAVOURABLE (3)
	natural slopes			areas subject to seismic activity)
K	Areas subject to seismic activity	10% probability of an event less than 100 cm/s^2 within 50 years	Mining induced seismic activity more than 100 cm/s^2	Natural seismic activity more than 100 cm/s^2
L	Areas subject to flooding	A "most favourable" situation for this constraint does not occur	Areas adjacent to a known drainage channel or floodplain with slope less than 1%	Areas within a known drainage channel or floodplain

Based on the above, the site is classified as follows:

- Engineering geological zone 1: 1A 2B 2C 1/2D 1/2E 3F 2I
- Engineering geological zone 2: 1A 1/2B 2/3C 2D 2E 2/3F1I
- Engineering geological zone 3: 1A 2B 2/3C 1/2D 1/2E 3F 2/3I
- Engineering geological zone 4: 1A 1/2B 3C 2D 2E 2F 1/2I
- Engineering geological zone 5: 3L
- Engineering geological zone 6: Not applicable

13. NHBRC ZONING

ZONE	NHBRC ZONE	MOTIVATION
1 Geotechnical classification: 1A 2B 2C 1/2D 1/2E 3F 2I (see table)	P(Perched water table) - R – H	The hillwash classifies as "Medium" expansive. The calculated heave is less than 7,5 mm; therefore this part of the site is zoned as H. The presence of the shallow perched water table is accommodated by adding a zoning of P(Perched water table), and the presence of shallow bedrock is accommodated by adding a zoning of R.
2 Geotechnical classification: 1A 1/2B 2/3C 2D 2E 2/3F1I (see table)	P(Perched water table) - H2	The hillwash and colluvium classify as "Medium" expansive. The calculated heave is between 15 mm and 30 mm; therefore this part of the site is zoned as H2. The presence of the shallow perched water table is accommodated by adding a zoning of P(Perched water table).
3 Geotechnical classification: 1A 2B 2/3C 1/2D 1/2E 3F 2/3I (see table)	P(Perched water table) - R – S1/S2 – H2	The hillwash and yellowish brown diabase classify as "Medium" expansive and the red brown residual diabase classifies as "High". The calculated heave varies from less than 7,5 mm to more than 15 mm. Due to the variable weathering, presence of boulders and variable expansiveness a conservative approach is recommended; the average calculated heave is between 15 mm and 30 mm. Therefore this part of the site is zoned as H2. Due to the abundant boulders and the variable depth of weathering, differential settlement is expected if unadapted structures are founded partly on boulders and partly on the residual material or bedrock. Therefore, this part of the site is zoned as S1/S2. The presence of the shallow perched water table is accommodated by adding a zoning of P(Shallow water table), and the presence of shallow bedrock and boulders are accommodated by adding a zoning of R.

NHBRC ZONE P(Perched water table) - R - H

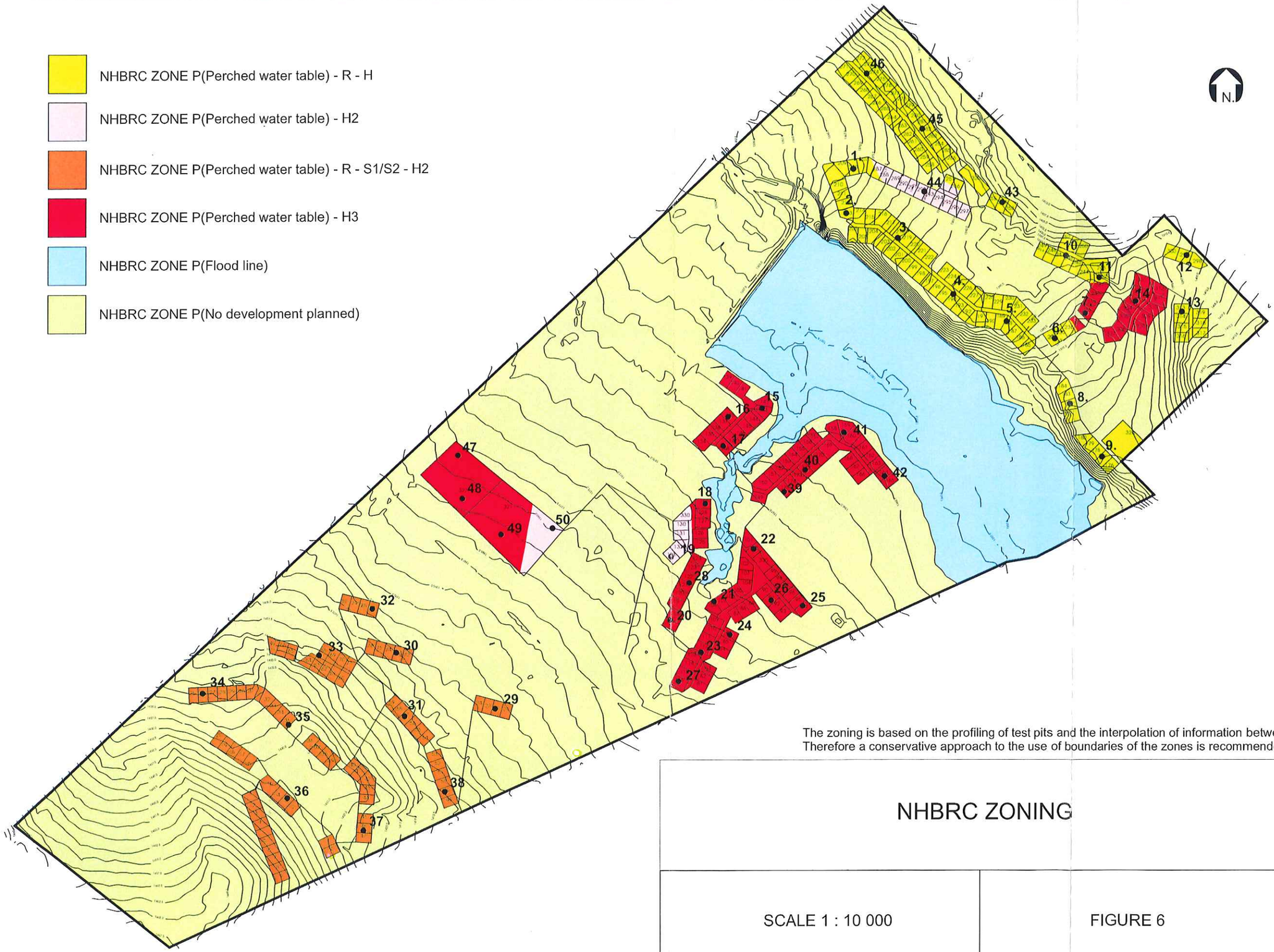
NHBRC ZONE P(Perched water table) - H2

NHBRC ZONE P(Perched water table) - R - S1/S2 - H2

NHBRC ZONE P(Perched water table) - H3

NHBRC ZONE P(Flood line)

NHBRC ZONE P(No development planned)



The zoning is based on the profiling of test pits and the interpolation of information between test pits. Therefore a conservative approach to the use of boundaries of the zones is recommended.

