PHASE I GEOTECHNICAL SITE INVESTIGATION

FOR

MCGREGOR HOUSING ERF360

FOR ASLA DEVCO (PTY) LTD



CONTACT DETAILS

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EXECUTIVE SUMMARY

The area for the proposed McGregor Housing development comprises a site located on the south-eastern side of the town of McGregor.

Geologically, the site is underlain from ground surface by dense gravelly silts of colluvial origin and gravelly residual clays. Over the major portion of the site, these soils overlie and mask completely to moderately weathered shales of rock consistency of the Bokkeveld Group.

No water table was encountered on site during the investigation and the main water table probably occurs as a fractured rock aquifer at greater depth. The site investigation was however carried out during the dry summer period and winter rainfall might result in a perched water table developing in the transported soils above the relatively impermeable rock. Surface water flow (sheet run-off) down-slope is also likely to develop during intense rainfall events.

Possible geotechnical impacts of the site on development, identified in Section 6.4, include:-

- Relative difficulty of excavation in less weathered shales, although excavation is not expected to fall into any subsidy variation categories
- Potentially low to moderately expansive soils, requiring modified normal construction for housing units
- Poor infiltration rates combined with slopes could result in significant surface water run-off

In terms of the Residential Site Class Designation, the site has been classified as S1/H1/R, H1/R and R in three delineated areas..

Recommendations for foundation design and drainage are given in Sections 8 and 9 respectively. Conventional strip foundations founded in the weathered bedrock where possible and, where not possible, modified strip foundations are recommended, with modified construction and design precautions as required.

Sound water management is recommended to prevent water ingress into soils below foundations and roadways in order to minimize long-term maintenance.

1. Introduction and terms of reference

At the request of Mr David Douglas of ASLA Devco, a Phase 1 Geotechnical Site Investigation has been carried out for the McGregor Housing Project.

The objectives of the investigation are summarised as follows:-

- a) Identify any potential hazards
- b) Define the ground conditions and provide site classifications including detailed soil profile and groundwater occurrences within the zone of influence of foundations
- c) Provide the geotechnical basis for safe and appropriate land use planning, infrastructure design, housing unit design and the formulation of precautionary measures and risk management procedures.
- d) Broadly classify the land that is to be developed for subsidy housing in terms of the Housings Code's Residential Site Class Designations
- e) Gather factual data that has a bearing on the determination of housing subsidy variations and the installation of township services.

The investigation report has been prepared in accordance with the standard specifications of the National Housing Code for Project Linked Greenfield Subsidy Housing Projects (Standard Specifications GFSH-2). However investigation requirements have been modified where site conditions indicate and can be justified.

2. Information used in the study

The following information sources have been used in the investigation:-

- Geological map (1:1 000 000) Council for Geoscience
- Remote imagery (1:5000 scale)- Google Earth
- Orthophotos (1:10 000) Dept. Land Affairs
- Site Plans for McGregor Housing Project ·

No geotechnical site investigation reports for sites in the immediate Barrydale area could be obtained.

3. Site description

The location of the site relative to the town of McGregor is shown in Figure 1, and its topographic setting is shown in the remote image, Figure 2.

Topographically, the site is relatively flat with a slight slope to the east, where a wetland has developed adjacent the site. A small earth dam is located on the eastern section.

Our information is that no underground mining activity has taken place here in the past and that no economic minerals are associated with the shales in the area. Consequently the site has probably not been undermined.



Figure 1: Locality of site



Figure 2: Topography of site

4. Nature of the investigation

4.1. Desk study and walkover survey

The available geological and topographical maps and orthophotos were used to determine the geology and geological history of the area and to better understand topography, drainage and soil and rock origin in the region. A walkover survey was also conducted to confirm the nature of site features identified in the desk study.

4.2 Test Pits

Nine test pits, spread over the site, were excavated using a digger-loader. Test pits were visually profiled, with representative soil samples being taken from selected horizons for laboratory testing.

Due to the stiffness of the soil and the shallow depth of bedrock, dynamic probe light (DPL) testing was not carried out on this site.

Test pit locations are shown on the site plan in Appendix A (Figure 3). Copies of the recorded test pit soil profiles included in Appendices B.

4.3 Laboratory testing

The following laboratory tests were carried out on selected soil samples;

- Indicator tests in the form of moisture content, grading and Atterberg Limits analysis; to determine basic soils engineering properties.
- Geochemical testing (pH and conductivity) to assess possible deleterious effects of soils on concrete and steel.

