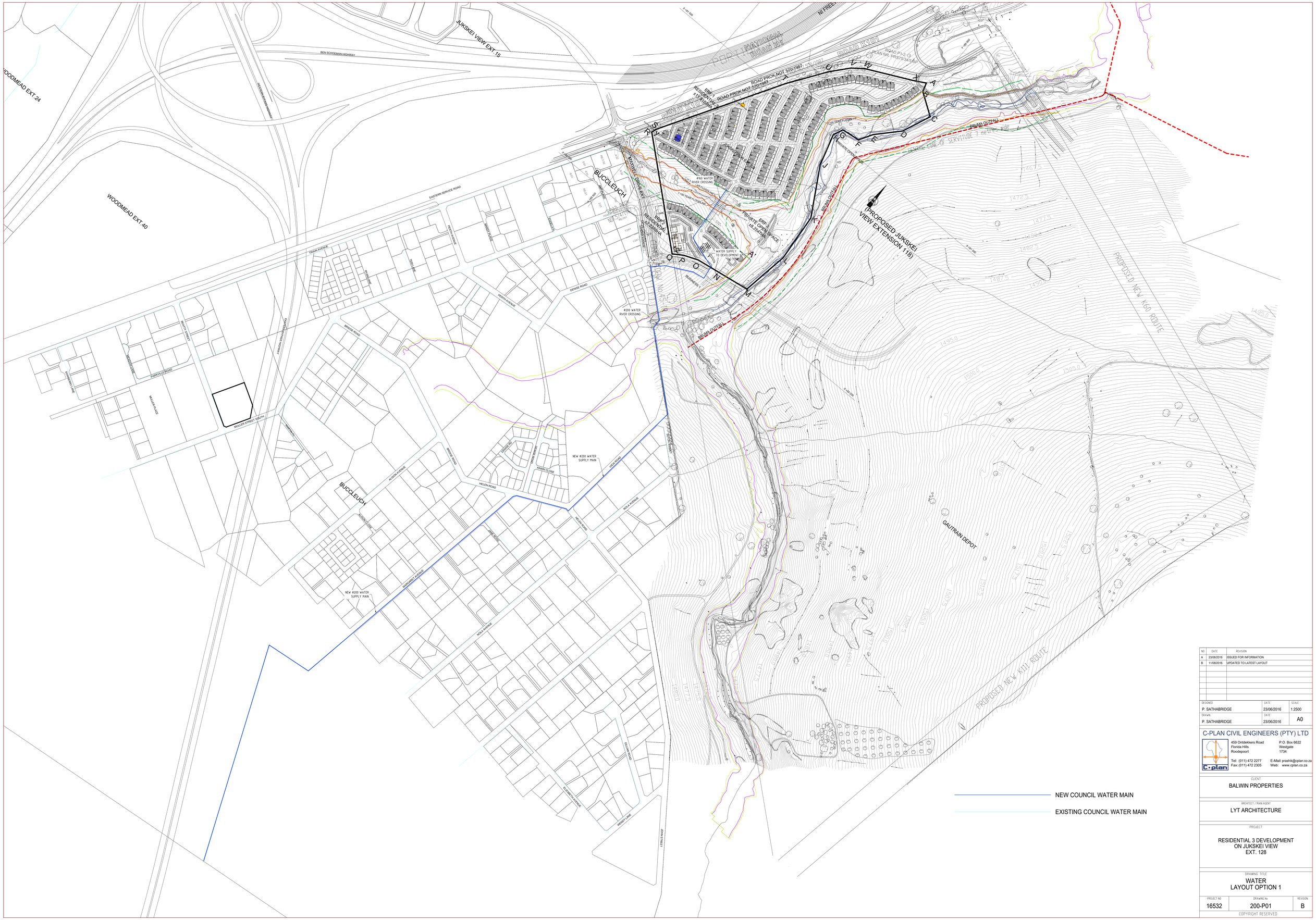
8. Drawings



NO	DATE	REVISION
A	23/06/2016	ISSUED FOR INFORMATION
B	11/08/2016	UPDATED TO LATEST LAYOUT

DESIGNED	DATE	SCALE
P. SATHABRIDGE	23/06/2016	1:2500
DRAWN	DATE	
P. SATHABRIDGE	23/06/2016	A0

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CLIENT
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ARCHITECT / MAIN AGENT
LYT ARCHITECTURE

PROJECT
RESIDENTIAL 3 DEVELOPMENT
ON JUKSKEI VIEW
EXT. 128

DRAWING TITLE
WATER
LAYOUT OPTION 1

PROJECT NO	DRAWING No	REVISION
16532	200-P01	B

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DRAWING TITLE
WATER
LAYOUT OPTION 2

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16532	200-P02	A

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CONNECT INTO 2.0m CONCRETE BRUMA OUTFALL

200mm uPVC SEWER MAIN

ROAD M50

Y +89 000

200mm uPVC SEWER MAIN

ROAD P1-2 PLAN NR. PRS75/34/5 BP

SEWER CONNECTION FOR DEVELOPMENT

BRUMA OUTFALL

A

B

C

D

E

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G

H

K

L

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RE/1
WATERVAL 5 IR

Y +89 500

N1 FREEWAY

NATIONAL ROAD N1

ROAD K101

ROAD PROK NOT 570/1987

X +81 500

JUKSKEI VIEW EXT.128

100 YEAR FLOODLINE

PRELIM SEWER ROUTE FOR DEVELOPMENT

(PROPOSED JUKSKEI VIEW EXTENSION 118)

N

1:100 YEAR FLOODLINE

160mm uPVC SEWER RIVER CROSSING

1:100 YEAR FLOODLINE

A'

MAXWELL DRIVE EXT

JUKSKEI VIEW EXT.15

BUCCLEUCH

X +82 000

ABERFOYLE

SANDRA AVENUE

HUISKA DELLEVILLE

ENGELA PL

DENISE ROAD

MANDY PL

SERVICE ROAD

Y +89 500

BRUMA OUTFALL

GAUTRAIN DEPOT

NO	DATE	REVISION
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ON JUKSKEI VIEW
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CONNECT INTO BRUMA OUT