NHBRC ZONING

SCALE 1 : 10 000

FIGURE 6

ZONE	NHBRC ZONE	MOTIVATION
4 Geotechnical classification: 1A 1/2B 3C 2D 2E 2F 1/2I (see table)	P(Perched water table) – H3	The hillwash, colluvium, residual shale and yellowish brown diabase classify as "Medium" expansive, the alluvium classifies as "Very high", and the red brown residual diabase classifies as "High". The calculated heave exceeds 30 mm, therefore this part of the site is zoned as H3. The presence of the shallow perched water table is accommodated by adding a zoning of P(Shallow water table.
5 Geotechnical classification: 3L (see table)	P(Flood line)	These parts of the site lie below the 1 : 100 year flood lines of the streams.
9	P(No development planned)	No development is planned in this zone and it was therefore not investigated.

It is important to note that since the investigation was done for township establishment the zoning is based on the profiling of test pits and the interpolation of information between test pits. Therefore a conservative approach to the use of boundaries of the zones is recommended. The zoning is shown on Figure 6.

14. CONCLUSIONS AND RECOMMENDATIONS

The different zones were identified from field observations, aerial photographic interpretation and the interpolation of information between test pits; therefore it is possible that variations from the expected conditions can occur.

14.1 Foundations

The following general alternatives are recommended for the NHBRC zones:

14.1.1 P(Perched water table) - R – H

The hillwash classifies as potentially expansive and the calculated heave is less than 7,5 mm. Therefore these materials are considered unsuitable in its natural state to act as a founding medium. This even applies for light structures with a foundation pressure of less than 100kPa. From the discussion foundation improvement and imparting flexibility in the brickwork are clearly required. The following alternatives are recommended:

- *Normal construction:*
  Found structures on the shale bedrock, should the depth to suitable founding material become to deep to found economically, the alternatives for zone H2 or H3, depending on the soil profile, will apply.

Due to the slope of this part of the site, it is envisaged that level platforms for structures will be created by way of a balanced cut to fill operation. This means that on the cut end of the platform, excavations may have proceeded to suitable founding material, depending on the depth of cut and the thickness of the transported material at the cut end. When building platforms are constructed, the soil profile should be investigated to establish the approximate thickness of the various horizons within the platform area. The following guidelines should be followed:

- In cut sections, the alternatives listed in the previous section apply. Should the cut extend up to competent founding material, only loose material at founding level has to be removed or must be compacted

- On the fill end, the founding alternatives listed in the previous section apply. If the entire fill section is constructed by compacting a competent material, founding at shallow depth is possible.

It is important though that in spite of the guidelines given above, inspection of foundation excavations and the involvement of a competent engineer familiar with structural founding are necessary. ***It is recommended that the trenches for services be profiled and that a construction report be compiled for the development. The purpose of the construction report is to confirm or adapt the zoning of the site, and to provide more accurate information regarding the founding conditions. Due to the variability of the founding conditions it is furthermore recommended that the founding conditions for individual structures should be investigated.***

14.1.2 P(Perched water table) - H2

The hillwash and colluvium classify as potentially expansive and the calculated heave is between 15mm and 30 mm. Therefore these materials are considered unsuitable in its natural state to act as a founding medium. This even applies for light structures with a foundation pressure of less than 100kPa. From the discussion foundation improvement and imparting flexibility in the brickwork are clearly required. The following alternatives are recommended:

- *Split construction:*
  A combination of reinforced masonry and full movement joints, with suspended floors or fabric reinforced ground slabs, acting independently from the structure.

- *Stiffened or cellular raft:*
  Found structures on a stiffened or cellular raft. Structures should be provided with articulation joints and lightly reinforced masonry.

- *Soil raft:*
  Remove all or necessary parts of the expansive horizon to 1,0 meters beyond the perimeter of the structures. The loose material in the bottom of excavations should be compacted, and the excavations backfilled with inert material, compacted to at least 93% of Mod AASHTO density at -1% to +2% of optimum moisture content. Structures can be founded on normal, lightly reinforced strip footings on the backfill and should be provided with light reinforcement in the masonry if the residual movements are < 7,5 mm, or the construction type should be appropriate to residual movements.

- *Piled construction:*
  Piled foundations with suspended floor slabs, with or without ground beams.

It is important though that in spite of the guidelines given above, inspection of foundation excavations and the involvement of a competent engineer familiar with structural founding are necessary. ***It is recommended that the trenches for services be profiled and that a construction report be compiled for the development. The purpose of the construction report is to confirm or adapt the zoning of the site, and to provide more accurate information regarding the founding conditions. Due to the variability of the founding conditions it is furthermore recommended that the founding conditions for individual structures should be investigated.***

14.1.3 P(Perched water table) - R – S1/S2 - H2

The hillwash and residual diabase classify as potentially expansive and the calculated heave is between 15 mm and 30 mm. Furthermore the founding partly on boulders, residual material and bedrock could cause unacceptable differential settlement. Therefore these materials are considered unsuitable in its natural state to act as a founding medium. This even applies for light structures with a foundation pressure of less than 100kPa. From the discussion foundation improvement and imparting flexibility in the brickwork are clearly required. The following alternatives are recommended:

- *Split construction:*
  A combination of reinforced masonry and full movement joints, with suspended floors or fabric reinforced ground slabs, acting independently from the structure.

- *Stiffened or cellular raft:*
  Found structures on a stiffened or cellular raft. Structures should be provided with articulation joints and lightly reinforced masonry.

- *Soil raft:*
  Remove all or necessary parts of the expansive horizon to 1,0 meters beyond the perimeter of the structures. The loose material in the bottom of excavations should be compacted, and the excavations backfilled with inert material, compacted to at least 93% of Mod AASHTO density at -1% to +2% of optimum moisture content. Structures can be founded on normal, lightly reinforced strip footings on the backfill and should be provided with light reinforcement in the masonry if the residual movements are < 7,5 mm, or the construction type should be appropriate to residual movements.