The results of the laboratory tests are summarized in Table 6.1. Copies of the full laboratory test results are included as Appendix C.

5. Site geology and groundwater conditions

5.1 General

From ground surface, relatively thin Tertiary deposits of colluvial origin and residual shale soils mask the underlying weathered shale rock. These shales form part of the Bokkeveld Group - Gydo Formation and consist of black to dark grey fossiliferous shale, mudstone and siltstone.

5.2 Soil profile

Near-surface colluvial soils essentially comprise dense gravelly silts to silty gravels, which are up to 0.70 m thick. These are underlain by residual shale soils that consist mainly of firm to stiff gravelly silty clays up to 1.4 m thick. Calcrete was intersected in test pit TP4 but is expected to be a relatively thin horizon just above the rockhead contact.

The soil horizons are underlain by shales (rock) where the rock depth varies from surface outcrop to 1.4 m depth. The rockhead depth is seen to increase from the north eastern side of the site to the south western portion.

5.3 Water Table

No groundwater was encountered in any of the test pits. The main water table is expected to be located within a fractured rock aquifer at moderate depth. The site investigation was however conducted during the middle of the summer period with high summer temperatures. High winter rainfall might result in the forming of a shallow perched water

table above the relatively impermeable rock . Significant surface water run-off down-slope can be expected during intense rainfall events as indicated by prominent drainage gullies.

6. Geotechnical evaluation

6.1 Engineering and materials characteristics

Soils engineering properties relevant to design and development are summarized in Tables 6.1 and 6.2. On the basis of the field investigation, soils engineering data and site geology, the following points relating to geotechnical engineering conditions on the site may be made:-

- a) The near-surface transported (colluvial) soils are generally dense and are consider to be moderately compressible. Due to the density of these soils and their vertical extent in some sections, this horizon may be considered for use as a founding horizon.
- b) The underlying residual shale soils exhibit moderate plasticity and low to moderate potential expansiveness. If founding on this horizon is to be considered, appropriate foundation design measures will be required.
- c) The weathered shales underlying the soils are completely to moderately weathered, jointed and exhibit low compressibility, moderate strength and low permeability. The shales occur at an average depth of 0.55 m, where intersected, and are considered to exhibit low potential expansiveness. They will thus form a competent founding horizon for structures.
- d) In terms of material properties, the residual soils show moderate plasticity with low to moderate heave potential. These soils can be expected to exhibit moderate post-compaction strength and could form a construction material of general fill or subgrade quality (see Table 6.2). In terms of the TRH14 classification for pavement design, the transported material would most likely classify as a G10 quality construction material.
- e) The weathered shale bedrock material exhibits low plasticity and fair post-compaction strength (from computed CBR values). This material can be expected to form a G7 (selected layer) quality material or could also be used as gravel wearing course, if not too deeply weathered.
- f) Near-surface soils are acidic, with the potential for minor deleterious effects on buried services. Design precautions may thus be required.
- g) Relatively low infiltration rates and significant surface run-off down-slope can be expected generally. Attention will thus have to be paid to storm water management and drainage measures.

Test Pit No.	Depth (m)	Description	LL	PI	LS	M C	GM	рН	CBR*@ 95% Mod. AASHTO	TRH 14 Classificatio n
2	0.5	Silty gravelly clay	28	11	4.5	13	0.98	3.8	-	G10?
						.9				
3	0.8	Shale	28	7	3.0	-	2.64	-	21	G7

Table 6.1 Summary of soils engineering properties

Key; LL - liquid limit.. PI — plasticity index. LS – liquid limit. MC — in-situ moisture content GM — grading modulus. N-P — non-plastic. CBR — California Bearing Ratio. CBR* - computed CBR value.

Material	Potential usage	Shear strength when compacted	Drainage characteristics	Workability as a construction material
Residual gravelly clay	General fill	Moderate	Poor	Poor
Weathered shale	Selected sub grade, Gravel wearing coarse	Good	Moderate	Moderate

Table 6.2 Engineering properties of compacted materials

6.2 Slope stability and erosion

No major slope stability issues are foreseen. There is a potential for soil erosion at surface due to the silty soils being underlain be relatively impermeable horizons. Erosion measures should therefore be incorporated in surface water drainage design.