PROJECT NO	DRAWING No
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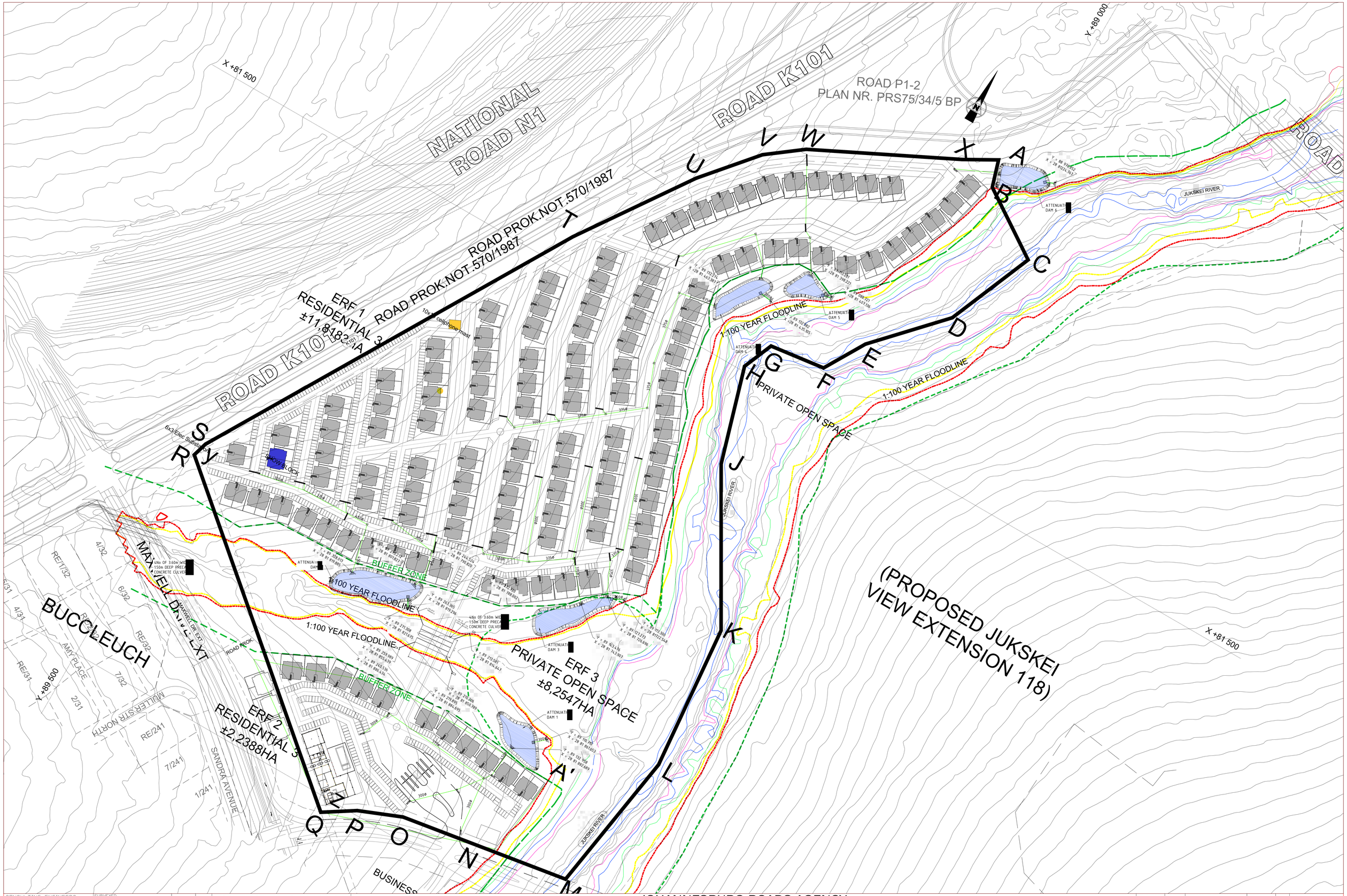

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		DESIGNED	P SATHABISE
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		SERVICES CHECKED	
		GEOTECHNICAL INVESTIGATION	
		SERVITUDES	
		APPROVED	

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Pr. Eng. No.
DATE

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STORMWATER MANAGEMENT PLAN
FOR THE RESIDENTIAL 3 DEVELOPMENT
ON JUKSKEI VIEW EXT 128

DESIGN MANAGER

DATE

SCALE
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AMENDMENTS	APPROVED	DATE
A FOR INFORMATION		23/06/2016
B UPDATED TO THE LATEST LAYOUT		10/08/2016

DRAWING No.
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SHEET
SHEET 1 OF 1

APPENDIX G8: GEOTECHNICAL REPORT

Report number 0537

REPORT ON A PHASE 1 GEOTECHNICAL SITE INVESTIGATION FOR THE PROPOSED WATERFALL GOLF ESTATE ON PORTIONS OF PORTION 1 OF THE FARM WATERVAL 5IR, MIDRAND, GAUTENG PROVINCE

August 2005

Prepared for:

WITWATERRAND ESTATES (PTY) LTD. & INVESTEC
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EXECUTIVE SUMMARY

A Phase 1 Geotechnical Site Investigation was conducted during June 2005 for the proposed housing and golf estate on portions of Portion 1 of the farm Waterval 5-IR, Midrand, Gauteng. The subsurface conditions were evaluated by excavating eighty five test pits. The soil properties were determined during the profile descriptions and the testing of twenty eight soil samples.

The site was subdivided into four areas, 1) area east of the N1, 2) area north of the Jukskei River, 3) area south-west of the Jukskei and 4) area south of the Jukskei River.
The general soil profile in the four areas corresponds, but slight differences in thickness of the different layers are evident. The typical profile consists of a surficial transported silty sand, a pebble marker consisting of quartz and granite pebbles in a sandy matrix overlying the residual granite and diabase in some instances.

Groundwater seepage was encountered in some of the test pits and in the areas on the lower slopes. Perched groundwater tables and surface seepage are therefore predicted for the lower elevated areas and the gulleys and river floodplain area.