- *Piled construction:*
  Piled foundations with suspended floor slabs, with or without ground beams.

Due to the slope of this part of the site, it is envisaged that level platforms for structures will be created by way of a balanced cut to fill operation. This means that on the cut end of the platform, excavations may have proceeded to suitable founding material, depending on the depth of cut and the thickness of the transported material at the cut end. When building platforms are constructed, the soil profile should be investigated to establish the approximate thickness of the various horizons within the platform area. The following guidelines should be followed:

- In cut sections, the alternatives listed in the previous section apply. Should the cut extend up to competent founding material, only loose material at founding level has to be removed or must be compacted

- On the fill end, the founding alternatives listed in the previous section apply. If the entire fill section is constructed by compacting a competent material, founding at shallow depth is possible.

It is important though that in spite of the guidelines given above, inspection of foundation excavations and the involvement of a competent engineer familiar with structural founding are necessary. ***It is recommended that the trenches for services be profiled and that a construction report be compiled for the development. The purpose of the construction report is to confirm or adapt the zoning of the site, and to provide more accurate information regarding the founding conditions. Due to the variability of the founding conditions it is furthermore recommended that the founding conditions for individual structures should be investigated.***

14.1.4 P(Perched water table) - H3

The hillwash, colluvium, residual shale and yellowish brown diabase classify as "Medium" expansive, the alluvium classifies as "Very high", and the red brown residual diabase classifies as "High". The calculated heave exceeds 30 mm, therefore these materials are considered unsuitable in its natural state to act as a founding medium. This even applies for light structures with a foundation pressure of less than 100kPa. From the discussion foundation improvement and imparting flexibility in the brickwork are clearly required. The following alternatives are recommended:

- *Stiffened or cellular raft:*
  Found structures on a stiffened or cellular raft. Structures should be provided with articulation joints and lightly reinforced masonry.

- *Soil raft:*
  Remove all or necessary parts of the expansive horizon to 1,0 meters beyond the perimeter of the structures. The loose material in the bottom of excavations should be compacted, and the excavations backfilled with inert material, compacted to at least 93% of Mod AASHTO density at -1% to +2% of optimum moisture content. Structures can be founded on normal, lightly reinforced footings on the backfill and should be provided with light reinforcement in the masonry if the residual movements are < 7,5 mm, or the construction type should be appropriate to residual movements.

- *Piled construction:*
  Piled foundations with suspended floor slabs, with or without ground beams.

It is important though that in spite of the guidelines given above, inspection of foundation excavations and the involvement of a competent engineer familiar with structural founding are necessary. ***It is recommended that the trenches for services be profiled and that a construction report be compiled for the development. The purpose of the construction report is to confirm or adapt the zoning of the site, and to provide more accurate information regarding the founding conditions. Due to the variability of the founding conditions it is furthermore recommended that the founding conditions for individual structures should be investigated.***

14.1.5 (Flood lines)

Since these parts of the site lie below the 1 : 100 year flood lines of the streams, no development is recommended in these zones.

14.1.6 P(No development planned)

No development is planned in this zone and it was therefore not investigated. Should these areas be developed in the future, engineering geological investigations should be done.

14.2 Foundations for large structures

Structure specific investigations should be done for large structures.

14.3 Excavatability

The excavatability was evaluated according to the South African Bureau of Standards Standardized Specification for Civil Engineering Construction DB: Earthworks (Pipe Trenches). The excavatability is considered to classify as "soft to intermediate" up to the following **average** depths:

- 0,3 meters in NHBRC Zone P(Perched water table) - R – H
- 1,5 meters in NHBRC Zone P(Perched water table) – H2
- 0,4 meters (boulder- and hard rock excavations from shallow depth) in NHBRC Zone P(Perched water table) – S1/S2 – H2/H3
- 1,8 meters in NHBRC Zone P(Perched water table) – H3

It is important to note that the evaluation is based primarily on the profiling of test pits and the interpolation of information between test pits. It is therefore possible that variations from the expected conditions can occur.

14.4 Geohydrology

All excavations should be provided with adequate drainage. Structures should be provided with damp proofing and provision should be made to prevent the ingress of water into– and below foundations.

14.5 Construction material

The materials encountered on the site are not expected to be suitable as construction material. *It is recommended that the suitability of material that is to be used, be confirmed by detailed laboratory testing.*

14.6 Slope stability

Although the slopes on the southern part of the site seem to be stable in its natural state, slope instability could be induced during or after development. Steep excavations and fills, excavations parallel to the contours and the ingress of water into the slopes should be avoided.

14.7 Stability of excavations

It should be noted that shales of the Pretoria Group underlie parts of the site, and the potential instability of this material, due to the northerly dip, is well documented. Based on the potential for instability, it is recommended that all excavations be cut back or laterally supported.

14.8 General recommendations

Water has a significant influence on the behaviour of the in-situ material. To reduce differential movements of structures it is necessary to maintain moisture equilibrium under the structures. Therefore it is recommended that the following measures regarding drainage around structures be implemented:

- No accumulation of surface water must be allowed around the perimeter of the structures and the entire development must be properly drained.
- Down pipes should discharge into a lined or precast furrow. This furrow should discharge the water 1,5 meters away from the foundation onto a paved or grassed surface sloping away from the building.
- Preferably, if no gutters or paving is to be provided around structures, a 1,5 meter wide sealed concrete apron should be cast along the perimeter of the structures the water must be channeled away from the foundation.

- Leaks in water bearing services should be attended to without undue delay.
- No large shrubs or trees should be planted closer to structures than the distances provided in the following Table:

DESCRIPTION	MATURE HEIGHT OF TREE		
	Up to 8m	8m tot 15m	Over 15m
Buildings other than single storey buildings of lightweight construction	-	0.5	1,2
Single storey buildings of lightweight construction (e.g. timber framed)	-	0.7	1,5
Free standing masonry walls	-	1,0[1] 0,5[2]	2,0[1] 1,0[2]
Drains and underground services • less than 1 meter deep • more than 1 meter deep	 0,5 -	 1,5 1,0	 3,0 2,0

Note:

1) These distances will generally avoid all direct damage
2) These distances assume that some movement and minor damage, which may be tolerated, might occur.
3) This table provides guidance on the acceptable proximity of young trees or new planting to allow for future growth. This table should not be taken to imply that construction work can occur at the specified distances from existing trees, as such work might damage the tree, or render it dangerous, but refers to the potential or future growth, either of a young tree or of planting, occurring subsequent to construction

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L.J Kruger Pr. Sci. Nat.

