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DRAFT

A REPORT

ON

A SUPPLEMENTARY DRILLINGINVESTIGATION FOR AN OFFICE PARK ON DIE HOEWES EXTENSIONS 285 AND 286, (HOLDINGS 231 AND 232, LYTTELTON AGRIC HOLDINGS), CENTURION (TSHWANE METRO), GAUTENG.

BY

RELLY, MILNER AND SHEDDEN
P R E T O R I A

DATE: July 2013

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1. INTRODUCTION

This report (13106Westend) presents the results of a supplementary drilling investigation carried out for a proposed office park development on portions of Holdings 231 and 232, Lyttelton Agricultural Holdings, Centurion (see locality plan overleaf).

The purpose of this report was to provide additional subsurface information to meet the footprint investigation requirements of the latest SANS 1936 [2012] document.

This report has been prepared in accordance with guidelines published by the Council for Geoscience (CGS) (References 6 and 7) and South African Bureau of Standards (Reference 10) regarding development on dolomitic land. The contents of this report are intended for use by town planners, engineers and Local Authorities.

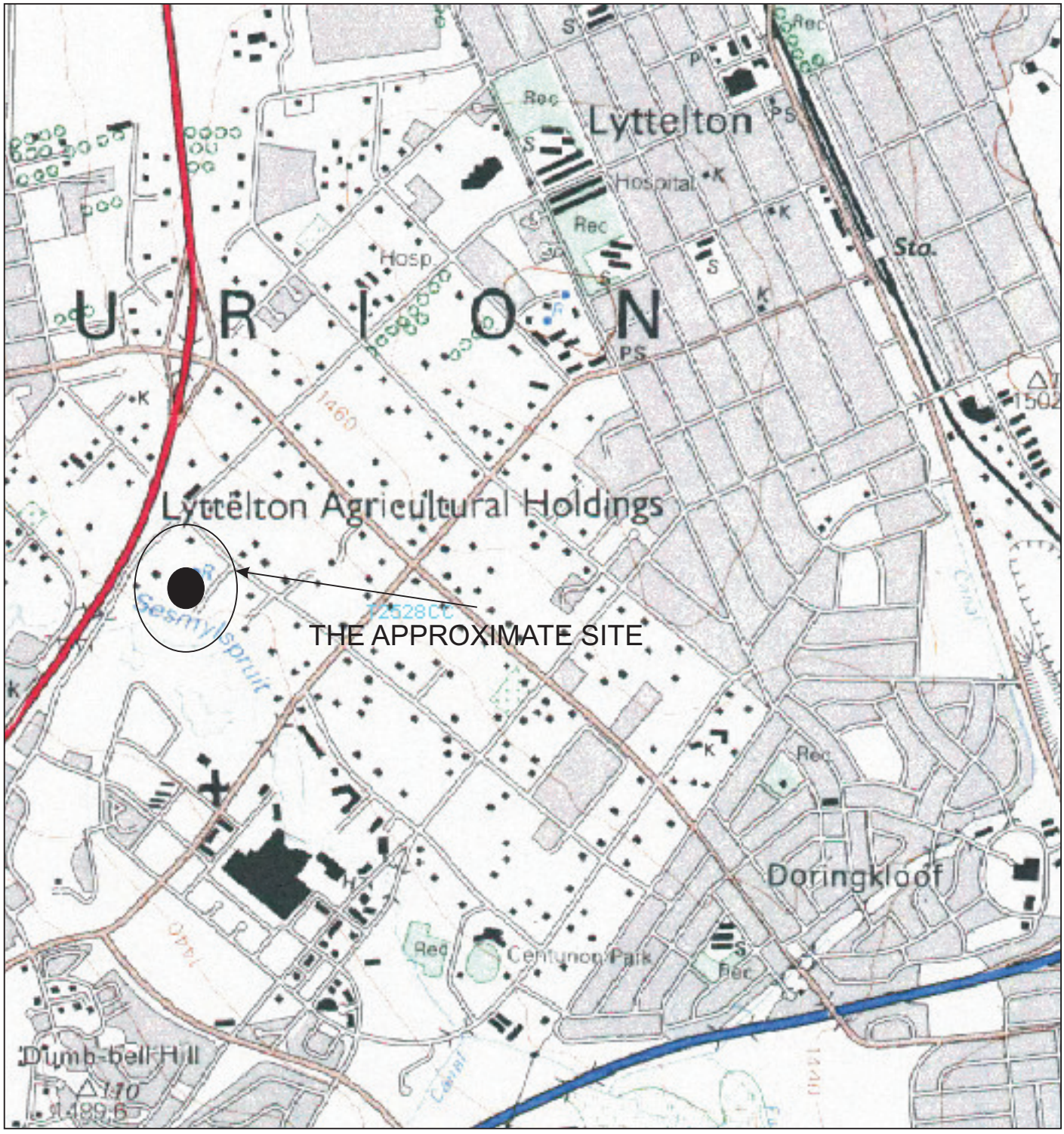
The project was commissioned at the written request of Mr T Delport of Abland, the developers of the land.

This phase of percussion drilling was completed in May 2013.

2. SITE DESCRIPTION

The site represents the combined area of two original Holdings (231 and 232) in the Lyttelton Agricultural Holdings, Centurion. Some of the land has been set aside for future road improvements and the remainder of the two properties has been subdivided into Die Hoewes Extensions 285 and 286. The site is bounded by Hall Street in the east, the proposed extension to West Avenue in the north, the future interchange in the west and the 1:100 year floodline of the Hennops River in the south. An area between the 1:100 year floodline and the river is registered as a municipal servitude.

At the time of the latest investigation (May 2013), a gatehouse had been erected at the entrance to the proposed office park just off Hall Street on the eastern side. All the previous structures have been demolished and a large amount of waste soil and rock has been dumped and levelled



LOCALITY PLAN

Die Hoewes Extensions 285 and 286,
CENTURION, Pretoria (Tshwane Metro),
Gauteng.
[Not to scale]

over a large portion of the site.

The vegetation on the site is mostly mature “bluegum” trees with a mix of other indigenous and exotic trees typical of an agricultural holding.

The relief of the site is low with an overall cross fall of about 14m from the northern corner to the river in the south. The slope of the site is flatter in the northern half with a gradient of about 2%. Steeper slopes occur in the south, particularly some 50m from the northern bank of the Hennops River. Gradients of the steeper slopes are as high as 35% next to the river. An average gradient is about 5% in the central portion of the site.

3. GEOLOGY

According to the 1:50 000 Geological Series (1973), Sheet No. 2528CC Lyttelton, the entire area is underlain by chert-rich dolomite of the Monte Christo Formation positioned towards the stratigraphic base of the Chuniespoort Group of the Transvaal Supergroup.

The dolomitic sediments have been intruded by sills and dykes of syenite in this region. Limited evidence of syenite was encountered in two percussion boreholes drilled on this site.

The hard rock geology is mantled by an irregular layer of overburden material comprising both colluvial and residual soils. Dolomite rock crops out in the north western portion and along southern edge of the site. Some of the southern outcrops are located close to and within the 1:100 year floodline. Fill material has obscured some of the outcrops observed in previous years particularly those close to the river bank.

4. EXISTING INFORMATION

This firm has been involved in four different phases of investigation on the two properties (Holdings 231 and 232) over the past 30 years. The first two investigations were carried out in 1983 and 1986 for the purposes of subdividing the properties. A third phase of drilling was undertaken in 2001 when the two owners decided to explore the possibility of developing the

combined properties for commercial purposes. A report (01108lah) dated June 2001 was submitted to the CGS for comment. The report assessed existing information and the results from three additional boreholes. A favourable comment was received from the CGS in June 2001. A more recent investigation was undertaken for Abland in 2007 when an office park development was first considered. A total of nineteen additional boreholes were drilled within the footprints of the proposed office blocks. A stability report dated October 2007 (F 303) was prepared and submitted by this firm to the CGS for comment. A letter of support was received in October 2007. The need for additional footprint drilling was highlighted in the letter.

5. METHOD OF INVESTIGATION

This investigation consisted of drilling another seven boreholes within the new footprint positions. A change in the layout between 2007 and 2013 resulted in some of the new office blocks having a limited number of boreholes in their footprint positions. Access problems prevented the drilling of BH 26 and necessitated a repositioning of BH's 23 and 25.

6. PERCUSSION DRILLING

A total of thirty-nine, 165mm ϕ, rotary percussion boreholes, totalling 1143m, have been drilled on this site. All of the drilling results have been used in the stability assessment even though some boreholes fall within the road reserve. The drilling contractors for the first two phases were requested to drill the boreholes to a maximum depth of about 25m below existing ground level or 6m into solid rock, whichever occurred first but with a minimum depth of 10m. The old boreholes range in depth from 20m to 25m below existing ground level. Bedrock was intersected in seven of the old holes at depths ranging from about 10m (BH 3/10) to 33m (BH 1). The abandonment of BH 2 at a depth of 26m below the surface was as a result of difficult drilling conditions in loose material. According to the driller, the drill bit was constantly sticking in "loose rocks". The possible loss of drilling equipment in the borehole led to the decision to abandon the hole. The drilling contractor (H Erwee) for the 2007 phase of drilling was requested to drill to a maximum depth of 60m below the surface or 6m into solid dolomite rock with a minimum of 10m. These boreholes range in depth from 10m to 55m below the surface.

The same contractor drilled the 2013 boreholes with the same instructions as for 2007 i.e. 60m maximum depth or 6m into solid rock. These seven recent boreholes range in depth from 13m (BH 27) to 60m (BH 29).

Samples were recovered (where possible) for every one metre of advance and retained in small labelled plastic bags. The penetration time per metre of advance was recorded together with any other information regarding air loss, the presence of cavities, and/or the presence of ground water during drilling operations.

Detailed descriptions of the samples recovered are given in the Borehole Profiles in Appendix B and the positions of all the boreholes are shown on the inherent hazard characterisation (IHC) map in Appendix C.

7. DRILLING RESULTS

A summary of the drilling results is presented in a table in Appendix B. The drilling results are discussed below:

7.1. Overburden Material: This refers to the "loose, unconsolidated" soil material that overlies the bedrock and includes all residual soils.

Colluvial (transported) overburden consists of a variable concentration of boulders and coarse, medium and fine chert gravel in a reddish brown clayey/sandy/silty matrix varying in thickness from 1m to about 4m although an average is about 3m. In some instances the bottom portion of the colluvial soil profile may represent residual material and not a transported layer. The difference between colluvium and residual dolomite is not always easily discernable in percussion borehole samples but this problem is more one of academic importance since their geotechnical properties are generally similar.

Residual dolomite ranges in composition from chert rubble (boulders and coarse, medium and fine chert gravel in a soil matrix) to material described as silt(wad) or clay(wad) with traces (5%-15%) to minor amounts (15%-35%) of chert gravel. Wad, the insoluble residue

from the dissolution of dolomite bedrock, ranges from a predominant to a subordinate constituent of the soil matrix and occurs from depths as shallow as 3m (BH 27) below the surface. This soil material is often easily erodible and can be highly compressible. The presence of wad also leads to the discolouration of samples when water is added during the drilling process. The thickness of residual overburden ranges from as little as 5m (between 1m and 6m in BH 27) to 60m (BH 29). Lenses of loose overburden, as indicated by zones of rapid penetration times of less than 15 seconds per metre advance, are recorded in some of the boreholes. These lenses are seldom more than 2m to 3m thick. The recent boreholes were terminated in solid bedrock except for BH 29m.

7.2. Bedrock: Bedrock is usually defined as the first layer of hard rock at least 6m thick in a dolomitic environment. This definition is necessary to avoid any confusion between large boulders (floaters), often metres in diameter, and solid bedrock.

According to the above definition, dolomite bedrock, in the form of grey to light grey, weathered to slightly weathered, hard rock is encountered in six of the seven recent boreholes. The dolomite bedrock occurs from a depth of 4m (BH 25) to greater than 60m (BH 29). Solid bedrock has been assumed in BH 28 where penetration times exceed 3 minutes per metre advance and where samples have not been recovered or where the addition of water has led to severe sample contamination and discolouration.

The drilling results indicate the presence of a broad, chert rubble-filled valley trending across the site is an east-west direction.

8. HYDROLOGY

No ground water strikes were recorded in the seven boreholes and neither were any water rest levels measured when the boreholes were backfilled a day later. It appears that the permanent ground water table away from the river lies at a depth of more than 60m below the surface.

A water rest level was measured at a depth of 16m in a domestic borehole located between the 1 in 50 year and 1 in 100 year flood-lines on the eastern boundary of the site in 2001. The owner

indicated the borehole to have a particularly strong yield. The presence of a shallow water table in the domestic borehole and an absence of water in the exploratory boreholes are probably due to proximity of the Hennops River some 25m to the south with the river providing the recharge for the nearby domestic borehole but not for the exploratory boreholes. Borehole 29 is dry to a depth of 60m.

A DWA report (GH3502) by P Hobbs indicates a possible water table at an elevation of about 1390m.a.m.s.l. The collar elevations of the boreholes range from 1417m.a.m.s.l to 1424m.a.m.s.l suggesting that a permanent water table could be expected at a depth of about 30m below existing ground level. It appears that the depth to the permanent water table on this site is much greater than indicated in the DWA report.

The site has been assessed as a NON-dewatering scenario since dewatering would have no adverse effect on the stability of the site as the water level is within the bedrock over most of the site. It is, nevertheless, strongly recommended that the extraction of ground water should not be allowed on this site.

No surface drainage feature is present on this site other than the Hennops River forming the southern boundary. Storm water run-off should be directed into the river via the shortest route.

9. STABILITY

The comments made below are based on the results of the additional percussion drilling.

The modern method of assessing dolomite stability requires that the probability of hazard (sinkhole and doline {compaction subsidence}) development and potential hazard (sinkhole) size be determined for each borehole (Reference 4). This is achieved by assessing the geological conditions from the drilling results at each borehole according to a standard set of criteria. The results allow a certain inherent hazard characterisation and potential hazard (sinkhole) size to be attached to each borehole. Boreholes exhibiting similar conditions are grouped together, depending on the gravity pattern, and an area is then designated as having a particular hazard classification in which certain types of development are recommended. The criteria that need to

be assessed are:

i) Nature of the blanketing layer.

ii) Maximum potential space in which a sinkhole may develop.

iii) Presence or absence of voids in overburden and bedrock.

iv) Presence or absence of a mobilising agency.

The probability of instability occurring is related to both the level of inherent susceptibility and the type of development that takes place, a high inherent hazard area, developed as cluster housing, has a greater probability of inducing a sinkhole than a commercial development on the same property because of the higher density of wet services and greater chance of an undetected leak. In an attempt to ensure development is compatible with a certain hazard characterisation, appropriate types of development are recommended according to the hazard classification of the area.

The additional drilling has confirmed the original hazard characterisation of the site i.e. subdivided into three different inherent hazard characterisation (IHC) zones.

ZONE A: CLASS (3(5,6))

Blanketing layer: This zone is present on either side of the chert rubble-filled valley. The ground profile consists of about 2m to 3m of chert-rich colluvium overlying a layer of residual chert rubble between 4m and 12m thick. Dolomite bedrock is intersected at depths ranging from surface (BH 17) to 12m (BH 14) below the surface. Borehole 23, drilled in the original Zone A, intersected dolomite bedrock at a depth of 29m and necessitated re-positioning the zone boundary along the southern edge. The depth to dolomite bedrock within this zone is between 5m and 15m.

The permeability of both the colluvial and residual overburden is regarded as moderate to high. The overburden is unlikely to inhibit the ingress of surface water into the subsoil.

Receptacles: Disseminated voids can be expected in the chert-rich overburden whether transported or residual. Voids should be expected in dolomite bedrock at depth.