The site was divided into four Site Class Designations according to the NHBRC guidelines:
Zone I comprise the drainage channels and floodplain zones, Zone II occurs in two small areas in the northwest and southeast of the area to the west of the N1, Zone III comprises the largest part of the site and Zone IV covers the two uncontrolled fill areas in the areas to the southwest of the Jukskei River and eats of the N1. The parameters of concern in these zones are listed in the table below:

Site Class	NHBRC Site Class	Geological Constraints	Suggested foundations
Zone I	H2-C1-P	Moderate to high potential heave Moderate soil compressibility Localised excavation difficulty Permanent or perched water table less than 1,5m below ground surface. Areas subject to flooding	Stiffened or cellular rafts Split construction Piles/pier foundations Soil raft
Zone II	C2-H2	Collapse settlement Localised soil heave	Stiffened or cellular rafts Piles/pier foundations Soil raft
Zone III	C-P	Localised excavation difficulties	Normal foundations
Zone IV	P	Uncontrolled fill	No development Removal of fill material Dynamic compaction

Subsurface seepage, pollution of surface and groundwater, excavation difficulty, flooding and poor soil quality are the major factors that may impact on golf course construction.

The site soils are suitable for subgrade but not for the upper road pavement layers.
It will be suitable for platforms and bedding and fill for pipelines if the pebbles are removed.
The soils will be mildly corrosive to steel pipes.

Good site drainage will be necessary to prevent wet soil conditions and damp proofing of foundations and floors may be necessary.

The appropriate design and building procedures as outlined in this report must be implemented to limit damage to housing units. A Phase 2 site investigation will be necessary to determine the final site class designation zone boundaries.

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Ref 0537/rep

August 2005

REPORT ON A PHASE 1 GEOTECHNICAL SITE INVESTIGATION FOR THE PROPOSED WATERFALL GOLF ESTATE ON PORTIONS OF PORTION 1 OF THE FARM WATERVAL 5IR, MIDRAND, GAUTENG PROVINCE

1. INTRODUCTION

A Phase 1 Geotechnical Site Investigation was undertaken at the request of Mr Welf Eybers of WEB Consulting for the proposed township establishment on portions of Portion 1 of the farm Waterval 5IR, Midrand, Gauteng Province. This investigation is for the Waterfall Islamic Institute in conjunction with Investec.

The investigation was undertaken according to the Guidelines for Urban Engineering Geological Investigations (SAIEG & SAICE, 1997) for urban development on sites larger than 10 hectares.

The objectives of the investigation were to:

- Identify, where possible, the underlying geological formations and their near surface weathered, residual and transported soil cover.
- Broadly delineate the site into the prescribed geotechnical zones according to the different founding conditions.
- Obtain the basic data concerning the use of in situ material for guideline purposes.
- Provide suitable foundation recommendations for the proposed development.
- To comment on the excavation characteristics of the site soils.
- To comment on site water management aspects, particularly pertaining to shallow groundwater or seepage.

2. AVAILABLE INFORMATION

At the time of the investigation a copy of the site layout plan (revision 12, April 2005), an aerial photograph of the area, a land surveyors plan from Theo Westervelt, and the 1:250 000 Geological Sheet 2628 East Rand and 1:50 000 topocadastral map 2628AA Johannesburg were available.

The guideline and specification documents by the South African Institute of Engineering and Environmental Geologists and South African Institution for Civil Engineers (1997), the National Department of Housing (2002) and the National Home Builders Registration Council (1999) were also consulted.

Existing geotechnical report conducted on portion 62 of the farm Waterval 5IR was also consulted during the investigation (van Rooy, 2004).

3. SITE LOCATION AND DESCRIPTION

3.1 GENERAL

The investigated site is situated on the central eastern portions of the farm Waterval 5IR, Midrand. The N1 Highway, running north-south, separates the site into two major portions that will be referred to as the portion east of the N1 Highway and the portion west of the N1 Highway, (Figure 1, Appendix A).

The site boundaries for the portion situated to the east of the N1 Highway are:

West: Pretoria Main Road (running parallel to the N1 Highway).
East: Boundary of the proposed Gautrain shunting yard.
North: Proposed Provincial Road K68.
South: Northeastern municipal boundary of Buccleuch (City of Johannesburg).

The site boundaries for the portion situated to the west of the N1 Highway are:

West: Provincial Road R55 (Main Road).
Northwest: Southern boundary of the Farm Bothasfontein 408JR.
Northeast: Kyalami/Allandale Road.
East: N1 Highway.
South: Northern boundary of the Waterfall Islamic Institute (Concrete wall).

A portion in the central northern part of the site has been excluded and is earmarked for a shopping centre.

The site elevation varies between 1 510m and 1 430m above mean sea level. There is an elevation difference of approximately 90m between the upper and lower parts of the site.
The general slope angle falls between 2° and 6°, although there are local steeper and flatter areas.

A prominent drainage channel, the Jukskei River, flows in a northerly direction through the portion situated to the east of the N1 Highway, turning in a westerly and then a north-western direction, meandering through the portion situated to the west of the N1 Highway. A smaller tributary of the Jukskei River flows in a northerly direction and joins the Jukskei River west of the N1 Highway. These two more prominent drainage features will be used to further subdivide the portion situated to the west of the N1 Highway into three smaller areas that will be referred to as the area north of the Jukskei River, south-west of the Jukskei River and south of the Jukskei River.

To simplify matters, these areas will be discussed separately during the more detailed description of the site and geology.

There are several surface drainage features within the larger site boundaries and the direction and type of drainage will be discussed separately within the subdivided area descriptions.

Most of the surrounding area is serviced by stormwater reticulation and the usual municipal services, except the area to the south of the portion situated west of the N1 Highway and the northern and eastern boundaries of the portion situated east of the N1 Highway.

The different areas are discussed in more detail below.

3.2 AREA DESCRIPTIONS

3.2.1 North of Jukskei River

This area's elevation varies between 1 470m and 1430m above mean sea level with an elevation difference of approximately 40m between the higher northeastern portion and the lower southern portion.
The general slope angle falls between 2° and 6□

A prominent drainage channel is situated in the northwestern corner of the area, draining in a southeasterly direction into the Jukskei River with another drainage channel near the eastern boundary of the site, running in a south-south-westerly direction, parallel to the N1 Highway. A small earth dam is situated near Allandale Road in this drainage with another near the southern end close to the Jukskei River. Less prominent drainages also exist in which wet conditions and surface seepage will be experienced.

This area generally slopes towards the southwest and drainage will be in the form of unconcentrated surface flow towards the existing drainage channels emptying eventually into the Jukskei River.

Existing sewage works with outbuildings are situated in the northwest, adjacent to and east of the drainage channel.