15. REFERENCES

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- "Soil Survey for Engineering", Brink, Partridge & Williams
- South African Bureau of Standards Standardized Specification for Civil Engineering Construction DB: Earthworks (Pipe Trenches) SABS 1200 DB-1982
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- "High-Impact Innovation", Jay Landers. Civil Engineering—ASCE, Vol. 74, No. 2, February 2004, pp. 50-57

APPENDIX A

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 1.

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, brown, loose, slightly slickensided, shattered, gravely, silty sand with abundant shale fragments - Hillwash
			0,3 Slightly moist, light brown mottled yellow with red and black stained joints, jointed, laminated, Soft rock shale
			0,7 Slightly moist, greyish black, jointed, laminated, Medium hard rock shale (slate)
			1,0 Refusal on medium hard rock shale (slate) No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 2.

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, brown, loose, slightly slickensided, shattered, gravely, silty sand with abundant shale fragments - Hillwash
		0,2	Slightly moist, light brown mottled yellow with red and black stained joints, jointed, laminated, Soft rock shale
		0,5	Slightly moist, greyish black, jointed, laminated, Medium hard rock shale (slate)
		1,0	Refusal on medium hard rock shale (slate) No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 3.

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, brown, loose, slightly slickensided, shattered, gravely, silty sand with abundant shale fragments - Hillwash
			0,2 Refusal on medium hard rock shale (slate)
			No ground water

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SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 4.

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, brown, loose, slightly slickensided, shattered, gravely, silty sand with abundant shale fragments - Hillwash
			0,2 Refusal on medium hard rock shale (slate)
			No ground water

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SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 5.

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, brown, loose, slightly slickensided, shattered, gravely, silty sand with abundant shale fragments - Hillwash
			0,3 Slightly moist, greyish black, shattered, jointed, laminated, Medium hard rock shale (slate)
			1,2 Refusal on medium hard rock shale (slate) No ground water

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SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 6.

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, brown, loose, slightly slickensided, shattered, gravely, silty sand with abundant shale fragments - Hillwash
			0,2
			Slightly moist, light brown mottled yellow with red and black stained joints, jointed, laminated, Soft rock shale
			1,2
			Slightly moist, greyish black, jointed, laminated, Soft- to medium hard rock shale (slate)
			1,6
			Refusal on medium hard rock shale (slate) No ground water

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SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 7.

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, bright red brown, soft to firm, fissured, slickensided, silty clay with ferricrete nodules and with occasional small diabase corestones - Residual diabase
		1,5	Slightly moist, yellowish brown with black stained joints, firm to stiff, intact, slightly slickensided, clayey silt with small to medium medium hard rock diabase corestones - Residual diabase
		2,5	No refusal No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 8.

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, brown, loose, slightly slickensided, shattered, gravely, silty sand with abundant shale fragments - Hillwash
			0,3
			Slightly moist, greyish black, jointed, laminated, Medium hard rock shale (slate)
			0,8
			Refusal on medium hard rock shale (slate) No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 9.

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, brown, loose, slightly slickensided, shattered, gravely, silty sand with abundant shale fragments - Hillwash
			0,3
			Refusal on medium hard rock shale (slate) No ground water

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SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 10

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, brown, loose, slightly slickensided, shattered, gravely, silty sand with abundant shale fragments - Hillwash
			0,3
			Slightly moist, greyish black, jointed, laminated, Medium hard rock shale (slate)
			0,8
			Refusal on medium hard rock shale (slate) No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

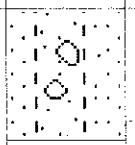
CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 11

SAMPLE / TEST	GROUND WATER	LEGEND		DESCRIPTION
				Slightly moist, brown, loose, slightly slickensided, shattered, gravely, silty sand with abundant shale fragments - Hillwash
			0,6	Slightly moist, light brown mottled yellow with red and black stained joints, jointed, laminated, Soft rock shale
			0,8	Slightly moist, greyish black, jointed, laminated, Medium hard rock shale (slate)
			1,2	Refusal on medium hard rock shale (slate) No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 12

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			0,2 Slightly moist, brown, loose, slightly slickensided, shattered, gravely, silty sand with abundant shale fragments - Hillwash Refusal on medium hard rock shale (slate) No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 13

SAMPLE / TEST	GROUND WATER	LEGEND		DESCRIPTION
			0,2	Slightly moist, brown, loose, slightly slickensided, shattered, gravely, silty sand with abundant shale fragments - Hillwash
				Slightly moist, light brown mottled yellow with red and black stained joints, jointed, laminated, Soft rock shale
			0,6	
				Slightly moist, greyish black, jointed, laminated, Soft- to medium hard rock shale (slate)
			1,5	Refusal on medium hard rock shale (slate)
				No ground water

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SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 14

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, brown, loose, slightly slickensided, shattered, gravely, silty sand with abundant shale fragments - Hillwash
		0,8	
			Slightly moist, bright red brown, soft to firm, fissured, slickensided, silty clay with ferricrete nodules and with occasional small diabase corestones - Residual diabase
		1,8	
			Slightly moist, yellowish brown with black stained joints, firm to stiff, intact, slightly slickensided, clayey silt with small to medium medium hard rock diabase corestones - Residual diabase
		2,4	
			No refusal No ground water

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SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 15

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, black, firm to stiff, fissured, slickensided, sandy clay with calcrete nodules and plant roots - Alluvium
			0,5
			Slightly moist, reddish orange brown mottled white, firm to stiff, intact, slickensided,clayey sand with ferricrete nodules - Residual shale
			2,5
			No refusal No ground water

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SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 16

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, black, firm to stiff, fissured, slickensided, sandy clay with calcrete nodules and plant roots - Alluvium
			0,5
			Slightly moist, reddish orange brown mottled white, firm to stiff, intact, slickensided,clayey sand with ferricrete nodules - Residual shale
			1,2
			Slightly moist, light brown mottled yellow with red and black stained joints, jointed, laminated, Soft rock shale
			2,2
			Slightly moist, light brown with red and black stained joints, jointed, laminated, Soft- to medium hard rock shale
			2,4
			Refusal on medium hard rock shale No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 17