Mobilising Agency: Any accumulation of water either on surface or below surface from a leaking service or water retaining feature is a potential mobilising agency. Infiltration of any mobilising agency should occur with moderate ease into and within the overburden. The risk of mobilisation is assessed as medium although isolated pockets of medium to high mobilisation risk may occur in this zone.

Maximum Potential Sinkhole Development Space (MPSDS): This refers to the thickness of overburden in which a sinkhole may develop and is limited by the first layer of bedrock. The MPSDS layer is absent in places (BH 17) but reaches a thickness of 14m in BH 14. A sinkhole developing in a MPSDS layer 14m thick would result in small (<2m ø) to medium size (>2m-<5m ø) sinkholes developing.

Inherent Hazard Characterisation: A medium probability for small and medium size sinkholes developing and a medium to high probability for dolines (compaction subsidences) forming are assessed for this zone. Pockets of high probability for small and medium size sinkholes cannot be excluded as indicated by the loose overburden in BH 27.

Hazard Class: A particular hazard class may be determined from the hazard characterisation of a single area. A summary of the hazard characterisation for each borehole is given in Table 1.

Table 1

Summary of Risk Characterisation

BH No.	RISK of SINKHOLE FORMATION				RISK OF DOLINES	CLASS
	Small <2m	Medium >2-<5m	Large >5-<15m	V Large >15m		
25	H	M	L	L	M	3(5)
27	M	M-H	L	L	H	3(6)

The zone has been designated **Class 3(5;6)** (Reference 4). An inherent risk characterisation of **Class 3(5,6)** renders an area suitable for certain types of commercial development. Specialised foundations will need to be designed and should be able to accommodate a

10m loss of support. The larger sinkhole size used for the foundation design requirements is as a result of all the office blocks straddling zones A and B. Zone B requires a 10m loss of support design.

ZONE B: CLASS 4(6)

Blanketing layer: This zone occupies the chert rubble-filled valley through the central portion of the properties. The overburden cover, comprising both transported and residual chert rubble, ranges in thickness from 20m (BH 16) to greater than 60m (BH 29). Wad forms both a predominant and subordinate portion of the residual soil matrix in certain boreholes. Layers within of the soil profile are described as silt(wad) with subordinate chert gravel in places. Dolomite bedrock underlies the overburden. Six metres of bedrock was confirmed in all of the recent (2013) boreholes except one (BH 29). Some of the older boreholes (2001 and earlier) were terminated at a requested depth rather than after confirmation of bedrock. Loose overburden conditions are intersected in a number of boreholes located within this zone. A loss of samples was recorded below a depth of 13m in BH 28 and is ascribed to presence of loose overburden conditions between 12m and 16m below the surface.

The chert-rich overburden is regarded as permeable and is unlikely to retard ingress of storm water run-off. The residual clayey/silty layers, where present, may retard infiltration but will not prevent it.

Receptacles: Disseminated voids may be present in the overburden as suggested by the pockets of rapid penetration times and no sample recovery. Voids are expected in dolomite bedrock whether encountered in boreholes or not.

Mobilising Agency: Any accumulation of water either on surface or below surface from a leaking service or water-retaining feature is a potential mobilising agency. Infiltration of any mobilising agency should occur with moderate ease into and within the overburden. The risk of mobilisation is assessed as medium with localized pockets of high.

Maximum Potential Sinkhole Development Space (MPSDS): This refers to the thickness of overburden in which a sinkhole may develop and is limited by the first layer of bedrock. The MPSDS layer is greater than 60m thick in this zone. A sinkhole developing in a 60m thick layer of overburden would be described as very large (>15m diameter).

Inherent Hazard Characterisation: A medium probability for any size sinkhole developing and a medium probability of doline (compaction subsidence) formation are assessed for this zone.

Hazard Class: A particular hazard class may be determined from the hazard characterisation of a single area. A summary of the hazard characterisation for the boreholes is given below in Table 2.

Table 2

Summary of Risk Characterisation

BH No.	RISK of SINKHOLE FORMATION				RISK OF DOLINES	CLASS
	Small <2m	Medium >2-<5m	Large >5-<15m	V Large >15m		
23	M	M	M	M	M	4
24	M	M	M	L	M	4
28	M	M-H	M-H	L	M	4(6)
29	M	M-H	M-H	M	M	4(6)
30	M	M	M	M	M	4

The zone has been designated **Class 4(6)** (Reference 4). An inherent hazard characterisation of **Class 4(6)** renders an area suitable for certain types of commercial development. Specialised foundations including the ability to span a 10m loss of support and stringent water precautionary measures are required within this zone.

ZONE C: CLASS 7

Blanketing layer: No additional drilling was undertaken in this zone and the classification remains unaltered.

Inherent Hazard Characterisation: A high probability for small and medium size sinkholes developing and a high risk of doline (compaction subsidence) formation are assessed for this zone.

Hazard Class: A particular hazard class may be determined from the hazard characterisation of a single area.

The zone has been designated **Class 7** (Reference 4). An inherent risk characterisation of **Class 7** renders an area unsuitable for development unless a D4 process is followed.

10. CONCLUSIONS AND RECOMMENDATIONS

The geological conditions underlying the properties favour the delineation of the site into three zones with a classification ranging from **Class 3(5,6)** to **Class 7**. The development potential of the property is discussed in the following paragraphs. This report must be read in conjunction with our 2007 report covering the same site.

ZONE A: (CLASS 3(5,6))

Hazard: Medium probability for small and medium size sinkholes and a medium to high probability for doline development. Isolated pockets exhibiting a high probability of small and medium sinkholes cannot be excluded.

Development Potential: The proposed office park development comprising a number of separate office blocks may be considered provided appropriate foundations are designed to accommodate the subsurface conditions. A possible loss of a 10m support must be included in any foundation design. The presence of shallow rock may hamper the excavation of any basements in certain areas where dolomite outcrop is indicated.

Development is conditional upon the implementation of the attached precautionary measures in Appendix E.

Location: The northwest corner and a strip of land along the 1 in 100 year flood-line.

ZONE B: (CLASS 4(6))

Risk: Medium risk for any size sinkholes and a medium risk for doline formation.

Development Potential: Office park development similar to that described for Zone A may be considered.

Development of any sort is conditional upon the strict implementation of certain precautionary measures.

Location: The deep, soil-filled valley that trends through the central portion of the site.

ZONE C: (CLASS 7)

Risk: High risk for small and medium size sinkholes and a medium risk for doline formation.

Development Potential: Structural development is not recommended in Zone C unless a D4 process is followed.

Location: A small area on the western boundary including BH's 4/16 and 10.

Normal foundations on shallow spread footings are not considered suitable for this site. The potential for differential movement is high as all structures straddle Zones A and B. Founding options for structures on this site could include foundations placed on/within an engineered fill (soil mattress) of suitable dimensions to accommodate the proposed loads; dynamic compaction (DC) as an alternate method to create an adequately sized platform or the use of piles socketed into proven bedrock. Borehole results suggest pile lengths could be greater than 60m (BH 29) in places although an average length would be about 35m. Any foundation design must consider a 10m loss of support.

In most instances of sinkhole development in a dolomitic environment, the concentrated ingress of an excessive volume of water, either from surface or leaking services, has been shown to be the triggering mechanism for instability. The recommended precautionary measures are designed to reduce the negative affect development may have on this site. The importance of careful water management cannot be over-emphasised as poor water control in one area may lead to some form of instability in another area. This is of particular importance where areas are left as open communal spaces. In order to ensure effective water management it is strongly recommended that an appropriate dolomite risk management plan (DRMP) is put into operation over the entire site and it be controlled by a single body rather than under the control of different office block tenants/owners. An example of such a plan is given in Appendix F.

12. GENERAL

It must be borne in mind that an investigation of this nature is aimed at delineating broad areas in which similar conditions and levels of risk occur. Consequently, it may be found that conditions at variance with those discussed in this report do occur locally. The variant conditions should be inspected by competent personnel to ensure that these conditions do not pose a problem for a specific development.

The founding recommendations are a guide to possible solutions and are not prescriptive. The list of solutions is not exhaustive. A certain founding solution may require additional exploratory work, particularly where there is a paucity of subsurface information within a footprint. The weathering process of dolomite gives rise to highly irregular subsoil conditions within limited areas.

RELLY, MILNER AND SHEDDEN **JULY 2013**

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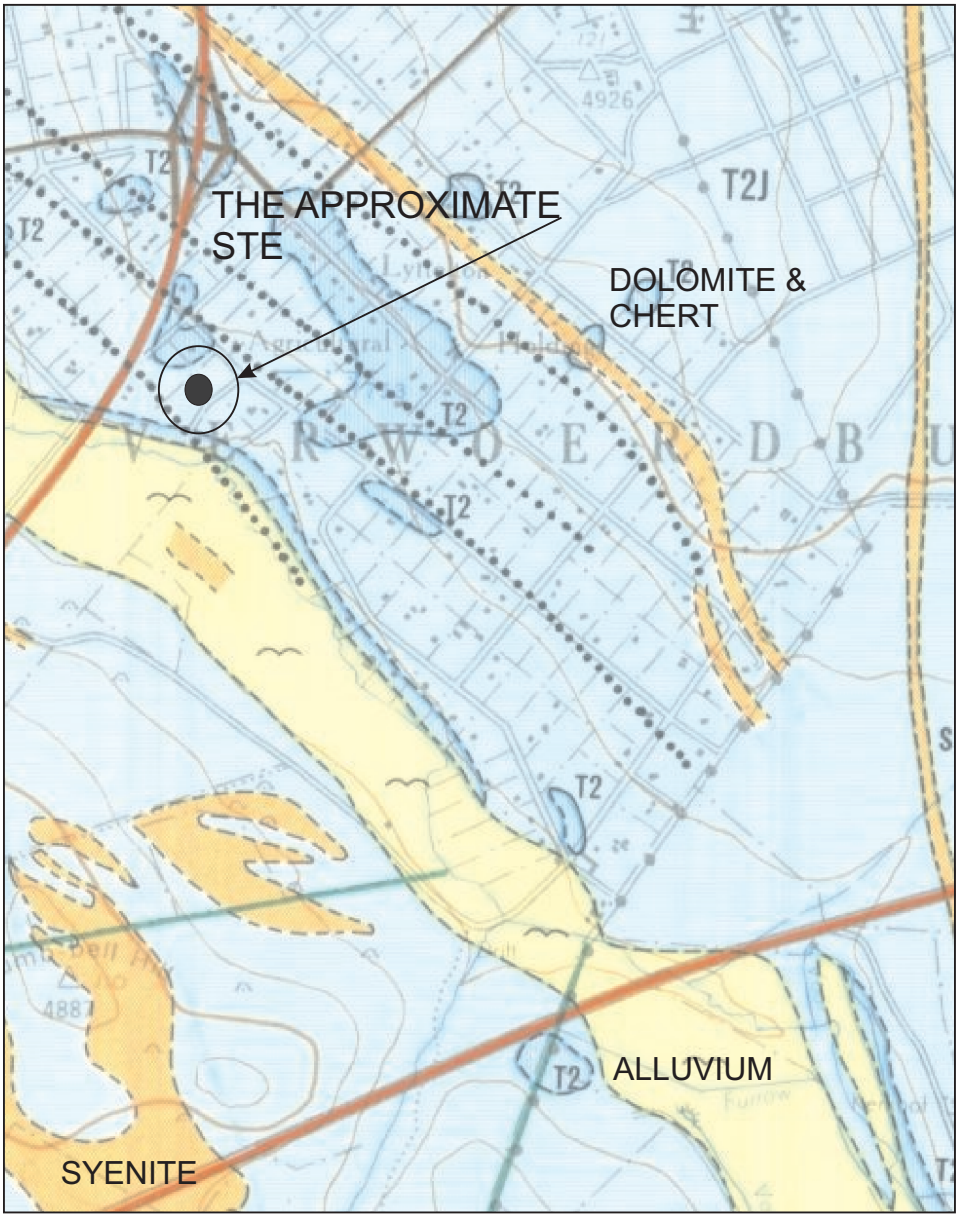
APPENDIX A

REGIONAL GEOLOGY

REGIONAL GEOLOGY

Die Hoewes Extensions 285 and 286,
CENTURION, Pretoria (Tshwane Metro),
Gauteng.



Excerpt from 1:50 000 Geological Series,
Sheet No: 2528CC Lyttelton
[Not to scale]

APPENDIX B

PERCUSSION BOREHOLE PROFILES
(2013; 2007; 2001; 1986 & 1983)

APPENDIX C

HAZARD CHARACTERISATION MAP

APPENDIX E

PRECAUTIONARY MEASURES

GENERAL PRECAUTIONARY MEASURES

General measures to be implemented on all dolomitic sites (minimum requirements - NHBRC Standards)

1. Wet services of entire development and individual stands

a. All wet services should be of good quality in order to ensure low maintenance.

b. Piping materials selected should also be appropriate to local subsurface conditions. If clay pipes are utilized in areas of shallow dolomite, a higher standard of pipe bedding is recommended e.g. stabilized bedding or over-excavation and re-compaction with an approved material (minimum specification to be G7 material) in layers of 150 mm thickness, compacted to 93% mod AASHTO. Some soils may have low pH values, which will render the use of ferrous material for underground services unsuitable. Chapter II in 'A Technical Guide to Good House Construction' NBRI of the CSIR (July 1984) should be consulted concerning the potential corrosion of pipes.

c. The NHBRC[1] makes the following recommendations: Water piping materials shall be one or more of the following:

* High impact PVC pipes with vitualic joints.
* Other flexible (as defined in SABS 0102, Part 1) water pipes with flexible, self anchoring connections.

Pipes having a diameter of less than 75 mm.

* HDPE type IV.
* Polypropylene.

Pipes should be flexible, while joints should be minimised.

d. Water pipes entering buildings should either be fitted with flexible couplings or kinked with a Z to allow opportunity for relative movement. A flexible connection at the junction with all outlet pipes should be used, which includes WC pan connections.

e. Pressure release systems tend to leak after a couple of years. This leaking water must flow directly into the storm- or sewerage water system.

f. Water reticulation to houses should be kept at a minimum depth of 500 mm up to the structure and above ground wherever possible along the structure.

g. As many services as possible should be placed within a single trench.

h. Encasement of pipes in concrete or soilcrete should be avoided. Preferably place pipes in sleeves. If this cannot be achieved, care must be taken to ensure that differential movement can still be accommodated without the pipe breaking.

i. All storm water, sewerage and water pipes and channels must be watertight. All laid wet services should be tested for leakage on installation using the air test (see NBRI Info Sheet X/BOU 2-34) for water pipes, and the water test for sewerage pipes.

[1] *1 National Home Builders Registration Council*

j. Placement of wet services below the footprint of structures must be avoided. No plumbing and drainage pipes should be placed under floor slabs, as far as practicable. Where this situation is unavoidable, reasons must be cited and the pipes must be placed in a sleeve to permit monitoring.

k. Where practical, pipes running parallel to structures should be kept at a distance of at least 5 m from the structure.

l. Each stand should have a rodding-eye or some similar access to the sewer connection in addition to the inspection eye.

m. Each stand/unit should have a water meter at a suitable location so that testing of the stand/unit specific water supply is possible. Water leakage testing must be undertaken regularly, as set out in the risk management system.

n The roots of trees planted in close proximity to the line of water-bearing services often cause leaks in or malfunctioning of the services. Care should therefore be taken to avoid the unfortunate positioning of trees and other plants.

o. Residents should be informed of where services traverse their garden so that accidental puncturing of pipes can be avoided.