A number of prominent north-northwest striking quartz veins and scattered granite outcrops exist in this portion.

Few large trees and grass cover the site, but a concentration of large trees occur near the northwestern border of the site and adjacent to the Jukskei River.

Evidence of previous cultivation is also present on this northern slope with some contour ploughing present.

3.2.2 South-west of Jukskei River
This area's elevation varies between 1 460m and 1415m above mean sea level with an elevation difference of approximately 45m between the higher southwestern portion and the lower northeastern portion.
The general slope angle varies between 2° and 6□

The Jukskei River forms the northeastern boundary of this area. A less prominent drainage channel forms the southeastern boundary and drains in a northerly direction towards the Jukskei River with 5 earth dams in this drainage channel. Three small existing earth dams are situated in the southern, central and northern portions of the site close to the R55 Road.
Less prominent drainage features also exist in which wet conditions and surface seepage will be experienced.

A furrow, generally on the 1 440m to 1 435m contour, running parallel to the Jukskei River is present from the northwestern corner to the southeastern border of the site continuing towards the portion situated to the south of the Jukskei River. The furrow receives water from the prominent and less prominent drainage features that flow into the furrow as well as seepage water in areas of shallow groundwater.

Existing buildings, stores and houses are situated on the southern part of this portion, adjacent to the R55.

An uncontrolled fill and dumping area is located to the north of the existing buildings stretching from near the R55 up to the existing furrow.

Seepage and wet surface conditions are present to the northeast of the furrow in close proximity to the existing uncontrolled fill. Wetland conditions are present and seepage occurs approximately from the 1 440m contour towards the Jukskei River.
An existing earth dam is situated outside the site boundary, to the west and next to the R55 near the curve to the south in this road. Water is seeping from this dam underneath the R55, in a northeasterly direction, following a path to the south of the existing buildings towards the Jukskei River. These seepage conditions are the main reason for the wet conditions experienced to the south of the existing buildings.

This area generally slopes toward the northeast and drainage will be in the form of unconcentrated surface flow towards the existing drainage channels and eventually into the Jukskei River.

A couple of large trees are situated along the central eastern boundary, parallel to the R55, and adjacent to the Jukskei River.

3.2.3 South of Jukskei River
The elevation in this area varies between 1 480m and 1 430m above mean sea level with an elevation difference of approximately 50m between the higher southern portion and the lower northern portion.
The general slope angle falls between 2° and 6□

The Jukskei River forms the northern boundary of this portion. A less prominent drainage channel forms the eastern border and drains in a northerly direction towards the Jukskei River with 5 earth dams within this drainage channel. A less prominent drainage/seepage channel drains through the centre of this area in a northerly direction towards the Jukskei River with two earth dams within

the drainage feature and a concrete dam adjacent to the Jukskei River where the drainage channel joins the Jukskei. Another earth dam is situated to the northeast, adjacent to the Jukskei River. Less prominent drainage features also exists in which wet conditions and surface seepage will be experienced.

A furrow, extending from the area southwest of the Jukskei, generally on the 1 440 to 1 435m contour, running parallel to the Jukskei River occurs from the eastern border of the site and meets the Jukskei River in the east of this area. In this area the furrow generally receives water from the two more prominent drainage features flowing into the furrow as well as seepage water in zones of shallow groundwater.

This area generally slopes towards the north and drainage will be in the form of unconcentrated surface flow towards the existing drainage channels and towards the Jukskei River.

A lane of large Eucalyptus trees is present through the entire width of this section and runs in a southeasterly direction to the northern half.

Numerous trees are situated on the western and northeastern portions of this area, usually associated with shallow bedrock and/or outcrop in which the joints act as water bearing features for the larger flora.

Scattered granite and diabase outcrops are present in this area.

3.2.4 East of N1 Highway

This area's elevation varies between 1 510m and 1 455m above mean sea level with an elevation difference of approximately 55m between the higher eastern portion and the lower western central portion.
The general slope angle falls between 2° and 6□

The Jukskei River flows from south to north through the western half of this portion. A less prominent drainage channel, the Modderfontein Spruit, flow in a northwesterly direction through the lower southern part into the Jukskei River. A drainage channel also drains from the northeastern corner of the adjacent piece of land, Portion 74 of the farm Waterval 5IR, in an east-northeasterly direction towards the Jukskei River with one earth dam in this drainage channel close to the Jukskei River.
Less prominent drainage features also exist in which wet conditions and surface seepage may be experienced.

The western and eastern parts slope towards the Jukskei River. Drainage will be in the form of unconcentrated surface flow towards the existing drainage channels and towards the Jukskei River.

Uncontrolled fill is placed in the northwestern corner of this area.

An existing structure is also situated on the central eastern border, close to the R101.
A few large trees are mainly situated on the central west, central east and southern boundaries.

Minor rock outcrops are present throughout this area with more prominent outcrop near the southern corner and riverbed.

4. METHOD OF INVESTIGATION

The fieldwork, entailing a site walkover, trial pitting and profile descriptions, was conducted between 22 and 27 June 2005. Eighty-five test pits were excavated using a CAT 416B TLB.

The test pits covered the accessible parts of the site and their positions are indicated on the site plan (Figure 2, Appendix A).

Qualified Engineering Geologists inspected the test pits and recorded the soil profiles using the standard procedures as recommended by SAIEG (1997). The soil profiles are included in

(Appendix B).

One undisturbed and twenty-seven disturbed soil samples were retrieved and submitted to Soillab (Pty) Ltd. of Pretoria for foundation indicator and collapse potential testing.

Laboratory test results from the adjacent Portion 62 of the farm Waterval 5IR, including six foundation indicator and two collapse potential tests, were also used to evaluate the soil properties.

The test results are included in Appendix D.

5. GEOLOGY

5.1 GENERAL

According to the 1:250 000 geological sheet 2628 East Rand, the site is underlain by gneiss, migmatite or porphyritic granodiorite of the Halfway House Granite.
A northwest-southeast striking syenite dyke and north-south striking diabase dyke are indicated within the site boundaries.
Prominent quartz veins also strike through the portion north of the Jukskei in a northwesterly direction.

This site is not underlain by dolomitic bedrock and a stability investigation is therefore not required.

According to the geological maps and accompanied explanation no specific mineral deposits are present on the site. A large aggregate quarry is operating to the north of the portion east of the N1.