SAMPLE / TEST	GROUND WATER	LEGEND		DESCRIPTION
				Slightly moist, black, firm to stiff, fissured, slickensided, sandy clay with calcrete nodules and plant roots - Alluvium
			0,4	Slightly moist, reddish orange brown mottled white, firm to stiff, intact, slickensided,clayey sand with ferricrete nodules - Residual shale
			0,7	Slightly moist, light brown mottled yellow with red and black stained joints, jointed, laminated, Soft rock shale
			1,5	Refusal on medium hard rock shale No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 18

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, black, firm to stiff, fissured, slickensided, sandy clay with calcrete nodules and plant roots - Alluvium
		0,3	
			Slightly moist, reddish orange brown mottled white, firm to stiff, intact, slickensided,clayey sand with ferricrete nodules - Residual shale
		0,9	
			Slightly moist, light brown mottled yellow with red and black stained joints, jointed, laminated, Soft rock shale
		2,2	
			Refusal on medium hard rock shale No ground water

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SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 19

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, red brown, soft, microshattered, slightly slickensided gravely clay with shale fragments - Colluvium
			0,3
			Slightly moist, reddish orange brown mottled white, firm to stiff, intact, slickensided,clayey sand with ferricrete nodules - Residual shale
			1,2
			Slightly moist, light brown mottled yellow with red and black stained joints, jointed, laminated, Soft rock shale
			1,8 Refusal on medium hard rock shale No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 20

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			0,2 Slightly moist, red brown, soft, microshattered, slightly slickensided gravely clay with shale fragments - Colluvium Refusal on medium hard rock diabase No ground water

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SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 21

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, black, firm to stiff, fissured, slickensided, sandy clay with calcrete nodules and plant roots - Alluvium
		2,8	Slightly moist, yellowish brown with black stained joints, firm to stiff, intact, slightly slickensided, clayey silt with small medium hard rock diabase corestones - Residual diabase
		3,2	No refusal No ground water

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SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 22

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, black, firm to stiff, fissured, slickensided, sandy clay with calcrete nodules and plant roots - Alluvium
		2,4	Slightly moist, reddish orange brown mottled white, firm to stiff, intact, slickensided,clayey sand with ferricrete nodules - Residual shale
		3,0	Refusal on medium hard rock shale No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

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SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 23

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, black, firm to stiff, fissured, slickensided, sandy clay with calcrete nodules and plant roots - Aliuvium
			2,8 Slightly moist, yellowish brown with black stained joints, firm to stiff, intact, slightly slickensided, clayey silt with small to medium medium hard rock diabase corestones - Residual diabase
			3,2 No refusal No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 24

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, black, firm to stiff, fissured, slickensided, sandy clay with calcrete nodules and plant roots - Alluvium
			3,0 No refusal No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 25

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, black, firm to stiff, fissured, slickensided, sandy clay with calcrete nodules and plant roots - Alluvium
		1,2	
			Slightly moist, yellowish brown with black stained joints, firm to stiff, intact, slightly slickensided, clayey silt with small to medium medium hard rock diabase corestones - Residual diabase
		2,5	No refusal No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 26

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, black, firm to stiff, fissured, slickensided, sandy clay with calcrete nodules and plant roots - Alluvium
		3,0 / 3,2	Slightly moist, yellowish brown with black stained joints, firm to stiff, intact, slightly slickensided, clayey silt with small to medium medium hard rock diabase corestones - Residual diabase
			No refusal No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 27

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, red brown, soft, microshattered, slightly slickensided gravely clay with shale fragments - Colluvium
		0,9	
			Slightly moist, yellowish brown with black stained joints, firm to stiff, intact, slightly slickensided, clayey silt with small to medium medium hard rock diabase corestones - Residual diabase
		3,0	No refusal No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 28

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, black, firm to stiff, fissured, slickensided, sandy clay with calcrete nodules and plant roots - Alluvium
		0,9	Slightly moist, yellowish brown with black stained joints, firm to stiff, intact, slightly slickensided, clayey silt with small to medium medium hard rock diabase corestones - Residual diabase
		1,5	Refusal on medium hard rock diabase No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

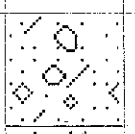
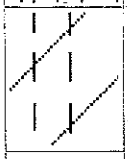
CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 29

SAMPLE / TEST	GROUND WATER	LEGEND		DESCRIPTION
				Slightly moist, dark brown, loose, microshattered, clayey gravely sand with diabase cobbles and plant roots - Hillwash
			0,5	Slightly moist, yellowish brown with black stained joints, firm to stiff, intact, slightly slickensided, clayey silt with small to medium medium hard rock diabase corestones - Residual diabase
			1,2	Refusal on medium hard rock diabase No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 30

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, loose, microshattered, clayey gravely sand with diabase cobbles and plant roots - Hillwash
			0,3
			Refusal on medium hard rock diabase No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

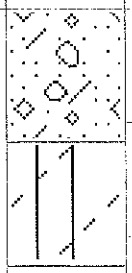
CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 31

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, loose, microshattered, clayey gravely sand with diabase cobbles and plant roots - Hillwash
			0,6 Slightly moist, yellowish brown with black stained joints, firm to stiff, intact, slightly slickensided, clayey silt with small to medium medium hard rock diabase corestones - Residual diabase
			1,2 Refusal on diabase bouldersl No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

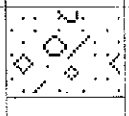
CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 32

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, loose, microshattered, clayey gravely sand with diabase cobbles and plant roots - Hillwash
			0,4
			Refusal on diabase boulders No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 33

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, loose, microshattered, clayey gravely sand with diabase cobbles and plant roots - Hillwash
			0,3
			Refusal on diabase boulders
			No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

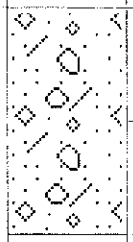
CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 34

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, loose, microshattered, clayey gravely sand with diabase cobbles and plant roots - Hillwash
			1,0 Refusal on medium hard rock diabase No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

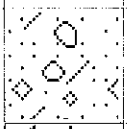
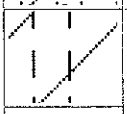
CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 35

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, loose, microshattered, clayey gravely sand with diabase cobbles and plant roots - Hillwash
			0,5 Slightly moist, yellowish brown with black stained joints, firm to stiff, intact, slightly slickensided, clayey silt with small to medium medium hard rock diabase corestones - Residual diabase
			0,9 Refusal on medium hard rock diabase No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