2. Entire development

a. The design of wet services should be governed by the need to create low maintenance systems. Wherever possible keep services above ground to facilitate detection of leaks, maintenance and repair.

b. The stability of the centre-line of all bulk water services should be considered.

c. Piping used in mains and communication pipes should be flexible, while joints should be minimised and, where required, self anchoring type (i.e. not reliant on thrust blocks for their anchorage at fittings, except at valves and end caps).

d. The relevant provision of SABS 1200 DB, L, LB, LC, LD and LE shall be observed in the installation of all underground services.

e. Water mains shall be laid only in road reserves.

f. Provision for future connections shall be made in order to minimise the cutting into pipes to provide such connections.

g. Water pipe entries into the building shall be in accordance with those of the JSD's code of practice [2].

h. The use of pre-manufactured, unjointed manholes are preferred. The manhole should be placed on a properly prepared foundation.

i. Use flexible couplings on either side of manholes.

j. Water-borne sewerage reticulation must be installed. French drains are unacceptable.

k. A detailed sanitation and water reticulation plan should be drawn up for the development

[2] *JSD Code of Practice reference*

according to the local geological setting and engineering geological characteristics. The plan must be incorporated into the services management system of the local authority.

3. Storm water drainage

a. No accumulation of surface water is to be permitted and the entire development must be properly drained.

b. A minimum gradient of 1:150 should be maintained along storm-water systems.

c. Brick and pre-cast concrete walls must be so designed as to provide drainage ports at ground level permitting passage of maximum probable volumes of water.

d. When courtyards are designed the free flow of surface water should be ensured. Where gutter downpipes are to be found in such a courtyard, a lined canal should permit passage of water into a drain or onto the lawn away from the structure. The courtyard should preferably be paved and no garden beds should be created at gutter discharge points. Lawns must be graded in such a way to facilitate drainage.

e. In order to deal with rainwater run-off from the roofs of structures the following is recommended:

- Down-pipes should discharge into a lined or pre-cast furrow. This furrow should remove the water from the structure. The storm water should be trained, without ponding, off the property and into the municipal storm water system.
- If no guttering is to be utilized (not recommended), then a sealed surface with a width of 1,5m should be cast along those walls of the structure where water will be discharged from the roof. Roof water will cascade off this sloping roof onto the apron into a lined or pre-cast furrow. The storm water should be drained, without ponding, off the property and into the municipal storm water system.
- The ground immediately against the buildings shall be shaped to fall in excess of 75 mm over the first 1,5 m beyond the perimeter of the building, from where it shall drain freely away from housing units. Apron slabs, where provided, shall have the same fall.

f. All ponds, watercourses and road surfaces shall be rendered impervious.

g. No trees shall be planted within 1,5 times their eventual height from the line of storm water services.

h. The storm water drainage system shall incorporate measures to ensure water tightness of conduits and other compartments. Whenever possible, storm water should be channeled in lined, surface canals.

i. Concrete non-pressure pipes should be of the spigot and socket type with rubber ring seals. Joints in box culverts, channels etc should be sealed.

j. Storm water drainage conduits shall be constructed at gradients that will not permit the deposition of silt, or sand, of the type present in the catchment area

4. Trenching

a. Trenches and excavation works should be opened and closed as rapidly as possible. Avoid leaving trenches open over weekends or holidays. All trenches and excavation works must be properly backfilled and compacted according to specifications given in subclause 5.2.4 of SABS 1200 DA, but specifically to ground surface to prevent them acting as French drains. Once services/cables are installed and backfilling is completed, it must be ensured that ground surface is graded to match the slope of the surrounding area. No rocks in the top layer.

b. Berms should be constructed on the up-slope side of trenches to prevent the inflow of water during storms.

c. The fall of trenches shall be away from buildings. Wherever practical, service trenches shall not be excavated along the length of housing units within the first 3 m beyond the perimeter of such units.

d. No ponding of surface water is to be permitted over, in, or in the vicinity of trenches and excavations.

5. Roads

a. Ensure that roadways are in fact placed below the site level so as to facilitate drainage. If the road network is the sole storm water system, in a township, care must be taken that the roads are surfaced.

b. Ponding of surface water on or next to roads that are not tarred should be avoided.

c. Roadways which have a gradient of less than 1:80 shall be surfaced/sealed.

d. The velocity of the 1 in 20 year storm water, flowing along unsurfaced roadways shall not exceed 1,5 m/s.

6. Water features/Swimming pools

The following minimum requirements must exist:

Construction:

a. The design, construction and use of the swimming pool/feature should at all times be to the satisfaction of the local city engineer, who should be aware of the requirements of swimming pools/water features in dolomitic areas.

b. The swimming pool must be designed as an *independent unit, which will not give way or distort*. The sides or floor of the pool/feature should not crack in the event of any ground movement underneath or nearby the swimming pool/feature.

c. The swimming pool/feature may be constructed from concrete, metal or any other suitable material on condition that the design conforms to condition (7a) above.

d. All water pipes, pumps and connections should be installed either in the open, on the surface, or in service canals where these may be inspected or repaired without access problems.

e. The swimming pool/feature should be built so as to prevent any rain water flowing into or towards the pool/feature.

Maintenance and responsibilities

f. All back wash water must be discharged *directly* into the main storm water line.

g. Any abnormal loss of water from the pool/feature as well as any noticeable ground movement (cracks forming in the ground or in the pool/feature) must be reported by the stand owner to the Home Owners Association or Body Corporate and the local council.

h. It is important to note that the responsibility of checking pipes to and from the pool, the handling of run-off water from the pool/feature as well as the repairing of cracks in the pool/feature and replacing of leaking pipes lies solely with the stand owner. Negligence could result in instability.

APPENDIX F

DOLOMITE RISK MANAGEMENT PLAN

A GENERALISED DOLOMITE RISK MANAGEMENT PLAN FOR AN OFFICE PARK ON DIE HOEWES EXTENSIONS 285 AND 286, CENTURION, PRETORIA (TSHWANE METRO).

1. INTRODUCTION

A office park is to be developed on Die Hoewes extensions 285 and 286 (originally Holdings 231 and 232) in the Lyttelton Agricultural Holdings, Centurion (Tshwane Metro). The site lies within an area designated as a "dolomitic environment" and it is therefore necessary that a Dolomite Risk Management Program (DRMP) be implemented. The geology dictates that the DRMP be initiated throughout the property. This DRMP is of a general nature and a detailed plan will be submitted with a site development plan for the first office block. The plan will be ammened as each new office block comes on stream.

A DRMP is based on the information given by the competent persons involved in the risk assessment and assumes that each party has to fulfill their obligations. This DRMP deals with all wet services associated with this particular development. The management is a part of the DRMP and has a responsibility to fulfill the requirements as set out in the DRMP.

The DRMP must therefore be seen as a program which is managed and audited by management and an appointed, responsible person through whom a number of parties work together to ensure the long-term safety and stability of the site.

2. PARTIES INVOLVED IN THE DEVELOPMENT PROCESS.

The following parties have been involved in the guardhouse development and the DRMP is based on information obtained from their contributions:

Relly Milner and Shedden: Dolomite stability report.

Council for Geoscience: Providing geological comment and support for the office park development.

Abland: Owners of the property.

3. PARTIES INVOLVED IN THE DOLOMITE RISK MANAGEMENT PROGRAM.

The following parties are involved in and co-responsible for the implementation and maintenance of the DRMP

- The owner of the office park.
- The management of the office park.
- Responsible person appointed by management.
- Tshwane Metropolitan Municipality: Ownership and maintenance of the bulk sewer and water serving Die Hoewes Ext 285 and 286.

4. DOLOMITE RISK MANAGEMENT PROGRAM

The Dolomite Risk Management Program (DRMP) will be implemented by the owner and managed by an appointed representative.

The DRMP consists of the following elements:

4.1 Existing information

4.2 Management system (including monitoring)

4.2.1 Groundwater

4.2.2 Water

4.2.2 Sewer

4.2.3 Storm water

4.2.4 Occurrences and incidences

4.2.5 Education and vigilance

4.1 Existing Information

4.1.1 Geological report

A dolomite stability investigation was conducted and a report (F303) compiled by this firm for Holdings 231 and 232 in 2007. Additional drilling to meet footprint investigation requirements

was undertaken by this firm in 2013.

4.1.2 Correspondence from Council for Geoscience (CGS)

All correspondence received from the CGS should be put on file (letter dated 18 October 2007 - Ms J Grobler 012 8411152).

4.1.3 Construction report

No construction report has been prepared.

4.1.4 Local Authority

The local authority is the Tshwane Metropolitan Municipality.

4.1.5 As-built drawings of water, sewer and storm water.

All wet services should be indicated on a plan and will need to be integrated into the existing services.

4.2 Risk Management System

The risk management plan may be divided into two main functions:

- *Monitoring:* The visual inspection of the stands must be undertaken on a regular basis. (i.e. once a month, annual (seasonal) or biennial). Initially the intervals should be fairly close but may be extended with time if performance warrants it. The inspections should take place at least once a month in the wet season and once every three months in the dry season. The inspections in the wet season should be undertaken after heavy showers to assess the effectiveness of surface drainage measures. Any untoward conditions such as excessive ponding on pavements must be recorded and, if necessary, appropriate remedial action must be taken.
- *Recording:* A continual record will allow an assessment to be made as to whether the problem is a recurring one (poor design and/or construction) and needs professional

attention. The inspections must be undertaken by the responsible person delegated by the management. The records should be retained as hardcopies for a reasonable period (5 years) and should be passed on if the property is sold.

4.2.1 Groundwater

The groundwater table lies within the bedrock below the site and does not pose a risk to the stability even if drawn down. Nevertheless, boreholes should not be drilled nor existing boreholes be used for the withdrawal of ground water unless permission is granted by the relevant authority.

4.2.2 Water

The management will be responsible for repairing and maintaining the water network within the property.

The responsible person will carry out the following yearly inspections and maintenance:

- Clean the water valve manhole and inspect for leakages. The valve must be closed and opened again to make sure the mechanism is in good working condition.
- Mark the position of the water valve on the kerb of the road or on the sidewalk.
- Test the water line by closing off all taps and checking the water meter. The cause of any unexplained water loss should be sought immediately. This exercise should be undertaken every two months in the first year then at least each quarter thereafter.

4.2.3 Sewer

The management will be responsible for repairing and maintaining the sewer network.

All reported sewer line blockages and the reasons for the blockages, if known, must be recorded on the data base by the management. Should tree roots cause blockages or if blockages occur regularly in the same areas, the management must immediately investigate the problem. The management must appoint a competent person to inspect the line and to rectify the problem as

soon as possible.

Inspection manholes (if installed) should be opened and the flow of water must be confirmed in both sewer and storm water lines.

The sewer-line may require inspection by camera at biennial intervals, particularly if regular problems are associated with these services.

4.2.4 Storm water

The internal storm water network must be maintained by the management.

The management will carry out the following yearly inspections and maintenance:

- Clear all storm water outlets on boundary walls (if applicable) of sediment, grass and other waste.
- Visually inspect all storm water pipes, channels and manholes.

4.2.6 Garden beds and parking areas

The responsible person must inspect the "open" ground as part of routine maintenance/monitoring. Results of inspections must be recorded whether or not problems are identified.

- Excessive ponding of surface water must be reported particularly against boundary walls. Where ponding occurs the situation should be remedied. All these actions need to be recorded to ensure a proper audit trail if any instability should occur.
- Any signs of cracking either in structures or in the earth are indicative of some movement. These cracks are often the precursor to more serious instability. The cause of cracking should be sought without delay. The management must be notified.
- Areas of unnaturally vibrant growth may be indicative of excessive moisture in the soil from leaking, buried wet services.

4.2.8 Occurrences and incidences

The following occurrences and incidences must be recorded and put on the database:

- Sewer blockages.
- Subsidences.
- Sinkholes.
- Leakages (water, sewer and storm water systems)
- Flooding (after heavy rains) and ponding
- Damage to structures

4.2.9 Education and vigilance

The owner must institute an education program for all occupants in the office block.

5 EMERGENCY REACTION PLAN

The emergency reaction plan forms part of the education program and the employees must be continually informed of the procedures and emergency contact numbers.

The emergency procedures are as follow:

5.1 For a sinkhole:

- Contact the management and the emergency services of the Tshwane Metro immediately.
- An area of 20 metres around a sinkhole must be evacuated immediately.
- A sinkhole must be cordoned off to prevent any unsuspecting people from getting too close to the area.
- The water supply must be closed off if related to the cause of the sinkhole.
- No person must be allowed to climb into the sinkhole
- The management (or appointed professional) will investigate the cause of the sinkhole and set a plan in motion for rehabilitation. The sinkhole must be repaired as soon as possible to prevent further damage to the area or structures.

5.2

For a subsidence (doline):

- Contact the management and the emergency services of the Tshwane Metro immediately.
- An area of 20 meters around a subsidence must be evacuated immediately.
- A subsidence must be cordoned off to prevent any unsuspecting people from getting too close to the area.
- The water supply must be closed if related to the cause of the subsidence.
- The management (or appointed professional) will investigate the cause of the subsidence and set a plan in motion for rehabilitation. The area must be repaired as soon as possible to prevent the development of a sinkhole and further damage to services or structures.

Emergency contact numbers are:

- Tshwane Metropolitan Municipality: Emergency services
- Office Park: Maintenance manager
  Caretaker/maintenance official (TBA).
- Tshwane Metropolitan Municipality:
  Dolomite Risk Management – Ms A Sudu 012 358 3206

6 REHABILITATION PLAN

The management will be responsible for the rehabilitation of any sinkhole, subsidence or damage caused by any service under their ownership.

The rehabilitation of a sinkhole or subsidence and the repair of damaged services will be handled on an Ad Hoc basis. If a rehabilitation project is the responsibility of the management, the appointed consultant/competent person of the management must advise and supervise the project.

The management must be responsible for providing funds for the following:

- Maintenance and repair of storm water network.
- Investigating the cause of any subsidence or sinkhole in the storm water network.
- Repairing any damage caused by internal services and the rehabilitation of an affected

area.

7 DATABASE

The database is system (preferably electronic) that maintains records of all incidences relating to the overall stability of the site. The database must be kept up to date on a monthly basis. The database must contain the following:

- All existing information (geological and engineering): Layout plan of all services (water, sewer, storm water, electrical and Telkom).
- Occurrences and incidences: Occurrences and incidences such as blocked sewers, water leaks etc, as set out in clause 4.2.7 must recorded on the database.
- Education and vigilance: The education program as set out in clause 4.2.8 must be recorded on the database.

8 REASSESSMENT

In order to ensure that the Dolomite Risk Management Program is functional and addresses all known and new issues, reassessment of the DRMP on a five yearly basis is essential. This exercise will involve the evaluation of the present DRMP methodology in the context of future standards and requirements. Notes should be made of weaknesses in the program as well as necessary additions which may become evident over the five-year period.

9 SUMMARY

The Dolomite Risk Management program must be managed and maintained by the management and inspection interval are as follows:

Element	Party responsible	Inspection intervals
9.1. Existing information	Management	Continuous
9.2. Management system		
9.2.1 Ground water:		
▪ Monitoring borehole water level (if applicable)		Six monthly
9.2.2 Water:		

▪ Valve inspection	RP	Yearly
▪ Monitoring	RP	Monthly
▪ Maintenance and repair	RP	Continuous
9.2.3 Sewer:		
▪ Monitoring	RP	Continuous
▪ Maintenance and repair	RP	Continuous
9.2.4 Open ground:		
▪ Inspection	RP	Monthly (initially)
▪ Maintenance and repair	RP	Continuous
9.2.5 Storm Water:		
▪ Inspection and cleaning	RP	Annually (prior to wet season)
▪ Maintenance and repair	RP	` Continuous
9.2.7 Occurrences and incidence (Recording, investigate and planning of rectification):		
	RP	Continuously
9.2.8 Education and vigilance:	Management	Six monthly
9.2.9 Emergency reaction plan:	Management	Continuous
9.2.10 Rehabilitation plan:		
▪ Investigate and plan repair	Management	Ad Hoc
▪ Funds	Management	Continuous
9.2.11 Data base:	Management	Monthly
9.2.12 Reassessment:	Management	Monthly/5 years

RP = Responsible person (appointed by management).