Corestones, outcrop, and shallow bedrock will be encountered throughout large portions of the site.

5.2 SOIL PROFILES

A brief description of the various soil horizons encountered in the different areas during this investigation is given below with test pit summaries of the different site portions in Appendix C (Tables C1 – C4).
A summary of the average thickness values for each area is given in Table 1.

5.2.1 Area north of Jukskei River

A summary table (Table C1) is included in Appendix C.

5.2.1.1 Colluvium

The area is covered with a transported colluvial material. The thickness of this layer varies from 0,05m in test pit GPS016 to 0,90m in test pit TP20 with an average thickness of 0,33m.

The layer was generally described as slightly moist, light greyish-brown to brownish-grey, loose to medium dense, intact, gravelly silty sand with scattered sub-angular quartz gravel.

5.2.1.2 Pebble Marker

A typical pebble horizon separating the transported surficial soil from the deeper residual material occurs across this part of the site.
The horizon generally has the same matrix as the colluvium with a loose to medium dense consistency and consists of abundant sub-angular quartz pebbles.

The average thickness of this horizon is 0,23m, but the thickness varies from 0,0m to 0,32m.

5.2.1.3 Residual granite
Almost all the test pits were terminated in residual granite.
A reworked residual horizon generally underlies the pebble marker and was described as slightly moist light brown to brownish-orange mottled and streaked black stained orange, medium dense, intact, clayey gravelly silty sand.

A weakly exposed residual horizon occurs below this reworked layer and was generally described as slightly moist, light pinkish-brown to light orange-brown medium dense to dense, intact to jointed, clayey silty gravelly sand.

5.2.1.4 Ferricrete
Highly ferruginised residual granite to hardpan formation was encountered in test pits GPS018, TP21, GPS022, GPS024 and GPS062. Refusal was reached on the highly ferruginised material at depths varying between 0,76m in test pit GPS062 to 1,20m in test pit TP21.

5.2.2 Area south-west of Jukskei River

A summary table (Table C2) is included in Appendix C.

5.2.2.1 Colluvium
The area is covered with a transported colluvial material. The thickness of this layer varies from 0,05m in test pit GPS248 to 1,92m in test pit GPS262 with an average thickness of 0,44m.

The layer was generally described as slightly moist, light brown to light greyish-brown, loose to medium dense, intact, clayey gravelly silty sand with scattered sub-angular quartz gravel.

5.2.2.2 Pebble Marker
A typical pebble horizon separating the transported surficial soil from the deeper residual material occurs across the site.
The horizon generally has the same matrix as the colluvium with a loose to medium dense consistency and consists of abundant sub-angular quartz pebbles.

The average thickness of this horizon is 0,35m, but the thickness varies from 0,0m to 0,97m.

5.2.2.3 Residual granite
Almost all the test pits were terminated in residual granite.
A reworked residual horizon generally underlies the pebble marker and was described as slightly moist light brownish grey to brownish orange mottled and streaked black stained orange with grey vertical weathering zones, intact, clayey gravelly silty sand. The consistency of this layer varies between loose to medium dense to dense.

A weakly exposed residual horizon occurs below this reworked layer and was generally described as light brown to orange-brown, medium dense to very dense depending on the degree of ferruginisation, intact to jointed, clayey silty gravelly sand.

5.2.2.4 Ferricrete
Hardpan formation was encountered in test pits GPS247 and GPS253. Refusal was reached on the highly ferruginised material at 1,00m and 0,70m respectively.

5.2.3 Area south of Jukskei River

A summary table (Table C3) is included in Appendix C.

5.2.3.1 Colluvium
The area is covered with a transported colluvial material. The thickness of this layer varies from 0,05m in test pit GPS278 to 1,80m in test pit GPS286 with an average thickness of 0,36m.

The layer was generally described as slightly moist, light brown to light grey, loose to medium dense, intact, clayey gravelly silty sand with scattered sub-angular quartz gravel.

5.2.3.2 Pebble Marker
A typical pebble horizon separating the transported surficial soil from the deeper residual material occurs across the site.
The horizon generally has the same matrix as the colluvium with a loose to medium dense consistency and consists of abundant sub-angular quartz pebbles.

The average thickness of this horizon is 0,39m, but the thickness varies from 0,0m to 0,90m.

5.2.3.3 Residual granite
Almost all the test pits were terminated in residual granite.
A reworked residual horizon generally underlies the pebble marker and was described as slightly moist light brownish grey to brownish orange mottled and streaked black stained orange with grey vertical weathering zones, intact, clayey gravelly silty sand. The consistency of this layer varies between loose to medium dense to dense.

The residual granite horizon occurs below this reworked layer and was generally described as light brown to orange-brown, medium dense to very dense depending on the degree of ferruginisation, intact to jointed, clayey silty gravelly sand.

5.2.3.4 Ferricrete
Hardpan formation was encountered in test pit GPS272. Refusal was reached on the highly ferruginised material at 0,80m.

5.2.4 Area east of N1 Highway

A summary table (Table C4) is included in Appendix C.

5.2.4.1 Colluvium
The area is covered with a transported colluvial material. The thickness of this layer varies from 0,05m in test pit GPS055 to 0,64m in test pit GPS034 with an average thickness of 0,29m.

The layer was generally described as slightly moist, light brown to light greyish-brown, loose to medium dense, intact, clayey gravelly silty sand with scattered sub-angular quartz gravel.

5.2.4.2 Pebble Marker
A typical pebble horizon separating the transported surficial soil from the deeper residual material occurs across the site.
The horizon generally has the same matrix as the colluvium with a loose to medium dense consistency and consists of abundant sub-angular quartz pebbles.

The average thickness of this horizon is 0,30m, and the thickness varies from 0,06m to 0,76m.

5.2.4.3 Residual granite
Almost all the test pits were terminated in residual granite.
A reworked residual horizon generally underlies the pebble marker and was described as slightly moist brownish-orange mottled and streaked black stained orange, intact, clayey gravelly silty sand. The consistency of this layer varies between loose to medium dense.

A less obscure residual horizon occurs below this reworked layer and was generally described as light pinkish-orange to orange-brown, medium dense to very dense, intact to jointed, clayey gravelly silty sand.

5.2.4.4 Ferricrete
Hardpan formation was encountered in test pit GPS034. Refusal was reached on the

highly ferruginised material at 0,70m.