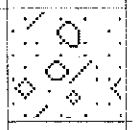
CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 36

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, loose, microshattered, clayey gravely sand with diabase cobbles and plant roots - Hillwash
			0,5 Refusal on diabase boulders No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 37

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, loose, microshattered, clayey gravely sand with diabase cobbles and plant roots - Hillwash
			0,3
			Slightly moist, yellowish brown with black stained joints, firm to stiff, intact, slightly slickensided, clayey silt with small to medium medium hard rock diabase corestones - Residual diabase
			1,2
			Refusal on medium hard rock diabase No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

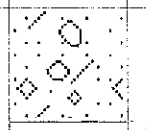
CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 38

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, loose, microshattered, clayey gravely sand with diabase cobbles and plant roots - Hillwash
			0,5 Refusal on medium hard rock diabase No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 39

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, black, firm to stiff, fissured, slickensided, sandy clay with calcrete nodules and plant roots - Alluvium
		3,0	No refusal No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

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SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 40

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, black, firm to stiff, fissured, slickensided, sandy clay with calcrete nodules and plant roots - Alluvium
		3,0	No refusal No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

218

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 41

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, black, firm to stiff, fissured, slickensided, sandy clay with calcrete nodules and plant roots - Alluvium
			3,0 No refusal No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

219

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 42

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, black, firm to stiff, fissured, slickensided, sandy clay with calcrete nodules and plant roots - Alluvium
		3,0	No refusal No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

220

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 43

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, loose, microshattered, clayey gravely sand with diabase cobbles and plant roots - Hillwash
			0,5 Slightly moist, light brown mottled yellow with red and black stained joints, jointed, laminated, Soft rock shale
			0,8 Slightly moist, greyish black, shattered, jointed, laminated, Medium hard rock shale (slate)
			1,5 Refusal on medium hard rock shale (slate) No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 44

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, loose, microshattered, clayey gravely sand with diabase cobbles and plant roots - Hillwash
			0,5
			Slightly moist, reddish orange brown mottled white, firm to stiff, intact, slickensided,clayey sand with ferricrete nodules - Residual shale
			2,2 Refusal on medium hard rock shale (slate) No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

222

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 45

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, loose, microshattered, clayey gravely sand with diabase cobbles and plant roots - Hillwash
			0,3
			Slightly moist, greyish black, shattered, jointed, laminated, Medium hard rock shale (slate)
			1,2
			Refusal on medium hard rock shale (slate) No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 46

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, loose, microshattered, clayey gravely sand with diabase cobbles and plant roots - Hillwash
			0,3
			Slightly moist, light brown mottled yellow with red and black stained joints, jointed, laminated, Soft rock shale
			1,1 Refusal on medium hard rock shale (slate)
			No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

224

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 47

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, black, firm to stiff, fissured, slickensided, sandy clay with calcrete nodules and plant roots - Alluvium
		0,8	
			Slightly moist, black mottled orange, firm to stiff, fissured, slickensided, sandy clay plant roots - Alluvium
		2,0	Refusal on diabase boulders No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 48

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, black mottled orange, firm to stiff, fissured, slickensided, sandy clay plant roots - Alluvium
		1,1	
			Slightly moist, bright red brown, soft to firm, fissured, slickensided, silty clay with ferricrete nodules and with occasional small diabase corestones - Residual diabase
		2,2	Refusal on medium hard rock diabase No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 49

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, black mottled orange, firm to stiff, fissured, slickensided, sandy clay plant roots - Alluvium
		1,1	Slightly moist, bright red brown, soft to firm, fissured, slickensided, silty clay with ferricrete nodules and with occasional small diabase corestones - Residual diabase
		2,4	Refusal on medium hard rock diabase No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

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SOIL PROFILE

PROJECT: RESIDENTIAL

SITE: BOSCHKOP 369 JR

CLIENT: TIMPROPS

LOGGED BY: JJ

MACHINE: TLB

DATE: 14/07/2005

TEST PIT: 50

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, red brown, soft, microshattered, slightly slickensided gravely clay with shale fragments - Colluvium
			0,5
			Slightly moist, reddish orange brown mottled white, firm to stiff, intact, slickensided,clayey sand with ferricrete nodules - Residual shale
			1,2
			Slightly moist, light brown with red and black stained joints, jointed, laminated, Soft- to medium hard rock shale
			1,5
			Refusal on medium hard rock shale No ground water

LOUIS KRUGER GEOTECHNICS PO BOX 90093 GARSFONTEIN TEL/FAX (012) 348 4819

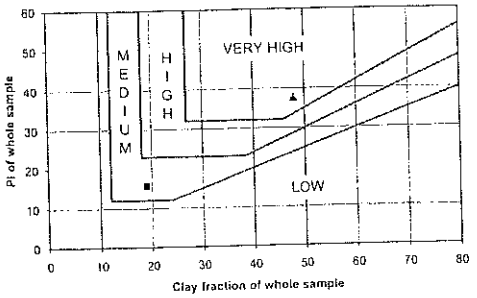
APPENDIX B

PARTICLE SIZE ANALYSIS

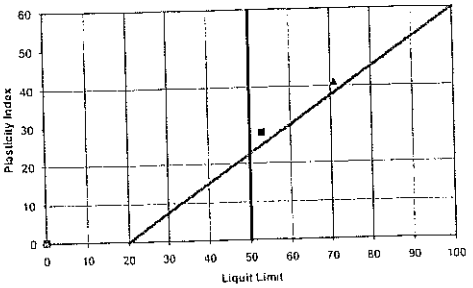
Sample No.	16860	16861
Soillab sample no.	S05-0635-03	S05-0635-04
Position	53	28
Depth (m)	-	-
Material Description	DARK BROWN SHALE CLAYEY SAND	DARK GREY SANDY CLAY
Dispersion (%)		
SCREEN ANALYSIS (% PASSING)		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	100	98
4.75 mm	98	97
2.00 mm	88	96
0.425 mm	56	92
0.075 mm	31	74
HYDROMETER ANALYSIS (% PASSING)		
0.040 mm	30	66
0.027 mm	29	64
0.013 mm	27	59
0.005 mm	25	55
0.002 mm	19	48
% Clay	19	48
% Silt	12	23
% Sand	57	25
% Gravel	12	4
ATTERBERG LIMITS		
Liquid Limit	53	71
Plasticity Index	28	41
Linear Shrinkage (%)	14.0	15.5
Grading Modulus	1.25	0.27
Classification	A-2-7(3)	A-7-5(20)
Unified Classification	SC	CH
Chart Reference	■-■-■	▲-▲-▲