Inspection periods may be extended from monthly to two monthly and later six monthly if records indicate an absence of problems.

E Shedden (Pr Sci Nat)

RELLY MILNER AND SHEDDEN **JULY 2013**

APPENDIX G

DRAFT SANS 1936 [2012] TABLE 2

Table 2 — Permissible land usage per inherent hazard class

1	2	3	4	5	6	7	8	9	10
Land usage		**Inherent hazard class determined in accordance with the requirements of SANS 1936-2**							
Designation	**Description**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
		Dolomite area designation and footprint investigation requirement							
Commercial and miscellaneous non-residential usage									
C1	Places of detention, police stations, and institutional homes for the handicapped or aged	D3 + FPI					D4		
C2	Hospitals (including clinics), hostels, hotels	D3 + FPI						D4	
C3	Commercial developments ≤ 3 storeys, including railway stations, shops, wholesale stores, offices, places of worship, theatrical, indoor sports or public assembly venues, other institutional land uses such as universities, schools, colleges, libraries, exhibition halls and museums, light (dry) industrial developments, dry manufacturing, commercial uses such as warehousing, packaging, and electrical substations, filling stations	D2 + FPI	D3 + FPI					D4	
C4	Commercial developments > 3 storeys, including railway stations, shops, wholesale stores, offices, places of worship, theatrical, indoor sports or public assembly venues, other institutional land uses such as universities, schools, colleges, libraries, exhibition halls and museums, light (dry) industrial developments, dry manufacturing, commercial uses such as warehousing, packaging, and electrical substations	D2 + FPI	D3 +FPI	D4					
C5	Fuel depots, processing plants or any other areas for the storage of liquids, waste sites.	D2 + DLI	D3 + DLI				D4		
C6	Outdoor storage facilities, stock yards, container depots	D2 + DLI	D3 + DLI					D4	
C7	Parking garages	D2	D3 + FPI					D4	
C8	Parking areas	D2	D3					D4	

DLI = Design level investigation in accordance with the requirements of SANS 1936-2, as deemed appropriate by the competent person.
FPI = Design level investigation specifically below the footprint of the structure.

NOTE 1 D1, D2, D3 and D4 have the meanings assigned in table 1.

NOTE 2 Residential coverage ratio = footprint area/site area.

Table 2 *(continued)*

1	2	3	4	5	6	7	8	9	10
Land usage		**Inherent hazard class determined in accordance with the requirements of SANS 1936-2**							
Designation	**Description**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
		Dolomite area designation and footprint investigation requirement							
High rise dwelling units									
RH1	> 10 storeys	D4							
RH2	> 3 storeys but ≤ 10 storeys with a population of ≤ 1 500 people per hectare	D2 + FPI	D4						
RH3	> 3 storeys but ≤ 10 storeys with a residential coverage ratio of ≤ 0,4, and a population of ≤ 800 people per hectare	D2 + FPI	D3 + FPI				D4		
Low rise dwelling units									
RL1	≤ 3 storeys with 80 to 120 units per hectare and a population not exceeding 600 people per hectare	D2 + FPI	D4						
RL2	≤ 3 storeys with up to 80 units per hectare and a population not exceeding 400 people per hectare	D2 + FPI	D3 + FPI				D4		
Dwelling houses									
RN1	Up to 60 dwelling houses per hectare with stands larger than 150 m^2	D2	D3	D4					
RN2	Up to 25 dwelling houses per hectare with stands no smaller than 300 m^2	D2	D3		D4				
RN3	Up to 10 dwelling houses per hectare with 1 000 to 4 000 m^2 stands	D2	D3			D3 + FPI	D4		
Other									
AO	Agriculture that does not require irrigation in any form or the storage of water, parkland and public open spaces that are not irrigated and grazing pastures	See SANS 1936-4							
DLI = Design level investigation in accordance with the requirements of SANS 1936-2, as deemed appropriate by the competent person. FPI = Design level investigation specifically below the footprint of the structure.									
NOTE 1 D1, D2, D3 and D4 have the meanings assigned in table 1. NOTE 2 Residential coverage ratio = footprint area/site area.									

Table 2 *(concluded)*

1	2	3	4	5	6	7	8	9	10
Land usage		**Inherent hazard class determined in accordance with the requirements of SANS 1936-2**							
Designation	**Description**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
		Dolomite area designation and footprint investigation requirement							
A1	Agriculture that requires intensive irrigation	See SANS 1936-4							
A2	Agriculture that requires irrigation, including botanical gardens, sports fields, driving ranges, golf courses, parkland and public open spaces	See SANS 1936-4							
DLI = Design level investigation in accordance with the requirements of SANS 1936-2, as deemed appropriate by the competent person. FPI = Design level investigation specifically below the footprint of the structure.									
NOTE 1 D1, D2, D3 and D4 have the meanings assigned in table 1.									
NOTE 2 Residential coverage ratio = footprint area/site area.									

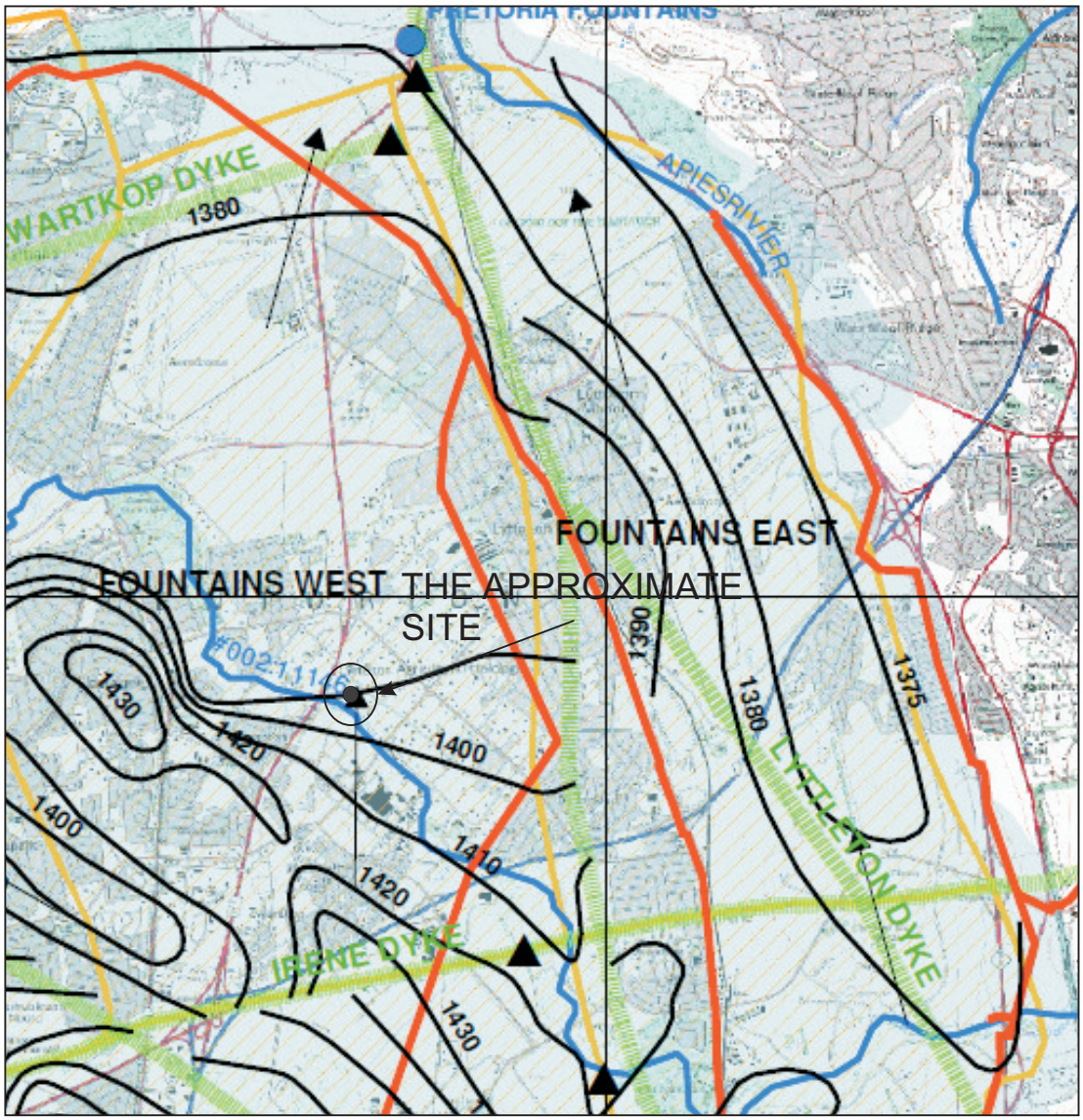
Table 3 — Permissible infrastructure and social facilities per inherent hazard class

1	2	3	4	5	6	7	8	9	10
Infrastructure and social facilities		**Inherent hazard class determined in accordance with the requirements of SANS 1936-2**							
Designation	**Description**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
		Dolomite area designation							
IN1	Trunk roads (national and regional roads which facilitate intercity travel) and primary distributor roads (major arterial roads forming the primary network for an urban area as a whole), railway lines, power lines, runways, bulk pipelines, including water, sewer, fuel and gas lines, and pump stations	D2	D3					D4	
IN2	Reservoirs and public swimming pools, water care works, attenuation and retention ponds for stormwater management and artificial lakes	D2	D3				D4		
IN3	Cemeteries	D3				D4			
IN4	Dams, slimes dams	D3	D4						
IN5	Solid waste disposal facilities	D3						D4	
NOTE D1, D2, D3 and D4 have the meanings assigned in table 1.									

APPENDIX D

HYDROLOGICAL MAP

HYRDOLOGICAL MAP



DIE HOEWES EXTENSIONS 285 AND 286,
CENTURION, PRETORIA (TSHWANE METRO),
GAUTENG.

Excerpt from DWA Hydrological map [not to scale].

WEST END OFFICE PARK ON HOLDINGS 231 AND 232, LYTTELTON AGRICULTURAL HOLDINGS, CENTURION, PRETORIA (TSHWANE METRO).

SUMMARY OF DRILLING RESULTS

BH No	Colluvium	RESIDUUM				BEDROCK		Bedrock type/IHC	Collar elevation (m amsl)/ Water strike	Water rest level after 24hr (m amsl)	Remarks (NS; RPT)
		Silt & Wad	Clay/Silt	Chert	Silt/Sand (Intrusive)	Weathered/ boulders	Sound				
2013 Boreholes											
23	0-3ch	5-7W 13-14W 29-41W		3-5 7-13w 14-29w			41-47##	Dolomite/4	1417/-	Dry	Waddy matrix from 5m
24	0-3ch	21-29W		3-20			29-35##	Dolomite/4	1418/-	Dry	RPT 3-4m
25	0-1ch			1-4 8-9		4-8DB?	9-15##	Dolomite/3(5)	1419/-	Dry	Fractured bedrock at 4m(?)
26	Not drilled because of access problems										
27	0-1s	3-5		1-3 5-6		6-7DB	7-13##	Dolomite/3(6)	1424	Dry	RPT 2-5m
28	0-4			4-7 7-11w 11-13D			*17-20D* *29-35##*	*Dolomite/*4(6)	1423	Dry	NS 13-35m RPT 13-16m 26-28m
29	0-1ch	8-11w 37-41W 49-54W		1-8 11-18 18-20w 20-26 26-37w 41-46w 54-60w##			46-49D	Chert Rubble/4	1421/-	Dry	RPT 38-41m 42-45m

BH No	Colluvium	RESIDUUM				BEDROCK		Bedrock type/IHC	Collar elevation (m amsl)/ Water strike	Water rest level after 24hr (m amsl)	Remarks (NS; RPT)
		Silt & Wad	Clay/Silt	Chert	Silt/Sand (Intrusive)	Weathered/ boulders	Sound				
30	0-4ch	7-9W		4-7 9-31w			31-37##	Dolomite/4	1424/-	Dry	Waddy matrix from 7m

NOTES: s=Sand; si=Silt; ch=Chert; w=wad (subordinate); W=Wad(predominant); D=dolomite; ?=Interpretation; NS=No samples; RPT=Rapid penetration times; ##=End of hole; IHC=Inherent Hazard Characterisation; m amsl=Metres above mean sea level;

BORHOLE PROFILE

Project: West End Office Park
Project No: 13106westend
Location: Die Hoewes Ext 163.
Recorded by: es ***Date:*** 10/5/2013

Coordinates Wg 29
Y: 81731 **X:** 2860250
Collar Elevation: 1416.5 mamsl

BOREHOLE No: 23
Water rest level: Dry
Date backfilled: 26/3/2013
Water strike at: None

Penetration time (m/min.sec)	Depth (m)	Lithology	Lithologic Description	Chip size (mm)	Water	Comments
0'40"	0		0-3m: White and brown, highly weathered and some translucent, weathered, CHERT fragments in a trace matrix of reddish brown, silty sand; colluvium.	<10		
0'48"				<15		
0'52"	2					
0'55"			3-5m: Translucent and some grey, weathered, CHERT fragments in a trace matrix of brown, sandy silt; residual dolomite (chert rubble).	<10		
0'58"	4					
0'38"			5-7m: Dark chocolate brown, sandy SILT(WAD) with scattered, dark brown, manganocrete nodules and some translucent, weathered, chert fragments; residual dolomite (wad and chert rubble).	<5		
0'36"	6					
0'34"			7-10m: Dark grey, translucent, weathered, CHERT fragments in a minor matrix of dark chocolate brown (almost black), sandy silt(wad); residual dolomite(?) (chert rubble in a waddy matrix).			
0'32"	8					
0'40"						
0'55"	10		10-13m: As above but minor matrix of dark chocolate brown to dark brown, slightly clayey silt(wad <15%); residual dolomite.	<15		
0'34"						
0'29"	12					
0'25"			13-14m: Brown, slightly sandy SILT with scattered grey, weathered, chert fragments and trace amounts of dark brown silt(wad <15%); residual dolomite (possibly lens of grey shale).			
0'30"	14		14-19m: Grey to dark grey, weathered, CHERT fragments in a minor matrix of dark chocolate brown, clayey silt(wad); residual dolomite(?) (chert rubble in a waddy matrix).	<5		
0'28"				<10		
0'42"	16					
0'54"			Samples wet below 18m. Matrix recovered as dark brown slurry.			
0'51"	18			<15		
0'36"						
0'28"	20					
0'49"			21-29m: Grey to dark grey stained dark brown, weathered, CHERT fragments in a minor matrix of dark chocolate brown, silty clay(wad); residual dolomite (chert rubble in a waddy matrix recovered as a slurry).			
0'43"	22					
0'39"						
0'41"	24					Water added between 18m and 41m.
0'18"				<10		
0'15"	26					
0'48"						
0'44"	28					
0'56"			29-41m: Dark chocolate brown, silty CLAY(WAD) with traces of dark grey stained dark brown, chert fragments; residual dolomite.			
	30					

Total depth: 47m

NOTES:
1) Hole stopped at 47m after penetrating 6m of assumed, solid, dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations. Water added below 18m.
3) Hole dry when backfilled on 26/3/2013.