Table 1. Summary of layer thicknesses (m)

Soil Layer		North of Jukskei	Southwest of Jukskei	South of Jukskei	East of N1
Colluvium	Avg thickness	0.33	0.44	0.36	0.29
	Variation	0.05 – 0.9	0.05 – 1.92	0.05 – 1.8	0.05 – 0.64
Pebble Marker	Avg thickness	0.23	0.35	0.39	0.3
	Variation	0 – 0.32	0 – 0.97	0 – 0.9	0.06 – 0.76
Depth to residual granite		0.45	0.63	0.66	0.56
Refusal depth on ferricrete		0.76 – 1.2	0.07 – 1.0	0.8	0.7
Average test pit depth in granite		1.56	1.85	1.74	1.65

5.3 GROUNDWATER

Shallow groundwater seepage was encountered in test pits GPS256, GPS257, GPS258, GPS285 and GPS286 that are situated in the areas southwest and south of the Jukskei River. These test pits are situated near the Jukskei River where seepage is expected from the lower slopes.

Due to the site gradient towards the Jukskei River and locally towards the smaller drainage features, percolating groundwater will flow downwards through the upper permeable horizons and follow the gradient to the drainage channels. Wet surface conditions are therefore expected along most of the lower slopes along the edge of the river floodplain and locally in the gulleys.

Local perched groundwater tables will also occur on the lower slopes, especially towards the Jukskei River and along the larger drainage channels.
These perched water tables will probably occur within the loose colluvial material and on the transported soil/residual granite or hardpan ferricrete interface on the lower slopes and will typically appear during and towards the end of the rainy season.

The regional groundwater in this area occurs in intergranular and fractured aquifers with an average depth to the groundwater table of between 10 and 20m, although shallower water tables may be expected closer to the drainages, at lower elevations and in the floodplain of the Jukskei River.

The area is drained by a well developed drainage network around the Jukskei River as the main drainage channel.
A number of earth and concrete dams also occur within the drainages and will change the groundwater conditions locally.

The wet area in the southwest is mainly due to leakage from the dam on the western side of the R55.

6. GEOTECHNICAL EVALUATION

The geotechnical appraisal is based on the field observations, aerial photograph interpretations, interpretations on site and available laboratory test results.

6.1 ENGINEERING AND MATERIAL CHARACTERISTICS

The foundation indicator test results conducted on the disturbed samples taken from various soil horizons in the test pits excavated during this investigation are summarised in Table 2.

The results from this investigation and the tests on the soil samples from the adjacent Portion 62 of the Farm Waterval 5IR indicate the following:

- The colluvium consists mainly of clayey silty sand material with varying percentages of clay and gravel.

Table 2: Indicator test results summary

Test Pit	Dept□ (m)	Description	Soil composition				Atterberg Limits		LS %	GM	Activity	AASHO classification
			Clay %	Silt %	Sand %	Gravel %	LL %	PI %				
GPS233	0.7-1.5	Transported	29	27	42	3	48	28	13	0.7	**Medium**	A-7-6(13)
GPS034	0.0-0.55	Colluvium	5	11	78	7	18	5	1.5	1.4	Low	A-1-b(0)
GPS044	0.3-0.55	Colluvium	4	10	76	10	--	NP	0	1.4	Low	A-2-4(0)
GPS285	0.1-0.5	Colluvium	16	17	64	3	28	14	6	1.1	Low	A-6(1)
GPS285	0.5-0.9	Colluvium	21	16	59	4	33	19	9	1	**Low to Medium**	A-6(4)
GPS286	0.6-1.0	Colluvium	26	34	40	1	38	19	8.5	0.5	**Medium**	A-6-(10)
TP20	0.0-0.9	Colluvium	3	10	43	43	22	6	2.5	1.9	Low	A-1-b(0)
K02	0.0-0.3	Colluvium/ pebble marker	3	6	34	57	23	7	2.5	2.2	Low	A-2-4(0)
GPS014	0.25-0.45	Pebble marker	2	3	22	73	20	6	2	2.5	Low	A-2-4(0)
GPS044	0.7-1.0	Pebble marker	2	9	42	47	17	3	1.5	2	Low	A-1-b(0)
GPS049	0.3-0.65	Pebble marker	5	11	43	41	21	6	2.5	1.9	Low	A-1-b(0)
GPS232	0.4-0.75	Pebble marker	2	4	26	69	19	4	1.5	2.5	Low	A-1-a(0)
GPS266	0.35-0.9	Pebble marker	10	9	40	41	34	16	7	1.9	Low	A-2-6(0)
GPS277	0.1-0.55	Pebble marker	3	5	38	54	19	5	2	2.2	Low	A-1-a(0)
GPS013	0.7-1.0	Reworked granite	6	12	43	39	22	8	4	1.8	Low	A-2-4(0)
GPS029	0.5-0.8	Reworked granite	4	13	53	30	21	4	2	1.7	Low	A-1-b(0)
GPS037	0.5-0.8	Reworked granite	6	16	47	31	20	5	2	1.6	Low	A-1-b(0)
GPS040	0.7-1.1	Reworked granite	35	30	30	5	53	27	12.5	0.5	**Medium to High**	A-7-6(16)
GPS264	0.45-1.2	Reworked granite	5	12	52	31	25	8	4	1.8	Low	A-2-4(0)
GPS271	0.95-1.20	Reworked granite	18	15	62	5	38	20	8.5	1.1	Low	A-6(2)
GPS275	0.9-1.2	Reworked granite	8	15	62	15	28	11	5	1.4	Low	A-6(2)
K02	0.3-0.7	Reworked granite	6	9	53	31	27	9	4.5	1.8	Low	A-2-4(0)
GPS012	0.8-1.0	Residual granite	10	17	60	13	40	17	8	1.4	Low	A-2-6(1)
GPS029	0.8-0.1	Residual granite	8	10	58	24	34	15	6.5	1.7	Low	A-2-6(0)
GPS234	0.9-1.2	Residual granite	2	8	78	11	--	NP	0	1.6	Low	A-1-b(0)
GPS263	0.9-1.2	Residual granite	4	6	79	11	23	8	4	1.8	Low	A-2-4(0)
GPS265	0.75-1.0	Residual granite	33	16	46	5	57	33	14.5	0.8	**Medium to High**	A-7-6(13)
GPS267	0.55-0.9	Reworked diabase	16	20	41	23	38	18	8	1.3	Low	A-6(3)