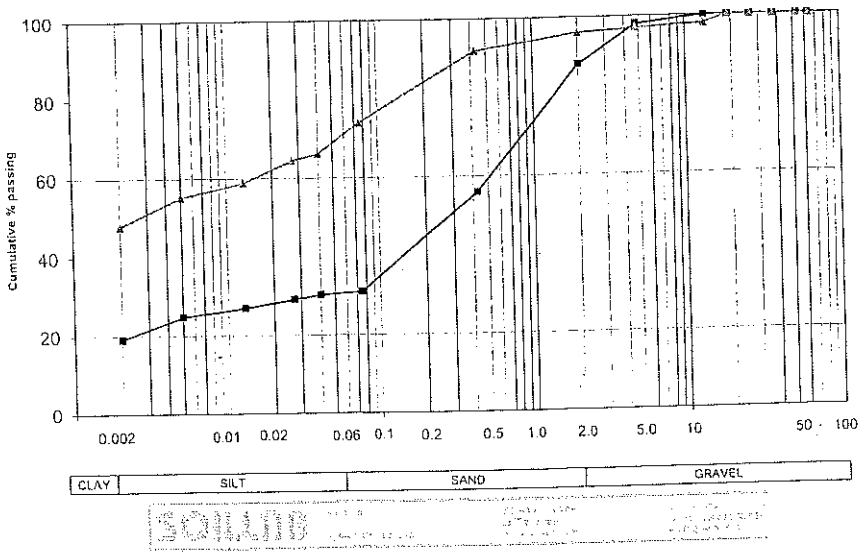
PROJECT : BOSCHKOP
JOB No. : S05-0635
DATE : 2004-07-21

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





HIDROMETER/0635-02

PARTICLE SIZE ANALYSIS

Sample No.	16864	16865
Soillab sample no.	S05-0635-07	S05-0635-08
Position	70	176
Depth (m)		
Material Description	DARK R/ORANGE SHALE SANDY SILT	DARK R/ORANGE SHALE SILTY CLAY
Dispersion (%)		
SCREEN ANALYSIS (% PASSING)		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	94	93
26.5 mm	93	91
19.0 mm	89	91
13.2 mm	87	91
4.75 mm	82	87
2.00 mm	79	81
0.425 mm	73	73
0.075 mm	57	64
HYDROMETER ANALYSIS (% PASSING)		
0.040 mm	47	55
0.027 mm	44	53
0.013 mm	39	50
0.005 mm	32	44
0.002 mm	22	34
% Clay	22	34
% Silt	31	26
% Sand	26	21
% Gravel	21	19
ATTERBERG LIMITS		
Liquid Limit	49	52
Plasticity Index	24	24
Linear Shrinkage (%)	12.0	12.0
Grading Modulus	0.91	0.82
Classification	A-7-6(11)	A-7-6(13)
Unified Classification	CL	MH
Chart Reference		

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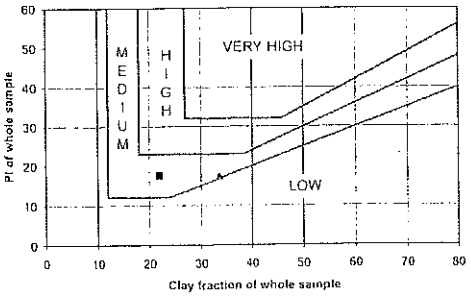
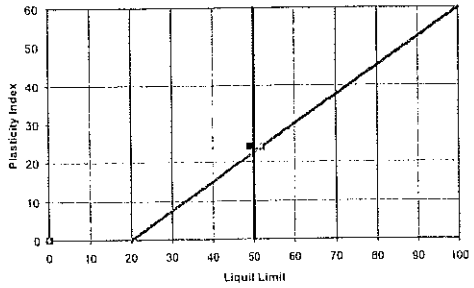
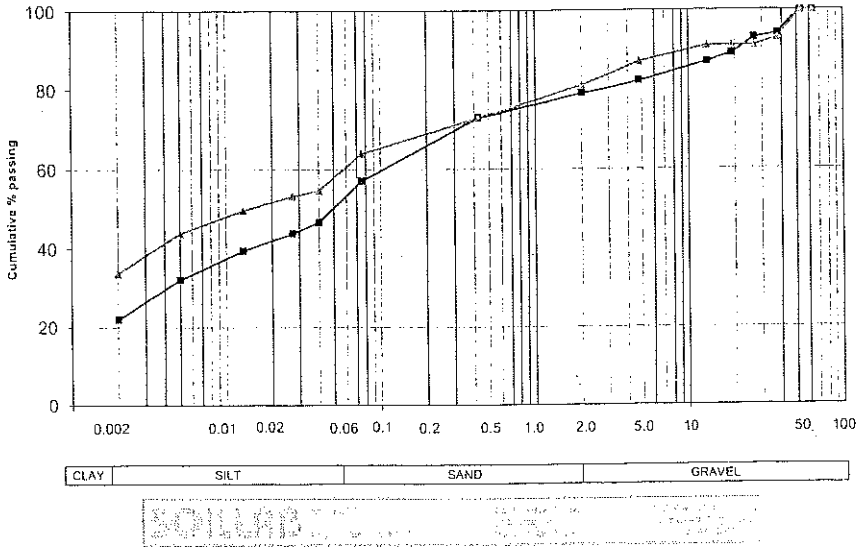
POTENTIAL EXPANSIVENESS



PLASTICITY CHART





HIDROMETER/0635-04

PARTICLE SIZE ANALYSIS

Sample No.	16866	16867
Soillab sample no.	S05-0635-09	S05-0635-10
Position	S25	DAM
Depth (m)		
Material Description	DARK BROWN W/DIABASE SANDY CLAY	DARK YELLOW W/DIABASE SILTY CLAY
Dispersion (%)		
SCREEN ANALYSIS (% PASSING)		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	99	100
4.75 mm	96	97
2.00 mm	89	94
0.425 mm	78	90
0.075 mm	64	80
HYDROMETER ANALYSIS (% PASSING)		
0.040 mm	52	67
0.027 mm	48	65
0.013 mm	42	58
0.005 mm	37	49
0.002 mm	31	40
% Clay	31	40
% Silt	28	35
% Sand	30	20
% Gravel	11	6
ATTERBERG LIMITS		
Liquid Limit	56	58
Plasticity Index	27	29
Linear Shrinkage (%)	13.0	10.0
Grading Modulus	0.69	0.36
Classification	A-7-6(15)	A-7-6(19)
Unified Classification	CH	CH
Chart Reference		