Contractor: H. Erwee Drilling.
Machine: Super Rock **Diameter:** 165mm
Drilling pressure: 1 900kPa
Date drilled: 22/3/2013

Borehole No: 23

RELLY MILNER and SHEDDEN, P O BOX 32107, GLENSTANTIA 0010, Tel: 012 9932049 Fax: 012 9986890 Cell: 082 5516034

BORHOLE PROFILE

Project: West End Office Park
Project No: 13106westend
Location: Die Hoewes Ext 163.
Recorded by: es ***Date:*** 10/5/2013

Coordinates Wg 29
Y: 81731 **X:** 2860250
Collar Elevation: 1416.5 mamsl

BOREHOLE No: 23
Water rest level: Dry
Date backfilled: 26/3/2013
Water strike at: None

Penetration time (m/min.sec)	Depth (m)	Lithology	Lithologic Description	Chip size (mm)	Water	Comments
0'47"	30		29-41m: Dark chocolate brown, silty CLAY(WAD) with traces of dark grey stained dark brown, chert fragments; residual dolomite.			
1'24"						
1'12"	32			<10		
1'14"						
1'10"	34		Consistent composition to 42m.	<20		
0'41"						Water added between 18m and 41m.
0'48"	36					
0'34"						
0'44"	38					
0'40"				<10		
0'38"	40					
3'27"			41-47m: Dark chocolate brown, silty CLAY(WAD) with traces of dark grey, weathered, chert fragments and occasional grey, weathered to slightly weathered, dolomite fragments.			
3'19"	42					
3'31"			Interpreted as solid dolomite bedrock - samples highly contaminated.			
3'17"	44		Dolomite fragments becoming more abundant with depth.	<15		
3'20"						
3'16"	46		EOH @ 47m.	<10		
	48					
	50					
	52					
	54					
	56					
	58					
	60					

Total depth: 47m

NOTES:
1) Hole stopped at 47m after penetrating 6m of assumed, solid, dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations. Water added below 18m.
3) Hole dry when backfilled on 26/3/2013.

Contractor: H. Erwee Drilling.
Machine: Super Rock **Diameter:** 165mm
Drilling pressure: 1 900kPa
Date drilled: 22/3/2013

Borehole No: 23

RELLY MILNER and SHEDDEN, P O BOX 32107, GLENSTANTIA 0010, Tel: 012 9932049 Fax: 012 9986890 Cell: 082 5516034

BORHOLE PROFILE

Project: West End Office Park
Project No: 13106westend
Location: Die Hoewes Ext 163.
Recorded by: es ***Date:*** 10/5/2013

Coordinates Wg 29
Y: 81821 **X:** 2860257
Collar Elevation: 1418 mamsl

BOREHOLE No: 24
Water rest level: Dry
Date backfilled: 26/3/2013
Water strike at: None

Penetration time (m/min.sec)	Depth (m)	Lithology	Lithologic Description	Chip size (mm)	Water	Comments
0'25"	0		0-1m: Brown, highly weathered, honeycomb and grey, weathered, solid, CHERT fragments in a minor matrix of reddish brown, clayey silt; fill(?)	<10		
0'37"				<15		
0'18"	2		1-3m: White, highly weathered and grey to dark grey, weathered, CHERT fragments in a trace matrix of brown, sandy silt; colluvium (chert rubble).			
0'14"			3-6m: White, highly weathered and some light grey, weathered, CHERT fragments in a trace matrix of dark brown, slightly clayey, sandy silt and traces of dark brown silt(wad <5%); residual dolomite (chert rubble).	<10		
0'16"	4					
0'33"						
0'37"	6		6-13m: Dark grey, weathered, CHERT fragments in a trace matrix of brown to pale brown, sandy silt; residual dolomite (chert rubble).	<5		
0'40"						
0'52"	8					
0'45"				<15		
0'34"	10					
0'32"						
0'40"	12					
1'41"			13-14m: Light grey to grey, weathered, fractured(?), hard rock DOLOMITE with abundant, dark grey chert fragments.			
0'35"	14		14-20m: Dark grey, weathered, CHERT fragments in a minor matrix of dark reddish brown, slightly sandy, clayey silt; residual dolomite (chert rubble in a silty matrix). Samples wet below 14m.	<5		
0'48"				<10		
0'51"	16		Matrix recovered as reddish brown slurry.			
0'43"						
0'36"	18			<15		
0'41"						
0'55"	20		20-28,5m: Dark chocolate brown, clayey SILT(WAD) with traces of dark grey, weathered, chert fragments; residual dolomite (chert rubble in a waddy matrix).			
0'46"						
0'54"	22		Matrix recovered as chocolate brown slurry.			
0'47"						
0'42"	24					Water added between 18m and 41m.
0'50"				<10		
0'58"	26					
1'04"						
1'59"	28					
3'46"			28,5-35m: Grey to dark grey, slightly weathered, hard rock DOLOMITE with scattered lenses of dark grey chert			
	30					

Total depth: 35m

NOTES:
1) Hole stopped at 35m after penetrating 6m of solid, dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled on 26/3/2013.

Contractor: H. Erwee Drilling.
Machine: Super Rock **Diameter:** 165mm
Drilling pressure: 1 900kPa
Date drilled: 22/3/2013

Borehole No: 24

RELLY MILNER and SHEDDEN, P O BOX 32107, GLENSTANTIA 0010, Tel: 012 9932049 Fax: 012 9986890 Cell: 082 5516034

BORHOLE PROFILE

Project: West End Office Park
Project No: 13106westend
Location: Die Hoewes Ext 163.
Recorded by: es ***Date:*** 10/5/2013

Coordinates Wg 29
Y: 81821 **X:** 2860257
Collar Elevation: 1418 mamsl

BOREHOLE No: 24
Water rest level: Dry
Date backfilled: 26/3/2013
Water strike at: None

Penetration time (m/min.sec)	Depth (m)	Lithology	Lithologic Description	Chip size (mm)	Water	Comments
3'16"	30		28,5-35m: Grey to dark grey, slightly weathered, hard rock DOLOMITE with scattered lenses of dark grey chert			
3'27"						
3'14"	32			<10		
3'29"						
3'35"	34		EOH @ 35m.	<20		
	36					
	38					Water added between 18m and 41m.
	40					
	42					
	44					
	46					
	48					
	50					
	52					
	54					
	56					
	58					
	60					

Total depth: 35m

NOTES:
1) Hole stopped at 35m after penetrating 6m of solid, dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled on 26/3/2013.

Contractor: H. Erwee Drilling.
Machine: Super Rock **Diameter:** 165mm
Drilling pressure: 1 900kPa
Date drilled: 22/3/2013

Borehole No: 24

RELLY MILNER and SHEDDEN, P O BOX 32107, GLENSTANTIA 0010, Tel: 012 9932049 Fax: 012 9986890 Cell: 082 5516034

BORHOLE PROFILE

Project: West End Office Park
Project No: 13106westend
Location: Die Hoewes Ext 163.
Recorded by: es ***Date:*** 10/5/2013

Coordinates Wg 29
Y: 81892 **X:** 2060238
Collar Elevation: 1419 mamsl

BOREHOLE No: 25
Water rest level: Dry
Date backfilled: 26/3/2013
Water strike at: None

Penetration time (m/min.sec)	Depth (m)	Lithology	Lithologic Description	Chip size (mm)	Water	Comments
0'40"	0		0-1m: White, highly weathered, CHERT fragments, grey MORTAR and some CONCRETE fragments in a minor matrix of reddish brown silty sand; fill.	<10		
0'54"						
0'58"	2		1-3m: Grey and dark grey, weathered, translucent and some dark grey, slightly weathered, CHERT fragments in a trace matrix of pale greyish brown, silty sand; residual dolomite (chert rubble).	<15		
1'09"						
0'52"	4		3-4m: Grey, weathered to slightly, weathered CHERT fragments in a trace matrix of brown, sandy silt; residual dolomite (chert rubble).			
1'18"			4-8m: Light grey, weathered, DOLOMITE fragments and CHERT fragments in a trace matrix of pale grey to off-white silt.			
1'14"	6		Interpreted as fractured dolomite bedrock with intercalated chert bands.			
1'06"						
0'45"	8		8-9m: Dark grey, weathered, CHERT fragments in a trace matrix of pale brown, sandy silt; residual dolomite. (Thick chert lens).	<10		
3'16"			9-15m: Grey to light grey, weathered to slightly weathered, hard rock DOLOMITE.			
3'21"	10		Becoming light grey below 12m.			
3'18"						
3'24"	12					
3'10"			Poor sampled recovery below 14m.			
3'19"	14		EOH @ 15m.	<15		
	16					
	18					
	20					
	22					
	24					
	26					
	28					
	30					

Total depth: 15m

NOTES:
1) Hole stopped at 15m after penetrating 6m of solid, dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled on 26/3/2013.

Contractor: H. Erwee Drilling.
Machine: Super Rock **Diameter:** 165mm
Drilling pressure: 1 900kPa
Date drilled: 22/3/2013

Borehole No: 25

RELLY MILNER and SHEDDEN, P O BOX 32107, GLENSTANTIA 0010, Tel: 012 9932049 Fax: 012 9986890 Cell: 082 5516034

BORHOLE PROFILE

Project: West End Office Park
Project No: 13106westend
Location: Die Hoewes Ext 163.
Recorded by: es ***Date:*** 10/5/2013

Coordinates Wg 29
Y: 81848 **X:** 2860135
Collar Elevation: 1424 mamsl

BOREHOLE No: 27
Water rest level: Dry
Date backfilled: 26/3/2013
Water strike at: None

Penetration time (m/min.sec)	Depth (m)	Lithology	Lithologic Description	Chip size (mm)	Water	Comments
0'36"	0		0,0-1,0m: Pale brown silty SAND with minor, white, highly weathered, chert fragments and brown manganocrete nodules; colluvium.	<15		
0'17"				<20		
0'10"	2		1-3m: Grey and some white, highly weathered to weathered, CHERT fragments in a minor matrix of light reddish brown to reddish brown, sandy silt; residual dolomite (chert rubble).	<15		
0'12"			3-5m: Dark brown, sandy SILT with scattered, brown to dark brown, highly weathered, honeycomb, chert fragments and trace amounts of brown silt(wad <10%); residual dolomite.	<20		
0'11"	4					
0'30"			5-6m: Dark grey, weathered, CHERT fragments in a minor matrix of dark brown, sandy silt and some brown silt(wad <5%); residual dolomite.			
0'36"	6		6-7m: Light grey, weathered to highly weathered, DOLOMITE fragments and some grey, weathered, CHERT fragments in a trace matrix of pale greyish brown, silty sand; residual dolomite (possibly fractured bedrock?)			
3'28"						
3'15"	8		7-13m: Grey, weathered to slightly weathered, hard rock DOLOMITE with scattered lenses of dark grey, weathered chert.	<10		
3'18"						
3'31"	10					
3'42"						
3'29"	12		EOH @ 13m.			
	14					
	16					
	18					
	20					
	22					
	24					
	26					
	28					
	30					

Total depth: 13m

Page 1 of 1

NOTES:
1) Hole stopped at 13m after penetrating 6m of solid, dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled on 26/3/2013.

Contractor: H. Erwee Drilling.
Machine: Super Rock **Diameter:** 165mm
Drilling pressure: 1 900kPa
Date drilled: 22/3/2013

Borehole No: 27

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BOREHOLE PROFILE

Project: West End Office Park
Project No: 13106westend
Location: Die Hoewes Ext 163.
Recorded by: es ***Date:*** 10/5/2013

Coordinates Wg 29
Y: 81778 **X:** 2860163
Collar Elevation: 1423 mamsl

BOREHOLE No: 28
Water rest level: Dry
Date backfilled: 26/3/2013
Water strike at: None

Penetration time (m/min.sec)	Depth (m)	Lithology	Lithologic Description	Chip size (mm)	Water	Comments
0'17"	0		0-3m: Brown to dark brown silty SAND with minor white streaked brown highly weathered chert fragments; colluvium(?) Abundant chert below 2m.	20		
0'22"						
0'19"	2					
0'16"			3-7m: Light grey, translucent, weathered and some brown, highly weathered, CHERT fragments in a trace matrix of dark brown, sandy silt; residual dolomite(?) (chert rubble).			
0'30"	4					
0'21"						
0'28"	6					
0'32"			7-11m: Grey to dark grey stained dark brown, weathered, solid and scattered, brown, highly weathered, CHERT fragments in a minor matrix of dark chocolate brown, clayey silt(wad <15%); residual dolomite (chert rubble in a waddy matrix).	<15		
0'24"	8					
0'21"						
0'23"	10					
0'57"			11-13m: Grey, weathered to slightly weathered, CHERT fragments and subordinate grey to light grey, weathered, DOLOMITE fragments in a minor matrix of light brown silt and trace amounts of brown silt(wad <5%); residual dolomite (chert rubble with some dolomite boulders).	<10		
0'18"	12					
0'14"			13-29m: No samples recovered below 13m.			
0'08"	14					
0'13"						
1'48"	16		No samples recovered. Interpreted as solid dolomite bedrock between 16,5 and 20,1m.			
3'46"						
3'39"	18					
3'27"						
0'24"	20		No samples recovered below 13m.	0		
0'17"						
0'26"	22					
0'31"						
0'49"	24					
0'54"						
0'09"	26					
0'14"						
0'39"	28					
3'19"			No samples recovered. Interpreted as solid dolomite bedrock below 29m.			
	30					

Total depth: 13m

NOTES:
1) Hole stopped at 35m after penetrating 6m of assumed solid, dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled on 26/3/2013.
4) Driller reports hole collapsing.

Contractor: H. Erwee Drilling.
Machine: Super Rock **Diameter:** 165mm
Drilling pressure: 1 900kPa
Date drilled: 22/3/2013

Borehole No: 28

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BORHOLE PROFILE

Project: West End Office Park
Project No: 13106westend
Location: Die Hoewes Ext 163.
Recorded by: es ***Date:*** 10/5/2013

Coordinates Wg 29
Y: 81778 **X:** 2860163
Collar Elevation: 1423 mamsl

BOREHOLE No: 28
Water rest level: Dry
Date backfilled: 26/3/2013
Water strike at: None

Penetration time (m/min.sec)	Depth (m)	Lithology	Lithologic Description	Chip size (mm)	Water	Comments
3'40"	30		No samples recovered. Interpreted as solid dolomite bedrock below 29m.	0		
3'19"	32					
3'31"						
3'16"	34					
3'24"			EOH @ 35m.			
	36					
	38					
	40					
	42					
	44					
	46					
	48					
	50					
	52					
	54					
	56					
	58					
	60					

Total depth: 13m

NOTES:
1) Hole stopped at 35m after penetrating 6m of assumed solid, dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled on 26/3/2013.
4) Driller reports hole collapsing.