6.3 Excavation classification with respect to services

Excavation in soils and highly weathered shale rock, classifies as "soft excavation" (restricted and non-restricted excavation) in terms of the SABS 1200 D Earthworks Specification. Materials can probably be efficiently removed using a digger-loader or backhoe.

The deeper less weathered shale and possibly calcrete, classify as "intermediate excavation". Material can probably be excavated to a depth of around 1.5 m, probably deeper, with tracked excavators of 20 tons or more. The need for blasting appears to be unlikely within at least 2 m of ground level.

6.4 Impact of the geotechnical character of the site on subsidy housing developments

The geotechnical character of the site is considered to impart a number of impacts on housing development and subsidy variations, including: -

- Relative difficulty of excavation in less weathered shales and calcrete, although excavation is not expected to fall into any subsidy variation categories
- Potentially low to moderate heave movements in active residual shale soils, necessitating at least some design precautions
- Poor infiltration rates combined with slopes could result in significant surface water run-off

7. Site classification

The site has a soil profile of colluvial and residual soils overlying weathered shale rock, as outlined in Table 7.1. The engineering design requirements applicable to this site class designation in relation to foundations are detailed in Section 8.

Site Classification	Character of Founding materials	Expected Range of Total Soil Movements (mm)	Assumed Differential Movement (% of Total)	Maximum Allowable Bearing Pressure (kPa)
S1/H1/R	Dense silty colluvium overlying clayey gravels overlying weathered shale rock	<15	50	200
R	Shale rock	-	50	500

8. Foundation recommendations and solutions

In areas where rock is close to surface and founding depths allow, residential and community structures may be founded using conventional strip footings. Excavations for foundations should be taken through the soils to found entirely and uniformly in weathered shale of rock consistency.

In areas where it is not possible to found on rock, structures should be found using normal reinforced strip footings together with modified normal construction, including articulation joints and reinforcement in masonry. Due to the heave potential of the residual soils it is recommended that flexible couplings be used on all wet services to accommodate any possible movements that may occur.

A geotechnical engineer should inspect representative foundation excavations prior to casting concrete. This will ensure that founding horizons are compatible with the design of the foundations and the structures.

Surface beds may be cast directly on silty colluvium after nominal compaction from final terrace level. Consideration should be given to isolating surface beds from walls to accommodate heave movements.

9. Drainage

In view of the risk associated with storm water run-off, sound water management is required. Suitable measures include grading of slopes to prevent ponding of water around housing units, effective collection and disposal off site of storm water and water from down pipes and regular checking of wet services for leaks.

Similar measures are required with regard to road construction, with regular maintenance of storm water to prevent water ingress into subgrade soils and to minimize long term maintenance.

10. Special precautionary measures

If the small earthfill dam is to be removed it must be ensured that all fill material is adequately compacted with any unconsolidated soft sediments in the dam basin to be trimmed out to spoil. In this area it would be recommended that foundations are taken down to bedrock.

11. Conclusion

This Phase 1 geotechnical site investigation indicates that the area investigated, is generally suitable for project linked subsidy housing development, provided that the aspects of concern relating to the geotechnical character of the site are addressed.

JOHN YATES

MATTHEW JONES

APPENDIX A

SITE PLAN AND CLASSIFICATION





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Prostal address: Postnet Suite 177, Private Bag X3, 7801, Plumstead Physical address: Unitb02, Clareview Business Park, 236 Lansdowne Road, Claremont

CLIENT	CLIENT: ASLA DEVCO (PTY) LTD								
PROJE	PROJECT: MCGREGOR HOUSING ERF360								
TITLE: SITE PLAN SHOWING TEST PIT POSITIONS AND SITE CLASSIFICATION									
DATE: May-13 SCALE: NTS TRACED BY: SS FIG.NO. 1 JOB NO. 066-13									