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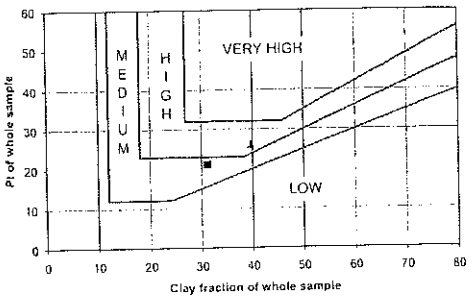
POTENTIAL EXPANSIVENESS



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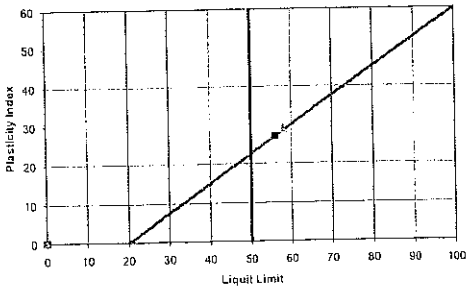

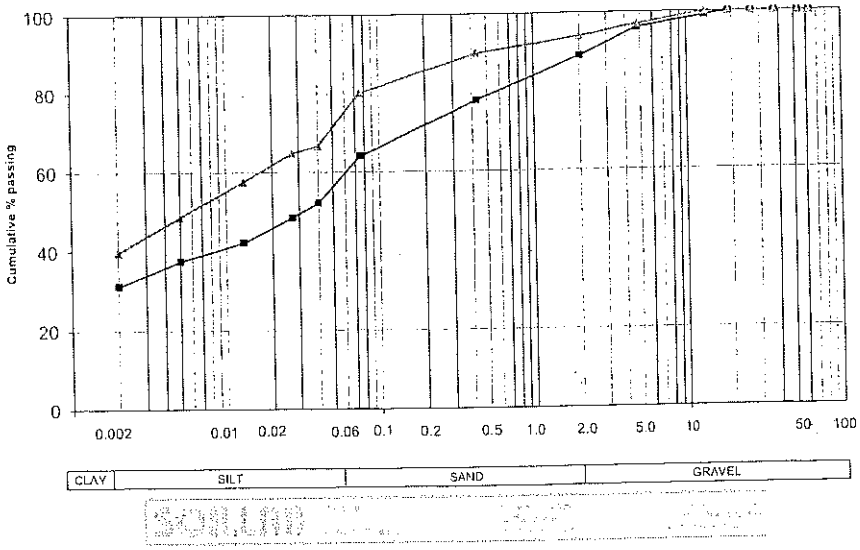

HIDROMETER/0635-05

PARTICLE SIZE ANALYSIS

Sample No.	16868	
Soillab sample no.	S05-0635-11	
Position	37	
Depth (m)		
Material Description	DUSKY RED W/DIABASE GRAVELLY CLAY	
Dispersion (%)		
SCREEN ANALYSIS (% PASSING)		
63.0 mm	100	
53.0 mm	100	
37.5 mm	100	
26.5 mm	98	
19.0 mm	97	
13.2 mm	91	
4.75 mm	83	
2.00 mm	73	
0.425 mm	63	
0.075 mm	55	
HYDROMETER ANALYSIS (% PASSING)		
0.040 mm	47	
0.027 mm	45	
0.013 mm	43	
0.005 mm	40	
0.002 mm	34	
% Clay	34	
% Silt	17	
% Sand	22	
% Gravel	27	
ATTERBERG LIMITS		
Liquid Limit	60	
Plasticity Index	27	
Linear Shrinkage (%)	13.5	
Grading Modulus	1.09	
Classification	A-7-5(13)	
Unified Classification	MH	
Chart Reference		

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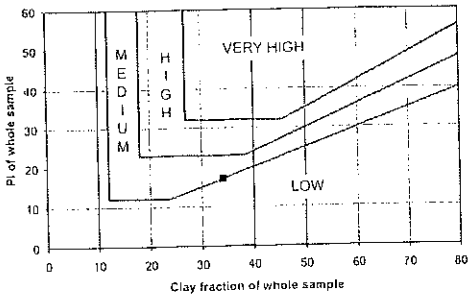
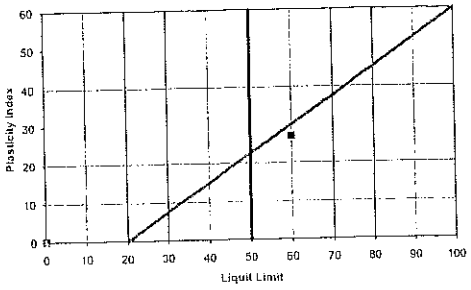
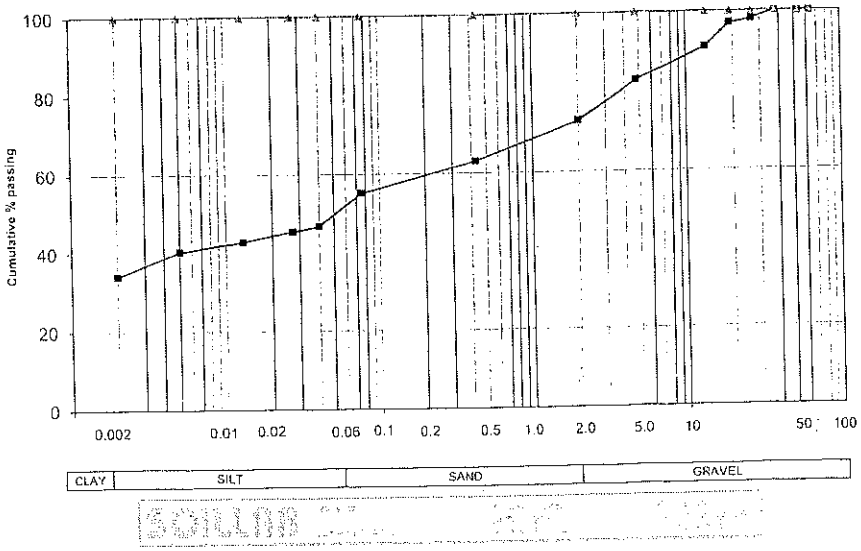
DATE : 2004-07-21

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





HIDROMETER/0635-06