Contractor: H. Erwee Drilling.
Machine: Super Rock **Diameter:** 165mm
Drilling pressure: 1 900kPa
Date drilled: 22/3/2013

Borehole No: 28

RELLY MILNER and SHEDDEN, P O BOX 32107, GLENSTANTIA 0010, Tel: 012 9932049 Fax: 012 9986890 Cell: 082 5516034

BORHOLE PROFILE

Project: West End Office Park
Project No: 13106westend
Location: Die Hoewes Ext 163.
Recorded by: es ***Date:*** 10/5/2013

Coordinates Wg 29
Y: 81978 **X:** 2860197
Collar Elevation: 1420.5 mamsl

BOREHOLE No: 29
Water rest level: Dry
Date backfilled: 26/3/2013
Water strike at: None

Penetration time (m/min.sec)	Depth (m)	Lithology	Lithologic Description	Chip size (mm)	Water	Comments
0'30"	0		0-1m: Reddish brown, silty SAND with traces of white, highly weathered, chert fragments; colluvium.	<15		
0'40"	2		1-6m: Grey and translucent, weathered, CHERT fragments in a trace matrix of pale brown to creamy brown, silty sand; residual chert (chert rubble - possibly as breccia in places).	<5		
0'34"						
0'29"	4			<10		
0'48"				<5		
0'36"???	6					
0'40"			6-8m: Grey and translucent, weathered, CHERT fragments in a trace matrix of brown, sandy silt and trace amounts of brown silt(wad <5%); residual dolomite (chert rubble). Some dark brown manganiferous nodules below 7m.	<10		
0'38"	8					
0'55"			8-11m: Dark brown, sandy SILT with trace amounts of grey, weathered, chert fragments and brown silt(wad <10%); residual dolomite (chert rubble in a waddy matrix).	<5		
1'14"						
1'10"	10					
0'46"			11-18m: Translucent, beige and grey, weathered, CHERT fragments in a trace matrix of sandy silt; residual dolomite (chert rubble).	<10		
0'41"	12					
0'35"						
0'40"	14		Trace amounts of brown silt (wad <5%) below 15m.	<15		
0'48"						
0'50"	16			<10		
0'35"						
0'25"	18		18-23m: Dark grey, weathered, CHERT fragments in a minor matrix of dark brown, sandy silt and some dark brown silt(wad <10%); residual dolomite (chert rubble).	<15		
0'36"						
0'44"	20					
0'33"						
0'32"	22					
0'39"			23-26m: Dark grey, weathered, CHERT fragments in a trace matrix of grey, silty sand; residual dolomite (chert rubble).			
0'41"	24					
0'54"				<10		
0'38"	26		26-37m: Dark grey stained dark brown, weathered, CHERT fragments in a minor matrix of dark brown to chocolate brown, clayey silt(wad<15%); residual dolomite (chert rubble in a waddy matrix).			
0'43"						
0'47"	28					
0'45"	30					

Total depth: 60m

NOTES:
1) Hole stopped at 60m after penetrating maximum depth (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled on 26/3/2013.

Contractor: H. Erwee Drilling.
Machine: Super Rock **Diameter:** 165mm
Drilling pressure: 1 900kPa
Date drilled: 22/3/2013

Borehole No: 29

RELLY MILNER and SHEDDEN, P O BOX 32107, GLENSTANTIA 0010, Tel: 012 9932049 Fax: 012 9986890 Cell: 082 5516034

BORHOLE PROFILE

Project: West End Office Park
Project No: 13106westend
Location: Die Hoewes Ext 163.
Recorded by: es ***Date:*** 10/5/2013

Coordinates Wg 29
Y: 81978 **X:** 2860197
Collar Elevation: 1420.5 mamsl

BOREHOLE No: 29
Water rest level: Dry
Date backfilled: 26/3/2013
Water strike at: None

Penetration time (m/min.sec)	Depth (m)	Lithology	Lithologic Description	Chip size (mm)	Water	Comments
0'49"	30		26-37m: Dark grey stained dark brown, weathered, CHERT fragments in a minor matrix of dark brown to chocolate brown, clayey silt(wad<15%); residual dolomite (chert rubble in a waddy matrix).	<10		
0'57"						
	32		Samples wet below 33m.			
0'54"						
0'33"			Matrix recovered as a chocolate brown slurry below 33m.			
	34			<15		
0'47"						
0'35"						
	36					
0'54"						
0'18"			37-41m: Dark chocolate brown, clayey SILT(WAD) with traces of dark grey, weathered, chert fragments; residual dolomite (chert rubble in a waddy matrix).	<5		
	38					
0'14"						
0'13"				<10		
	40					
0'10"						
0'25"			41-54m: Dark grey, weathered CHERT fragments in a minor matrix of dark chocolate brown, clayey silt(wad); residual dolomite.			Water added between 32m and 60m.
	42					
0'10"			Matrix recovered as a chocolate brown slurry.			
0'09"			Driller reports medium air loss from below 43m.			
	44			<47		
0'12"						
0'47"						
	46					
3'34"			46-49m: Assumed solid dolomite (indicated as solid by driller). No dolomite fragments visible - samples highly contaminated.			
3'29"				<5		
	48		Poor sample recovery between 47m and 54m.			
3'18"				<15		
0'54"			49-54m: Dark chocolate brown clayey SILT (WAD) with scattered, grey, weathered, chert fragments; residual dolomite (poor sample recovery).			
	50					
0'41"						
0'36"				<5		
	52					
0'49"						
1'46"				<10		
	54					
1'34"			54-60m: Grey, weathered, CHERT fragments in a minor matrix of chocolate brown, clayey silt(wad); residual dolomite (chert rubble in a waddy matrix).			
0'44"						
	56			<15		
0'41"						
0'38"						
	58					
0'44"						
0'35"				<5		
	60		EOH @ 60m.			

Total depth: 60m

NOTES:
1) Hole stopped at 60m after penetrating maximum depth (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled on 26/3/2013.

Contractor: H. Erwee Drilling.
Machine: Super Rock **Diameter:** 165mm
Drilling pressure: 1 900kPa
Date drilled: 22/3/2013

Borehole No: 29

RELLY MILNER and SHEDDEN, P O BOX 32107, GLENSTANTIA 0010, Tel: 012 9932049 Fax: 012 9986890 Cell: 082 5516034

BOREHOLE PROFILE

Project: West End Office Park
Project No: 13106westend
Location: Die Hoewes Ext 163.
Recorded by: es ***Date:*** 10/5/2013

Coordinates Wg 29
Y: 81821 **X:** 2860159
Collar Elevation: 1423.5 mamsl

BOREHOLE No: 30
Water rest level: Dry
Date backfilled: 26/3/2013
Water strike at: None

Penetration time (m/min.sec)	Depth (m)	Lithology	Lithologic Description	Chip size (mm)	Water	Comments
0'39"	0		0-1m: White and brown, highly weathered and some grey, weathered, CHERT fragments in a trace matrix of reddish brown, silty sand; fill(?).	<25		
0'42"				<15		
0'36"	2		1-4m: White, highly weathered, CHERT fragments in a minor matrix of pale reddish brown, sandy silt; colluvium (chert rubble).			
0'47"						
0'32"	4		4-7m: Dark grey and translucent, weathered, CHERT fragments in a trace matrix of greyish brown, silty sand (crushed chert); residual dolomite (chert rubble).			
0'40"						
0'50"	6		Trace amounts of dark brown silt (wad <10%) below 5m.			
0'45"			7-9m: Dark chocolate brown, clayey SILT(WAD) with trace amounts of brown, highly weathered, honeycomb and grey, weathered, solid, chert fragments; residual dolomite.			
0'56"	8					
0'35"			9-17m: Dark grey, weathered, CHERT fragments in a trace matrix of dark brown, sandy silt and traces of dark brown silt(wad <15%); residual dolomite (chert rubble).	<10		
0'33"	10					
0'37"						
0'24"	12					
0'22"						
0'29"	14		Some grey shaly chert between 14m and 15m.			
0'18"						
0'23"	16					
0'27"			17-31m: Dark grey, weathered, solid and some brown, highly weathered, honeycomb, CHERT fragments in a minor matrix of dark chocolate, brown, clayey silt(wad); residual dolomite (chert rubble in a waddy matrix).	<15		
0'30"	18					
0'40"			Samples wet below 17m.			
0'55"	20					
0'35"						
0'34"	22		Matrix recovered as a dark chocolate brown slurry below 22m.			
0'36"						
0'25"	24			<10		Water added between 15m and 37m.
0'38"			Consistent profile to 31m.			
0'44"	26					
0'47"						
0'54"	28					
0'52"						
	30					

Total depth: 37m

NOTES:

1) Hole stopped at 37m after penetrating 6m of assumed, solid, dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled on 26/3/2013.

Contractor: H. Erwee Drilling.
Machine: Super Rock **Diameter:** 165mm
Drilling pressure: 1 900kPa
Date drilled: 22/3/2013

Borehole No: 30

RELLY MILNER and SHEDDEN, P O BOX 32107, GLENSTANTIA 0010, Tel: 012 9932049 Fax: 012 9986890 Cell: 082 5516034

BORHOLE PROFILE

Project: West End Office Park
Project No: 13106westend
Location: Die Hoewes Ext 163.
Recorded by: es ***Date:*** 10/5/2013

Coordinates Wg 29
Y: 81821 **X:** 2860159
Collar Elevation: 1423.5 mamsl

BOREHOLE No: 30
Water rest level: Dry
Date backfilled: 26/3/2013
Water strike at: None

Penetration time (m/min.sec)	Depth (m)	Lithology	Lithologic Description	Chip size (mm)	Water	Comments
0'54"	30					
3'36"	32		31-37m: Light grey, weathered to slightly weathered, hard rock DOLOMITE with lenses of pink dolomite and some translucent, chert fragments in a trace matrix of dark chocolate brown, clayey silt(wad).			
3'44"						
3'35"	34		Interpreted as solid dolomite bedrock - samples highly contaminated from above.	<10		Water added between 15m and 37m.
3'16"						
3'30"	36					
3'17"			EOH @ 37m.			
	38					
	40					
	42					
	44					
	46					
	48					
	50					
	52					
	54					
	56					
	58					
	60					

Total depth: 37m

NOTES:
1) Hole stopped at 37m after penetrating 6m of assumed, solid, dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled on 26/3/2013.

Contractor: H. Erwee Drilling.
Machine: Super Rock **Diameter:** 165mm
Drilling pressure: 1 900kPa
Date drilled: 22/3/2013

Borehole No: 30

RELLY MILNER and SHEDDEN, P O BOX 32107, GLENSTANTIA 0010, Tel: 012 9932049 Fax: 012 9986890 Cell: 082 5516034

DIE HOEWES EXTENSION 163
SUMMARY OF DRILLING RESULTS

BH No	Colluvium	RESIDUUM				BEDROCK		NS	Collar elevation (mamsl)	Depth of hole
		Sand	Clay/ Silt	Chert	Chert in wad matrix	Weathered /boulders	Sound	Bedrock type/IRC	[Water strike]	
3/10	0-3si		3-7ch			7-10D	10-16**	Dolomite/3b	1424	16
4/12			11-15ch	0-11 15-20**				Residual dolomite/3b(4)	1423	20
4/16	0-1ch		4-7ch	1-3 7-9		3-4B	*14-20?***	NS >9m *Dolomite?*/6	1422	20
5/8				0-5	5-10	10-11	11-17**	Dolomite/3b	1424	17
7/9	0-3ch		3-7chw		7-10		10-17**	Dolomite/3b	1423	17
C/13	0-2ch		4-9				*12-18***	NS >9m *Dolomite?*/3b(6)	1419	18
D/10	0-1ch		1-5ch 7-13cl 14-19	5-7 13-14 19-22**				Residual dolomite/3b(4)	1419	22
E/12-13	0-3ch		6-11chw	3-6	11-22**			Residual dolomite/3b(4)	1418	22
F/9-10	0-3cl		4-5cl 8-13w	3-4 5-8	13-23**			Residual dolomite/4	1419	23
F-G/11	0-3ch	17-18	3-6cl 13-17w	6-9	9-13 18-25**			Residual dolomite/4	1417	25
1	0-2ch 2-3si		13-17 17-30chw	3-13			*33-39***	NS >30m *Dolomite?*/3b(4)	1421	39
2	0-1ch		16-17w 24-26w**	1-16 17-24				Residual dolomite/4(6)	1419	26
3	0-2ch		2-4si	4-31			31-37**	Dolomite/4	1422	37
4	0-2ch				2-12		*34-40***	NS >15m *Dolomite?*/4(6)	1421	40
5	0-1s		3-4si	1-3		4-15B	15-23**	Dolomite/3b	1415	23
6	0-4ch			4-27		27-34B	*45-51***	*Dolomite?*/4(6)	1419	51
7	0-2ch			2-5			7-13**	NS 5-7 Dolomite/3b	1416	13
8	0-5ch			5-25		25-38B	*38-44***	*Dolomite?*/4	1418	44

BH No	Colluvium	RESIDUUM				BEDROCK		NS	Collar elevation (mamsl)	Depth of hole
		Sand	Clay/ Silt	Chert	Chert in wad matrix	Weathered /boulders	Sound	Bedrock type/IRC	[Water strike]	
9	0-3ch		6-8sy	1-6 8-14 24-45	14-24		*45-50***	*Dolomite?*/3b	1421 [41m]	50
10	0-7ch				7-9		*13-17***	NS >9m *Dolomite?*/6	1422	17
11	1-6m			3-8	8-13		15-18 *29-30?* *33-39***	NS 13-15m >18m *Dolomite?*/4(6)	1420	39
12	0-8ch		8-13sy 19-22	13-19	22-37		*49-55***	NS>37m *Dolomite?*/4(6)	1422	55
13	0-2ch		2-3w 4-6cl	3-4 6-14	12-31		31-37**	Dolomite/4	1421	37
14	0-5ch			5-9			*12-15* *16-22***	NS>9m *Dolomite?*/3b	1423	22
15	0-1ch			1-4			4-10**	Dolomite/5	1422	10
16	0-3ch			3-7	7-15		*20-26***	NS 15-22m *Dolomite?*/4(6)	1422	26
17						2-4	0-2 4-10**	Dolomite/5	1423	10
18	0-3ch			3-7 14-17	7-11 21-22		11-14 *22-24* 24-28**	Dolomite/3b	1422	28
19	0-3ch		3-8w		8-15 40-41		*41-47***	NS 15-40m *Dolomite?*/4(6)	1419	47
20	0-3ch		3-7si	14-19	7-12 19-32	32-36	36-42	*Dolomite?*/4	1419	47
21	0-3ch		3-6	2-3 6-9	9-31		*31-37***	*Dolomite*/4	1420	37
22	0-4ch		6-9si	4-6	9-33		*34-40***	NS >33m *Dolomite?*/2(3a)	1420	40

NOTES: *Italics*= Interpreted as; si=silt; cl=clay; B=boulders; D=dolomite; ch=chert; NS=no samples; **=end of hole; IRC=Inherent Risk Characterisation.

Figure: 1

BOREHOLE PROFILE

JOB L.A.H. 232 , Sheet No.

HOLE NO. 3/10

DATE DRILLED 26/3/83

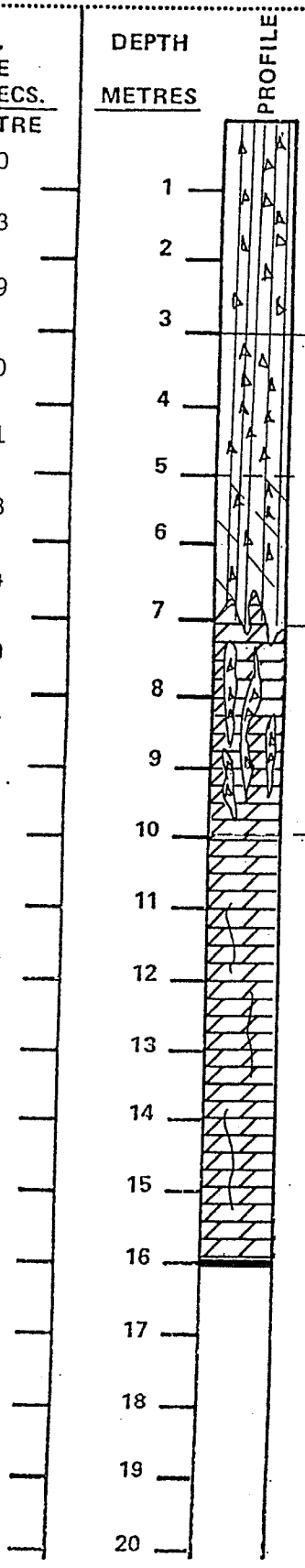
LOGGED BY E.S. Date 7/4/83

DRILLER BOOYSEN AND BOOYSEN

DRILL 150mm ϕ Percussion

CO-ORDS

COLLAR ELEV.