LL – Liquid limit; PI – Plasticity index; LS – Linear shrinkage; GM – grading modulus;

- It generally has a low to moderate plasticity, low potential expansiveness, low linear shrinkage and a moderate grading modulus. The samples retrieved from test pits GPS233, GPS285 and GPS286 shows a low to medium potential expansiveness
- According to the Unified Soil and AASHO classifications as well as the PRA classification the colluvium will be good subgrade, poor subbase, not suitable for use in base course in roads, but will have a good workability as construction material. This material will have a slight to medium compressibility when compacted and have fair to poor drainage characteristics. It

will be reasonably stable embankment material.
- The pebble marker grades as silty sandy gravel with low plasticity, low potential expansiveness, low linear shrinkage and a moderate grading modulus.
- According to the Unified Soil and AASHO classifications as well as the PRA classification the pebble marker will be good subgrade, poor to good subbase, not suitable for use in base course in roads, but will have a good workability as construction material. This material will have a low to very low compressibility when compacted and have good to fair drainage characteristics. It will be reasonably stable embankment material.
- The residual and reworked granite consist mainly of clayey silty gravelly sand material with varying percentages of clay.
- It generally has a low to moderate plasticity, low potential expansiveness, low linear shrinkage and a moderate grading modulus. The samples retrieved from test pits GPS040 and GPS265 shows a medium to high potential expansiveness.
- According to the Unified Soil and AASHO classifications as well as the PRA classification the reworked and residual granite will be good subgrade, poor subbase, not suitable for use in base course in roads, but will have a good workability as construction material. This material will have a slight to medium compressibility when compacted and have fair to poor drainage characteristics. It will be reasonably stable embankment material.

Collapse potential test on an undisturbed sample retrieved from test pit GPS013 from the residual granite showed collapse of 15%, which relates to severe trouble.
Collapse potential tests conducted on two undisturbed samples from portion 62 of the Farm Waterval 5IR showed collapse potential of between 8,5% to 11,5% which falls in the categories trouble to severe trouble.

6.2 SLOPE STABILITY AND EROSION

No natural slope instabilities are expected.

Due to the site gradient levelling of building sites may involve cut to fill preparation. To prevent differential settlements over the cut and fill parts controlled compaction should be implemented in especially the fills.

Due to the slope angle and the sandy nature of the colluvium covering the site, good water management practice must be employed to prevent erosion, especially after the vegetation has been cleared.

6.3 EXCAVATION CLASSIFICATION WITH RESPECT TO SERVICES

Based on excavation conditions in the trial holes and aerial photograph interpretations localized areas of corestones, shallow bedrock, outcrop and hardpan formation will cause excavation difficulty down to depths of 1,5m below natural ground level. The more prominent visible outcrops are indicated on the zonation map (Figure 3, Appendix A).

Localised and minor blasting will be required during the installation of services and foundations.

The colluvium and pebble marker material will be suitable as fill and bedding for pipelines if the gravel and pebble parts are removed.

Perched groundwater tables may cause difficulty with the installation of services.

7. SITE CLASSIFICATION AND FOUNDATION RECOMMENDATIONS

The site has been broadly classified into four major Site Class Designation zones (Figure 3), based on the above constraints and the criteria as set out in the NHBRC (1999) guideline document of which the appropriate tables have been included in Appendix A (Tables 4 – 6).

The classification and foundation recommendations are based on results from the present investigation, field interpretations, aerial photograph interpretations as well as from results

obtained during previous investigations, including Portion 62 of the Farm Waterval 5IR.

A total of 85 test pits were excavated during this first phase investigation and the proposed zone boundaries are only rough estimates. The final boundary and Site Class Designations for each stand can only be determined during the proposed phase 2 investigation.

A summary of the Zone conditions is given in Table 3.

7.1 Zone I
Site Class Designation H2/C1/P(Marshy areas, flooding, localised excavation difficulty)
Zone I includes all the existing drainage channels and the floodplain zones around these channels. The general geotechnical problems encountered within this zone are as follows:

- Moderate to high potential heave is expected.
- Moderate soil compressibility is expected on the loose soils.
- Local areas of excavation difficulty on hardpan formation.
- Permanent or perched water table less than 1,5m below ground surface.
- Include zones adjacent or within known drainage channels or floodplains.

No residential development should be allowed within this zone, especially in the areas below the 100 year flood line.

One of the following foundation options is recommended in areas that are not situated below the 100 year flood line, depending on the type of structure to be erected on site:

Stiffened or cellular raft foundations
Split construction
Piled or pier foundations
Soil raft

The final zone boundaries, i.e. the floodlines, must be determined by a qualified engineer. The boundaries indicated on Figure 3 are only approximations obtained from the aerial photograph..

7.2 Zone II
Site Class Designation C2/H2
This zone comprises of two areas, one in the area Southwest of the Jukskei River, in the northwestern corner and the other in the area to South of the Jukskei in the southeastern corner. The general geotechnical problems encountered within this zone are as follows:

- Estimated total collapse settlement of more than 10mm is expected due to the open texture in the soil profiles and severe trouble indicated in the collapse potential tests.
- Localized areas of moderate soil heave are expected.

One of the following foundation options is recommended depending on the type of structure to be erected on site:

Stiffened or cellular raft foundations.
Piled or pier foundations
Soil raft

7.3 Zone III
Site Class Designation C/P(excavation)
The largest part of the investigated site comprises this zone and excludes all the drainages and the fill areas.
No major collapse settlement is expected within this zone.
The major geotechnical problem expected is:

- Localized excavation difficulties on outcrop, shallow bedrock, corestones of substantial size and hardpan formation.

The following foundation option is recommended depending on the type of structure to be erected on site and if foundation pressures are less than 50kPa:

Normal foundations (strip footing or slab-on-the-ground foundations).
Good site drainage will be necessary.

7.4 Zone IV

Site Class Designation P(uncontrolled fill)

Two areas of uncontrolled fill have been identified during the investigation. These areas are present on the area Southwest of the Jukskei River and the area to the east of the N1 Highway as indicated on the zonation map (Figure 3).