APPENDIX B - SOIL PROFILES



dotPLOT 7008 PBpH67





dotPLOT 7008 PBpH67

CORE GEOTECHNIC CONSULTANTS Engineering Geology and Geohydrology	CAL MCGREGOR HOUSING ERF360	HOLE No: TP04 Sheet 1 of 1
	TEST PIT SOIL PROFILES	JOB NUMBER: 066-13
$\begin{array}{c c} Scale & & O_1 \\ 0 & O_1 \\ 1:10 \\ 0 & O_1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ $	Dry light orange brown <u>dense</u> intact <u>silty gravel</u> . Colluvium.	
	Dry white <u>very dense</u> intact <u>gravelly silt</u> . Pedogenic hardpan calcrete.	
	NOTES	
	1) No seepage.	
	2) Refusal at 0.2m.	
CONTRACTOR : MACHINE : TLB	INCLINATION : CO DIAM :	DLLAR LEVEL : X COORD :
PROFILED BY : PROFILED BY :	DATE : 17 April 2013	Y COURD : HOLE No: TP04
TYPE SET BY : SETUP FILE : STANDARD.SET	DATE : 06/05/2013 13:35 TEXT : C\dot5000\mcgreg.txt	

	ORE GEOTECHNI ONSULTANTS ineering Geology and Geohydrology	CAL	MCGREGOR HOUSING ERF360	HOLE No: TP05 Sheet 1 of 1			
			TEST PIT SOIL PROFILES	JOB NUMBER: 066-13			
Eng	Scale 1:10 Scale 1:10 Scale 1:10 Scale 1:10 Scale 1:10 Scale 1:10 Scale 1:10 Scale 1:10 Scale 1:10 Scale Scale 1:10 Scale	0.00 - 0.20 - 1.10 - 1.20 1 2	TEST PIT SOIL PROFILES JOB NUMBER: 066- Dry light brown dense intact gravelly silt. Colluvial. Light olive highly weathered very closely jointed medium hard rock shale Image: Collumn for the state of				
CONT I DR PRO TYPP	TRACTOR : MACHINE : TLB ILLED BY : FILED BY : Matthew Jones E SET BY :	5	INCLINATION : DIAM : DATE : DATE : 17 April 2013 DATE : 06/05/2013 13:35	COLLAR LEVEL : X COORD : Y COORD : HOLE No: TP05			





dotPLOT 7008 PBpH67



CORE GEOTECHNI CONSULTANTS	CAL	MCGREGOR HOUSING ERF360		HOLE No: TP09 Sheet 1 of 1
0 0 0/ / 0/		TEST PIT SOIL PROFILES		JOB NUMBER: 066-13
Scale 1:10	0.00	Light olive brown completely weathered soft conten.	rock sha	<u>le</u> with medium clay
	0.50	Olive moderately weathered medium hard ro	ck shale.	
	_ 0.70	NOTES		
	1	I) No seepage.		
	2	2) Refusal at 0.7m.		
DNTRACTOR : MACHINE : TLB DRILLED BY :		INCLINATION : DIAM : DATE :	COLLAF X Y	R LEVEL : COORD : COORD :
PROFILED BY : Matthew Jones TYPE SET BY :		DATE : 17 April 2013 DATE : 06/05/2013 13:35		HOLE No: TP09
	CORE GEOTECHNI Engineering Geology and Geohydrology Scale 1:10	CORE GEOTECHNICAL Engineering Geology and Geohydrology Scale 1:10 0.00 0.50 0.50 0.70 0.	CONTRACTOR: Information TLB DIVERSET TITS MICHARTON: MICHARTON	CONSULTANTS MCGREGOR HOUSING ERF300 I TEST PIT SOIL PROFILES I Scale 0.00 Light olive brown completely weathered soft rock shale conten. 0.00 Olive moderately weathered medium hard rock shale. 0.70 0.00 NOTES 1) No seepage. 2) Refusal at 0.7m. 2) Refusal at 0.7m. Image: Instance of the second seco