DESCRIPTION
Dry, creamy white, powdery SILT with 20-40% white, highly weathered chert fragments.
Powdery material produced by percussive effect of drill on chert.
Dry, pale reddish brown, clayey SILT with 30% white highly weathered chert and grey cellular chert fragments.
Matrix as above but chip size fine mainly white and grey chert fragments. Minor wad.
Fine grey and light brown, weathered, leached DOLOMITE fragments in a pale brown powder. Subordinate white and grey partly cellular chert fragments.
Some dolomite appears recrystallised.
Light grey, weathered, slightly leached jointed DOLOMITE.
Fragments of chert and grey shale between 12m and 13m. Probably fractured zone.
E.O.H.

BOREHOLE PROFILE

JOB L.A.H. 232 , Sheet No.

HOLE NO. 4/12

DATE DRILLED 11/5/83

LOGGED BY E.S. Date 26/5/83

DRILLER BOOYSEN AND BOOYSEN

DRILL 150mm ϕ Percussion

CO-ORDS

COLLAR ELEV.

PEN. RATE MINS./SECS. PER METRE	DEPTH METRES	PROFILE	DESCRIPTION
0/37	1		40-60% angular, white and grey, weathered to highly weathered CHERT fragments in a reddish brown silty clayey matrix.
1/22	2		
2/09	3		Concentration of chert varies throughout sequence.
2/42	4		
2/47	5		
1/17	6		70% grey angular unweathered CHERT in matrix as above.
1/05	7		
1/36	8		As for 1m to 5m
2/14	9		
1/12	10		
1/24	11		
1/32	12		Dry, dark reddish brown, silty CLAY with minor white and grey chert fragments.
1/24	13		
1/28	14		
1/22	15		
1/17	16		As for 5m to 7m but chip size finer.
1/13	17		
1/39	18		
1/34	19		
1/40	20		E.O.H.

Note: No groundwater encountered during drilling operation.

BOREHOLE PROFILE

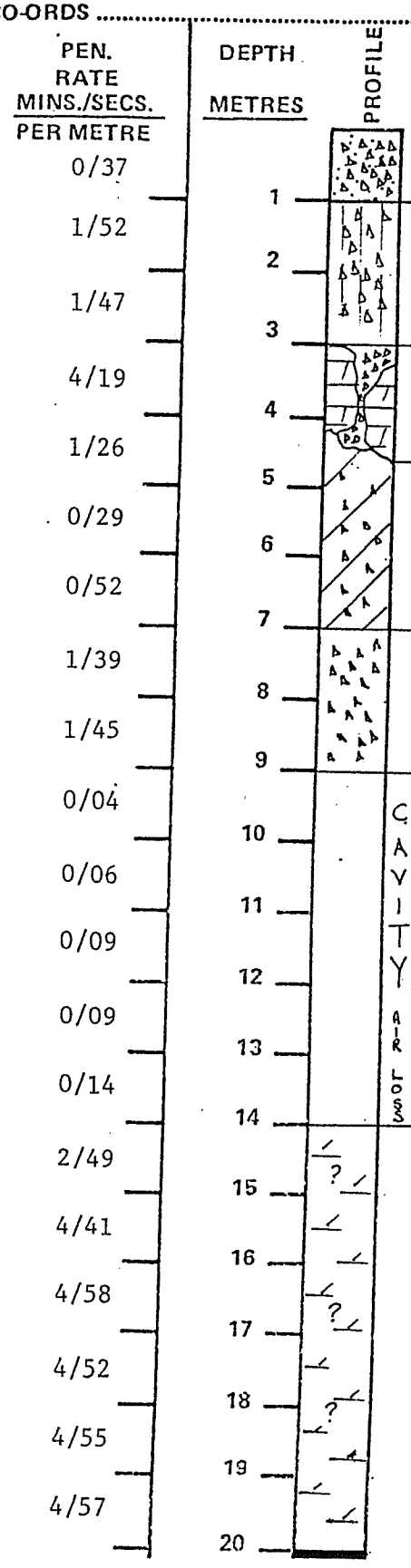
Sheet No.

JOB L.A.H. 232 HOLE NO. 4/16

DATE DRILLED 11/5/83 LOGGED BY E.S. Date 24/5/83

DRILLER BOOYSEN AND BOOYSEN DRILL 150mm ϕ Percussion

CO-ORDS COLLAR ELEV.



DESCRIPTION
60% sub angular, white highly weathered, CHERT fragments in a sandy matrix.
20-50% grey angular, slightly weathered CHERT fragments in a silty matrix.
Dark grey, slightly weathered, jointed DOLOMITE and CHERT.
Dry, reddish brown, silty CLAY with 20% fine, angular chert fragments.
Grey, angular, fine, fresh CHERT fragments. Possibly chert breccia.
Driller reports cavity between 9m and 14,?m.
Rapid penetration of drill-bit recorded.
Driller reports hard material below 14m but no samples recovered due to air loss in cavity.
e.o.h.

BOREHOLE PROFILE

JOB L.A.H. 232 , Sheet No.

HOLE NO. 5/8

DATE DRILLED 26/3/83

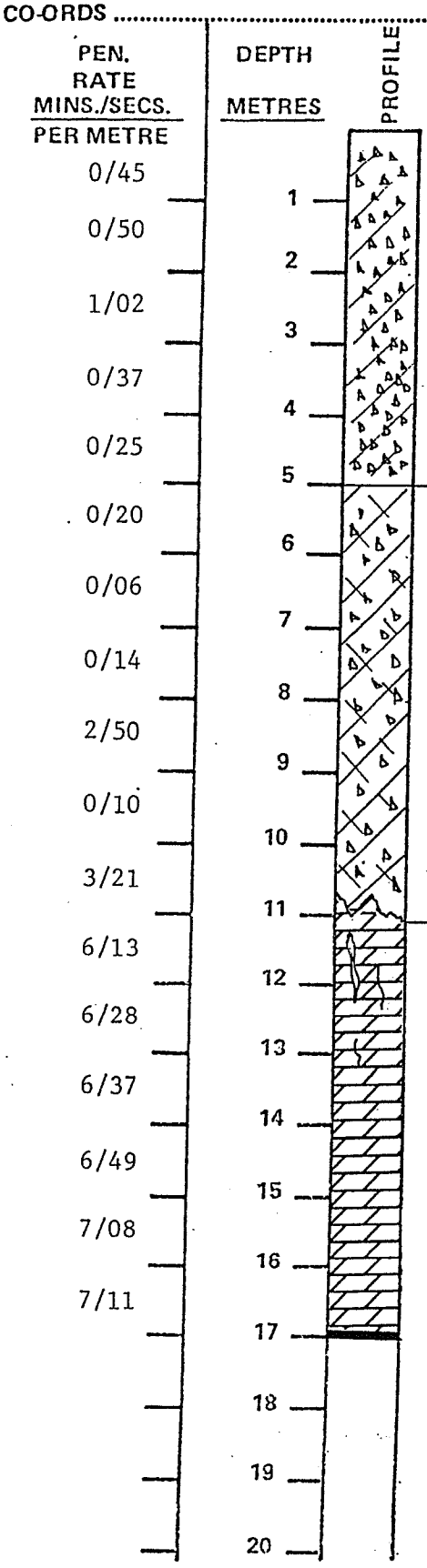
LOGGED BY E.S. Date 11/4/83

DRILLER BOOYSEN AND BOOYSEN

DRILL 150mm ϕ Percussion

CO-ORDS

COLLAR ELEV.



DESCRIPTION

60% white and grey, weathered to highly weathered, sub-angular CHERT fragments in a dark reddish brown (wet) clayey matrix. Subordinate dark brown manganocrete concretions present.

Dry, light brown, slightly waddy sandy CLAY with 30 - 40% fine, angular weathered chert fragments. Wad 10 -15%.

Driller reports "very soft ground".

Sample and chip size small.

Light grey, slightly leached, slightly weathered jointed DOLOMITE. Minor fragments of shaley dolomite presented between 11m and 13m.

E.O.H.

Notes: 1) No groundwater encountered during drilling operations.

2) Wet samples due to rain while logging.

BOREHOLE PROFILE

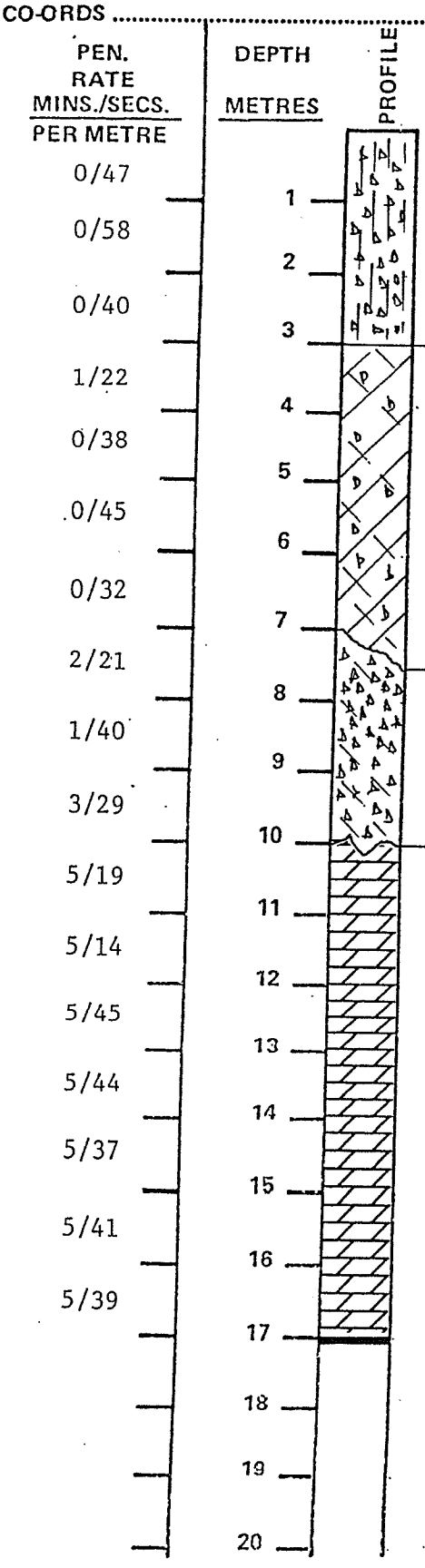
Sheet No.

JOB L.A.H. 232 HOLE NO. 7/9

DATE DRILLED 11/5/83 LOGGED BY E.S. Date 26/5/83

DRILLER BOOYSEN AND BOOYSEN DRILL 150mm ϕ Percussion

CO-ORDS COLLAR ELEV.



DESCRIPTION
30-50% white,angular,highly weathered CHERT fragments in a red silty matrix.
Damp,dark brown,slightly waddy CLAY with 20% angular and platey,white,brown and grey chert and subordinate cellular chert; wad 15-20%.
As above but grey powdery matrix from shaley chert.
As for 3m to 5m but only 15% fragments,predominately cellular chert.
80% grey,angular,fine CHERT fragments and minor grey dolomite in a powdery matrix. Some minor wad present.
Grey,slightly weathered DOLOMITE and chert.
Chip size ≈5mm. Possibly zone of recemented chert and dolomite.
E.O.H.

Note: No groundwater encountered during drilling operations.

BOREHOLE PROFILE

FIG. 1

PROJECT: L.A.H. 231 HOLE No: C/13

CONRACTOR E. Erwee LOGGED BY: E.S. Date 26/6/85

MACHINE Mangold. COLLAR ELEVATION:

DATE DRILLED 11/6/85 WATER REST LEVEL: Date

Driller's Remarks	Casing and drill diam.	Chip size Range(mm.)	Penetration (mins/metre)	DEPTH (m)	PROFILE	DESCRIPTION
	150mm ϕ Percussion	<10	0'48"	1		40-60% white stained brown, angular, highly weathered, CHERT fragments in a pale red silty matrix. Hillwash.
			2'13"	2		
			2'10"	3		Chert less weathered below 2m. Possibly represents chert residuum.
			3'24"	4		
			1'23"	5		Slightly moist, dark brown, waddy CLAY with 20% to 30% brown and grey angular chert and subordinate shale fragments.
			1'52"	6		
			0'30"	7		
		<2	1'25"	8		Fragments become finer below 8m. Probably due to air loss in porous waddy material.
			1'08"	9		Sample recovered as a silty coarse sand.
Driller reports "CAVITY"			1'57"	10	No Sample	Pale grey, weathered, slightly leached, fractured to jointed hard rock(?) DOLOMITE.
		0	0'08"	11		
			0'06"	12		Sample recovered as coarse sand.
		<1	5'40"	13		Becoming unweathered jointed dolomite below 13m.
			5'17"	14		
			5'51"	15		
			6'39"	16		
			13'24"	17		
			13'56"	18		E.O.H.

Notes:
1) No groundwater encountered during drilling operations.
2) Almost no coarse material recovered below 14m.
3) Drill product effervesces in conc HCl
4) Driller reports cavity between 10m and 12m.

▽ Groundwater encountered whilst drilling

▼ Water Rest Level (after 24 hrs).

E.O.H. End of Borehole

N.S. No Sample Recovered

PREPARED BY: BELLY MILNER AND PARTNERS

BOREHOLE PROFILE

FIG. 2

PROJECT: L.A.H. 231 — HOLE No: D/10

CONRACTOR: M.M. Willemse. — LOGGED BY: E.S. — Date 18/2/86

MACHINE: Super Rod. — COLLAR ELEVATION:

DATE DRILLED: 11/6/86 — WATER REST LEVEL: — Date

Driller's Remarks	Casing and drill diam.	Chip size Range(mm.)	Penetration (mins/metre)	DEPTH (m)	PROFILE	DESCRIPTION
	125mm ϕ Percussion	<10	1'12"	1		60% white stained brown, subrounded, highly weathered CHERT fragments in a pale red clayey matrix.
		<5	1'15"	2		Dry, pale reddish brown, silty CLAY with 25% - 35% fine grey and white highly weathered chert fragments.
			1'21"	3		
			2'30"	4		
			2'38"	5		
		<10	2'42"	6		As above but 60% grey angular, slightly weathered chert fragments (large boulders?) between 5m and 6m.
			2'39"	7		
		<5	2'41"	8		As for 1m to 5m but fragments subrounded to subangular. No evidence of wad.
			2'53"	9		
			2'46"	10		
			2'57"	11		
			3'02"	12		
			3'11"	13		Dark grey chert fragments between 13m and 14m suggest large boulder.
			3'26"	14		
			2'59"	15		
			2'46"	16		
			2'32"	17		
			2'27"	18		
			2'31"	19		
		<10	2'43"	20		50% grey angular, slightly weathered, CHERT fragments in a reddish brown clay matrix.

▽ Groundwater encountered whilst drilling

▼ Water Rest Level (after 24 hrs).

E.O.H. End of Borehole

N.S. No Sample Recovered

BOREHOLE PROFILE

FIG. 3

PROJECT: ..... HOLE No: D/10 (Contd.)

CONRACTOR ..... LOGGED BY: ..... Date .....

MACHINE ..... COLLAR ELEVATION: .....

DATE DRILLED ..... WATER REST LEVEL: ..... Date .....

Driller's Remarks	Casing and drill diam.	Chip size Range(mm.)	Penetration (mins/metre)	DEPTH (m)	PROFILE	DESCRIPTION
		<10	3'11"	21		50% grey, angular, slightly weathered, CHERT fragments in a reddish brown clayey matrix.
			3'16"	22		E.O.H.

Notes: 1) No groundwater encountered during drilling operations.