Depending on the feasibility and economic viability of the options one of the following are recommended regarding these fill areas:

- Removal of the fill.
- Levelling and compaction by means of dynamic compaction to the required density of 93% Mod AASHTO at –2% to +2% of OMC through the whole thickness of the fill.
- Exclusion of these areas from the development.

One of the following foundation options is recommended depending on the type of structure to be erected on the modified fill:

Stiffened or cellular raft foundations
Piled or pier foundations
Soil raft with modified normal construction

It is recommended that the structural engineers calculate the best economical foundation option for the proposed development based on the type of structure and the different available construction methods.

Table 3: Site Designation Class Summary

Site Class	NHBRC Site Class	Geological Constraints	Suggested foundations
Zone I	H2-C1-P	Moderate to high potential heave Moderate soil compressibility Localised excavation difficulty Permanent or perched water table less than 1,5m below ground surface. Areas subject to flooding	Stiffened or cellular rafts Split construction Piles/pier foundations Soil raft
Zone II	C2-H2	Collapse settlement Localised soil heave	Stiffened or cellular rafts Piles/pier foundations Soil raft
Zone III	C-P	Localised excavation difficulties	Normal foundations
Zone IV	P	Uncontrolled fill	No development Removal of fill material Dynamic compaction

The above foundation recommendations for the different site classes are according to the NHBRC Home Builders Manual (1999) for single storey masonry structures (Table 4 - 6, Appendix A).

8. ISSUES RELATING TO GOLF COURSE CONSTRUCTION

The proposed site layout indicates most of the golf course areas to be on the lower slopes within and along the drainage channels and floodplains.

It is expected that these areas will typically have natural perched groundwater tables and/or surface seepage occurring on the hardpan ferricrete horizons. Parts will obviously also be below the 1:100 year floodlines and may be prone to occasional flooding.

These conditions may influence drainage of the golf course, cause swampy conditions if the irrigation water is added to the natural water seepage and the possibility of groundwater and surface pollution from fertilisers is also high.

It is suggested that good site drainage be installed to drain the natural groundwater away from the golf course areas and that irrigation be managed in such a way that induced perched water tables or seepage is prevented or limited. Seepage water may also be utilised in water features.

Excavation into the hardpan formations will be difficult and the installation of subsurface services on the golf course may encounter localised problems with shallow rock and pedocrete.

The typical soils on the site have a low agricultural potential and this will also be the case for the fairway and greens parts of the golf course. The soil will have to be improved or alternatively a better growth medium will have to be imported.

9. SPECIAL PRECAUTIONARY MEASURES

The upper loose colluvium has a low bearing capacity and foundations should be placed below the loose layer.

Good site drainage will be necessary as the occurrence of perched water tables during high rainfall periods is a reality, especially on the lower lying areas. This may cause problems with dampness in surface structures and with installation of services. The possibility of saturation of the soil profile will also need special site drainage as this may lead to collapse settlements under load.
The occurrence of surface seepage and perched groundwater tables on the lower slopes will also have a negative influence on the mobility in the golf course areas.

Areas of termite and other biotic activity are present and additional foundation modifications to prevent damage to single-storey structures due to differential settlements may be necessary across these features. The biotic activity is generally limited to the upper soil horizon.

The test pits were positioned to cover the accessible parts in order to zone the site. The pits were backfilled by the TLB without proper compaction in layers. If structures are to be positioned over or across these pits proper compaction must be executed to prevent differential settlements from taking place. The same will apply to development across existing foundations, waste pits, root areas of removed large trees, old excavations, trenches, furrows, and septic tanks.

It is assumed that the development will be serviced by the usual municipal services and no recommendations are made on on-site sanitation, waste disposal, cemetery and stormwater reticulation services.

The corrosiveness of the granitic soils is usually mild to severe and it will be good practice to use plastic pipes rather than steel pipes for services.

Exposed soil areas, after removal of vegetation, will also need some preventative measures against surface erosion, parallel to the slope.

10. CONCLUSIONS

The site will be suitable for development if the appropriate foundation design and building procedures are implemented as listed in this report and the NHBRC Home Builders Manual.

The site is classified into four major Site Class Designation zones.

Zone I:
The major geological factors that may influence residential development are the following:

- Moderate to high potential heave are expected.
- Permanent or perched water table less than 1,5m below ground surface.
- Excavation difficulty on hardpan ferricrete.
- Moderate soil compressibility is expected on the loose soils.
- Flooding in areas adjacent or within known drainage channels or floodplains.

Zone II:
The major geological factors that may influence residential development are the following:

- Estimated total collapse settlement of more than 10mm is expected due to the open

texture of the soil profiles.
- Localized areas of moderate soil heave are expected.

Zone III:
The major geological factors that may influence residential development are the following:
- Localized excavation difficulties are expected on outcrop, shallow bedrock, corestones of substantial size and hardpan formation.
- No major collapse and/or heave are expected.

Zone IV:
The major geological factors that may influence residential development are the following:
- Uncontrolled fill.

Depending on the feasibility one of the following are recommended regarding these fill areas:
- Removal of the fill.
- Levelling and compaction by means of dynamic compaction to the required density.
- These areas to be excluded from the development.

The upper soil horizons will be suitable for construction of platforms, lower road pavement layers and backfill.

The site soils will be corrosive to steel pipes.

Outcrop, corestones, shallow bedrock and shallow ferricrete formation are present that will cause excavation difficulty.
General conditions prevail that may cause perched groundwater tables or seepage in all the small depressions and drainage features across the entire site.

11. REPORT PROVISIONS

While every effort is made during the fieldwork phase to identify the different soil horizons, areas subject to a perched water table, areas of poor drainage, areas underlain by hard rock and to estimate their distribution, it is impossible to guarantee that isolated zones of poorer foundation materials, or harder rock have not been missed.

For this reason this investigation has sought to highlight areas of potential foundation, groundwater and excavation problems, to provide prior warning to the developer.

A competent person should inspect foundation excavations for future structures or the open service trenches, at the time of construction to determine the variance from the above assessment of the site.

It is essential to conduct a Phase II Geotechnical Site Investigation. NHBRC enrolment of the site can only be completed once this Phase II Geotechnical Site Investigation has been executed. The final zone boundaries will only be determined during this investigation stage.

The present site zonation is based on the NHBRC Manual with the guideline site class designation specifically for single-storey masonry residential units.

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