APPENDIX C - LABORATORY TEST RESULTS



LABORATORIES (PTY) LTD

71 INDUSTRIAL RING ROAD PAROW INDUSTRIA 7490, P.O. BOX 288 PAROW 7499 TELEPHONE: (021) 933 8176 FAX: (021) 933 1079 CLIENT: Core Geotechnical PROJECT: McGreggor Housing Postnet Suite 177 Private Bag X3 30-04-2013 Plumstead 7801 DATE: ATT: Matthew **REF**: L130463 ASTM D422 SIEVE ANALYSIS DESCRIPTION : Dk red brown silty clay SAMPLE NO. : 22087 POSITION : TH2@0.5m CLIENT SAMPLE NO. : Percent **Sieve Analysis Hydrometer Analysis SCS Dispersion Test** Passing Percentage of Percentage of 75.00 Diameter of Diameter of soil suspension soil suspension particle (mm) particle (mm) 63.00 (%) (%) 0.0655 53.00 49 37.50 100 0.0339 42 26.50 99 0.0171 40 19.00 97 0.0090 37 13.20 91 0.0031 SIEVE SIZE (mm) 37 9.50 87 0.0022 34 86 6.70 0.0013 33 4.75 85 2.36 84 **Specific Gravity:** 2.00 84 Initial Moisture Content (%) : 13.9 3.80 1.18 76 pH: 0.600 69 Conductivity mS/m : 79.00 Passing 0.425 66 0.300 63 Particle Size Distribution Percentage | 06 00 08 00 0.150 57 ÷i 0.0750 52 | | | | | | | | | | | | Atterberg Limits : 70 1111 ٨ Liquid Limit 28 60 1 1 1 1 1 1 1 1 1 1 11 Plastic Index 50 H Linear Shrinkage 4.5 40 30 1 1 1 1 1 1 1 1 1 $\begin{array}{ccc} I & I & I & I \\ I & I & I & I \end{array}$ MOD AASHTO ; C.B.R. : 20 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 MOD AASHTO (Kg/m³) 10 $\begin{smallmatrix} 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ \end{smallmatrix}$ O.M.C. (%) 0 0.001 0.010 10.000 100.000 Particle Size (mm)^{1.000} C.B.R. @ 100% Comp. C.B.R. @ 98 % Comp. **Tabulated Summary** Percentage Gravel : Percentage - 4.75 mm 15 C.B.R. @ 95 % Comp. Sand : Percentage - 4.75mm and + 0.075mm 33 C.B.R. @ 93 % Comp. Silt : Percentage - 0.075mm and + 0.002mm C.B.R. @ 90 % Comp. 17 Clay : Percentage - 0.002mm 35 Swell (max)%

The above test results are pertinent to the samples received and tested only.

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For Geoscience:



L A B O R A T O R I E S (P T Y) L T D 71 INDUSTRIAL RING ROAD PAROW INDUSTRIA 7490, PO. BOX 288 PAROW 7499 TELEPHONE: (021) 933 8176 FAX: (021) 833 1079

CLIENT: Core Geotechnical PROJECT: McGreggor Housing Postnet Suite 177 Private Bag X3 30-04-2013 Plumstead 7801 DATE: **REF**: ATT: Matthew L130463 ASTM D422 SIEVE ANALYSIS DESCRIPTION : Dk red brown gravelly clay sand SAMPLE NO. : 22088 POSITION : TH3@0.8m CLIENT SAMPLE NO. : Percent **Sieve Analysis Hydrometer Analysis SCS Dispersion Test** Passing Percentage of Percentage of 75.00 94 Diameter of Diameter of soil suspension soil suspension particle (mm) particle (mm) 63.00 90 (%) (%) 0.0707 53.00 77 6 37.50 59 0.0364 5 26.50 43 0.0183 4 19.00 34 0.0096 4 13.20 0.0034 2 SIEVE SIZE (mm) 31 9.50 28 0.0024 2 24 2 6.70 0.0014 4.75 23 2.36 18 **Specific Gravity:** 2.00 18 Initial Moisture Content (%) : 1.18 15 pH: 0.600 13 Conductivity mS/m : Passing 0.425 12 0.300 11 Particle Size Distribution Percentage 06 08 09 0.150 8 1 1 1 1 1 1 1 1 1 1 0.0750 6 1111 Atterberg Limits : 70 Liquid Limit 28 60 7 Plastic Index 50 1 1 1 1 Linear Shrinkage 3.0 40 1 1 1 130 $\begin{smallmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{smallmatrix}$ MOD AASHTO ; C.B.R. : 20 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 MOD AASHTO (Kg/m³) 1948 10 O.M.C. (%) 12.3 0 0.001 0.010 Particle Size (mm) 1.000 10.000 100.000 C.B.R. @ 100% Comp. 35 C.B.R. @ 98 % Comp. 28 **Tabulated Summary** Percentage 77 Gravel : Percentage - 4.75 mm C.B.R. @ 95 % Comp. 21 17 Sand : Percentage - 4.75mm and + 0.075mm 16 C.B.R. @ 93 % Comp. Silt : Percentage - 0.075mm and + 0.002mm C.B.R. @ 90 % Comp. 13 4 Clay : Percentage - 0.002mm 2 0.00 Swell (max)%

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