2) No evidence of wad throughout profile.

▽ Groundwater encountered whilst drilling

▼ Water Rest Level (after 24 hrs).

E.O.H. End of Borehole

N.S. No Sample Recovered

BOREHOLE PROFILE

FIG. 4

PROJECT: L.A.H. 231 HOLE No: E/12-13

CONRACTOR M.M. Willemse LOGGED BY: E.S. Date 18/2/86

MACHINE Super Rod. COLLAR ELEVATION:

DATE DRILLED 14/2/86 WATER REST LEVEL: Date

Driller's Remarks	Casing and drill diam.	Chip size Range(mm.)	Penetration (mins/metre)	DEPTH (m)	PROFILE	DESCRIPTION
	125 mm ϕ Percussion	<15	1'45"	1		50-70% white, angular, highly weathered CHERT fragments in a reddish brown clayey silty matrix.
			1'53"	2		
			2'09"	3		
			2'12"	4		As above but 40% to 60% grey stained brown chert fragments in a brown silty matrix.
			2'16"	5		
		<5	1'59"	6		
			1'46"	7		Dry, brown, clayey SILT with 20% fine angular, chert fragments. Traces of wad (<3%).
			1'37"	8		
			1'47"	9		
			1'34"	10		Becoming pale grey silt from decomposed shale below 10m.
			1'57"	11		
			2'04"	12		40-60% grey stained brown, angular slightly weathered CHERT fragments in a brown slightly waddy clayey matrix. Wad <5%.
			2'12"	13		
			2'15"	14		
		<10	2'24"	15		
			2'31"	16		
			2'39"	17		
			2'21"	18		
		<5	2'36"	19		
			2'34"	20		

▽ Groundwater encountered whilst drilling

▼ Water Rest Level (after 24 hrs).

E.O.H. End of Borehole

N:S. No Sample Recovered

BOREHOLE PROFILE

FIG. 5

PROJECT: ..... HOLE No: E/12-13 (Contd.)

CONRACTOR ..... LOGGED BY: ..... Date .....

MACHINE ..... COLLAR ELEVATION: .....

DATE DRILLED ..... WATER REST LEVEL: ..... Date .....

Driller's Remarks	Casing and drill diam.	Chip size Range(mm.)	Penetration (mins/metre)	DEPTH (m)	PROFILE	DESCRIPTION
		<5	2'26"	21		40-60% grey and brown, angular weathered CHERT fragments in a brown slightly waddy clayey matrix. Wad <5%.
			2'39"	22		E.O.H.
						Note: No groundwater encountered during drilling operations.

▽ Groundwater encountered whilst drilling

▼ Water Rest Level (after 24 hrs).

E.O.H. End of Borehole

N.S. No Sample Recovered

BOREHOLE PROFILE

PROJECT: L.A.H. 231 FIG. 6

CONRACTOR M.M. Willemse. HOLE No: F/9-10

MACHINE Super Rod LOGGED BY: E.S. Date 14/2/86

DATE DRILLED 14/2/86 COLLAR ELEVATION:

WATER REST LEVEL: Dry (20m) Date 14/2/86

Driller's Remarks	Casing and drill diam.	Chip size Range(mm.)	Penetration (mins/metre)	DEPTH (m)	PROFILE	DESCRIPTION
	125mm ø Percussion	<15	0'53"	1		Dry, dark reddish brown silty CLAY with 15-20% white, subangular, highly weathered chert fragments.
		<5	1'26"	2		
			3'42"	3		
			6'24"	4		Light grey, slightly weathered, hard rock CHERT (BRECCIA?).
			2'15"	5		Dry, dark reddish brown, silty CLAY with minor chert fragments.
			2'27"	6		40-60% grey and light brown, subangular weathered CHERT fragments in a pale reddish brown clay matrix.
			2'36"	7		
		<10	2'42"	8		
			3'04"	9		Moist, brown to dark brown, slightly waddy CLAY with 10% brown stained chert fragments. (Wad <5%).
		<5	2'39"	10		
			1'40"	11		Becoming black CLAY (WAD) between 10m and 11m (Wad 20%).
			1'54"	12		As for 8m to 10m.
			1'32"	13		
			1'27"	14		40-60% grey, angular, weathered CHERT fragments in a brown slightly waddy clay matrix (Wad 5-10%).
		<10	1'16"	15		
			1'38"	16		
			1'47"	17		
		<15	2'02"	18		Becoming 50% to 70% chert fragments below 16m.
			2'11"	19		
			2'15"	20		

Groundwater encountered whilst drilling

Water Rest Level (after 24 hrs).

E.O.H. End of Borehole

BOREHOLE PROFILE

FIG. 7

PROJECT: .....

HOLE No: F/9-10 (Contd.)

CONRACTOR .....

LOGGED BY: ..... Date .....

MACHINE .....

COLLAR ELEVATION: .....

DATE DRILLED .....

WATER REST LEVEL: ..... Date .....

Driller's Remarks	Casing and drill diam.	Chip size Range(mm.)	Penetration (mins/metre)	DEPTH (m)	PROFILE	DESCRIPTION
	125mm ϕ Percussion	<15	1'39"	21		50% - 70% grey, slightly weathered, CHERT fragments in a dark brown slightly waddy clay matrix. Wad 5-10%.
			1'48"	22		
			1'56"	23		E.O.H.

Note: No groundwater encountered during drilling operations.

▽ Groundwater encountered whilst drilling

▼ Water Rest Level (after 24 hrs).

E.O.H. End of Borehole

N.S. No Sample Recovered

BOREHOLE PROFILE

FIG. 8

PROJECT: L.A.H. 231 — HOLE No: F-G/11

CONRACTOR: H. Erwee — LOGGED BY: E.S. — Date 26/6/85

MACHINE: Mangold. — COLLAR ELEVATION:

DATE DRILLED: 11/6/85 — WATER REST LEVEL: Dry (17m) — Date 14/2/86

Driller's Remarks	Casing and drill diam.	Chip size Range(mm.)	Penetration (mins/metre)	DEPTH (m)	PROFILE	DESCRIPTION
	150mm ϕ Percussion	<30	0'49"	1		60% white stained brown, angular to subangular, slightly weathered to highly weathered CHERT fragments in a pale red silty matrix.
			1'32"	2		Becoming clayey with depth.
		<15	1'11"	3		
		<5	1'36"	4		Slightly moist, pale brownish red, silty CLAY with 10% fine white chert fragments.
			2'30"	5		
			3'46"	6		
		<20	2'08"	7		40-60% grey to dark grey stained brown angular CHERT fragments in a brown silty clay matrix.
			3'16"	8		
		<5	2'40"	9		
			1'52"	10		As above but matrix darker in colour due to wad (5-10%).
		<15	1'40"	11		
			1'36"	12		
			1'44"	13		
			1'58"	14		Slightly moist, dark blackish brown, waddy CLAY with minor chert fragments. (Wad 30-40%).
		<5	3'49"	15		Moist, brown speckled pale red CLAY.
		N/A	4'51"	16		Possibly derived from decomposition of ferruginous shale(?)
			4'30"	17		
		<10	1'57"	18		Dry, yellowish porous clayey SAND with 40% brown ferruginous shale fragments.
			2'12"	19		40-60% grey angular, slightly weathered CHERT fragments in a dark brown clayey matrix. Wad 5%.
			2'31"	20		

Groundwater encountered whilst drilling

Water Rest Level (after 24 hrs).

E.O.H. End of Borehole

N.S. No Sample Recovered

BOREHOLE PROFILE

FIG. 9

PROJECT: ..... HOLE No: FG/11 (Contd.)

CONRACTOR ..... LOGGED BY: ..... Date .....

MACHINE ..... COLLAR ELEVATION: .....

DATE DRILLED ..... WATER REST LEVEL: ..... Date .....

Driller's Remarks	Casing and drill diam.	Chip size Range(mm.)	Penetration (mins/metre)	DEPTH (m)	PROFILE	DESCRIPTION
	150mm ϕ Percussion		1'59"	21		40-60% grey angular, slightly weathered CHERT fragments in a dark brown clayey matrix. Wad 5%.
			1'50"	22		
			2'06"	23		
			6'01"	24		Becoming pale grey due to shale below 24m. Wad 5-10%.
			5'12"	25		E.O.H.

Note: No groundwater encountered during drilling operations.

▽ Groundwater encountered whilst drilling

▼ Water Rest Level (after 24 hrs).

E.O.H. End of Borehole

N.S. No Sample Recovered

Borehole Profile

Project: Holdings 231 & 232, Lyttelton A. H. **Hole No.** 1
Machine: Super Rock(22,7m³/min; 17Bar) **Logged:** es **Date:** 23/04/01
Contractor: Bennett Drilling **Rest Level:** DRY
Date: 10/04/01 **Date:** 10/04/2001

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<10	0'21"	0 -		White stained brown, highly weathered, **CHERT** fragments in a trace matrix of light brown silty sand; colluvium.
	0'51"	1 -		As above but chert light brown and weathered.
	0'54"	2 -		Reddish brown, sandy **SILT** with traces of brown Mn nodules; colluvium(?).
<15	0'55"	3 -		Light brown and subordinate grey, weathered to highly weathered, **CHERT** fragments in a trace matrix of brown sandy silt; colluvium(?).
	0'47"	4 -		
	1'00"	5 -		
<20	1'06"	6 -		
	0'59"	7 -		Dark brown, clayey **SILT** with traces of brown, weathered, chert fragments and some dark brown, silt (wad); residual dolomite.
<15	1'00"	8 -		Dark grey, weathered, **CHERT** fragments in a trace matrix of brown sandy silt; residual dolomite.
	0'54"	9 -		
	0'49"	10 -		
<20	1'04"	11 -		Dark grey to light grey, slightly weathered, **CHERT** in a trace matrix of silty sand; residual dolomite.
	1'12"	12 -		
<15	1'01"	13 -		Dark brown, clayey **SILT** with traces of brown and grey, weathered, chert and some honeycomb chert fragments; residual dolomite.
	0'56"	14 -		
	1'15"	15 -		
<10	1'21"	16 -		
	1'17"	17 -		
	1'10"	18 -		Dark brown, silty **CLAY** with traces of grey, weathered, chert fragments and traces of black clay (wad); residual dolomite.
<5	1'07"	19 -		
	0'58"	20 -		Light reddish brown, silty **CLAY** with scattered fine chert gravel; residual syenite.
	-	21 -		Dark brown and light reddish brown, silty **CLAY** with traces of grey and brown, highly weathered, chert fragments and some black clay (wad); residual dolomite (and syenite?).
<10	-	22 -		
	-	23 -		Dark brown, silty **CLAY** with traces of brown, highly weathered, honeycomb, chert fragments and some black clay (wad); residual dolomite.
	0'44"	24 -		
	0'49"	25 -		Interpreted as stringers of syenite within residual dolomite (clayey wad).
	0'42"	26 -		
<5	0'59"	27 -		
	1'01"	28 -		
	1'43"	29 -		
		30 -		

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Borehole Profile

Project: Holdings 231 & 232, Lyttelton A. H. **Hole No.** 1
Machine: Super Rock(22,7m³/min; 17Bar) **Logged:** es **Date:** 23/04/01
Contractor: Bennett Drilling **Rest Level:** DRY
Date: 10/04/01 **Date:** 10/04/2001

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
		30 -		
	1'52"	31 -		No samples recovered below 30m. Material assumed to be similar to 23m to 30m
	1'55"	32 -		
	1'59"	33 -		
	2'01"	34 -		Penetration times suggest solid rock below 33m. Interpreted as hard rock dolomite.
0	2'55"	35 -		
	3'06"	36 -		
	3'11"	37 -		
	2'51"	38 -		
	2'54"	39 -		EOH

NOTES:
1) Hole stopped at 39m after penetrating 6m of "assumed" solid rock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry immediately after completion.
4) Clay cutter used to penetrate clay between 21m and 24m.
5) Water added below 27m to facilitate sample recovery of clay.

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Borehole Profile

Project: Holdings 231 & 232, Lyttelton A. H. **Hole No.** 2
Machine: Super Rock(22,7m³/min; 17Bar) **Logged:** es **Date:** 23/04/01
Contractor: Bennett Drilling **Rest Level:** DRY
Date: 10/04/01 **Date:** 10/04/2001

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<10	0'25"	0 - 1 -		White and light grey, weathered to highly weathered, **CHERT** fragments in a trace matrix of light reddish brown, silty sand; colluvium.
<25	0'44" 1'04"	2 - 3 -		White, highly weathered and scattered, light grey, slightly weathered **CHERT** fragments in a minor matrix of reddish brown, silty sand; colluvium(?).
<5	1'13" 0'57"	4 - 5 -		Grey and translucent, slightly weathered to weathered, **CHERT** fragments in a trace matrix of light reddish brown, silty sand; colluvium(?).
<15	1'03" 1'07" 1'23" 1'32" 1'13" 1'14"	6 - 7 - 8 - 9 - 10 -		Variable sequence of grey, dark grey and translucent, slightly weathered, chert fragments in a trace matrix of silty sand.
<10	1'12" 1'05"	11 - 12 - 13 -		Grey and translucent, slightly weathered to weathered, **CHERT** fragments in a trace matrix of reddish brown, sandy silt and some dark brown silt (wad); residual dolomite.
<15	1'14"	14 -		Grey and translucent, slightly weathered to weathered, **CHERT** fragments in a minor matrix of reddish brown, sandy silt; residual dolomite.
<10	1'16" 1'03" 1'16" 1'02" 1'10" 0'57"	15 - 16 - 17 - 18 - 19 - 20 -		Blackish brown, sandy **SILT (WAD)** with traces of grey, slightly weathered, chert fragments; residual dolomite. Grey and translucent, slightly weathered, **CHERT** fragments in a minor matrix of blackish brown, slightly clayey silt and traces of black silt(wad); residual dolomite.
<15	1'21" 1'31" 1'01" 1'33 1'44 1'52"	21 - 22 - 23 - 24 - 25 - 26 -		Grey, slightly weathered, **CHERT** fragments in a minor matrix of brown to reddish brown, clayey silt and traces of dark brown clay (wad); residual dolomite. Dark brown, silty **CLAY (WAD)** with traces of grey, slightly weathered, chert and some highly weathered, honeycomb, chert fragments; residual syenite. **EOH**

NOTES:
1) Hole abandoned at 26m. Unable to continue, drill continually sticking in loose conditions.
2) Ground water not encountered during drilling operations.
3) Hole dry immediately after completion.

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Borehole Profile

Project: Holdings 231 & 232, Lyttelton A. H. **Hole No.** 3
Machine: Super Rock(22,7m³/min; 17Bar) **Logged:** es **Date:** 23/04/01
Contractor: Bennett Drilling **Rest Level:** DRY
Date: 12/04/01 **Date:** 12/04/2001

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<25	0'14"	0 -		White stained brown, highly weathered, **CHERT** fragments in a minor matrix of reddish brown, silty sand; colluvium.
	0'53"	1 -		
<5	0'51"	2 -		Reddish brown to brown, sandy **SILT** with traces of brown Mn nodules; colluvium(?).
	2'06"	3 -		
<10	1'33"	4 -		Dark grey to grey, slightly weathered to weathered, **CHERT** fragments in a trace matrix of dark brown, clayey silt; colluvium(?).
	2'10"	5 -		
	1'11"	6 -		
	1'13"	7 -		Dark grey to grey, slightly weathered, **CHERT** fragments in a trace matrix of dark brown, clayey silt; residual dolomite(?).
	1'14"	8 -		
	1'03"	9 -		
<15	1'07"	10 -		Dark grey, slightly weathered to weathered, **CHERT** fragments in an abundant matrix of dark brown, clayey silt and black silt (wad); residual dolomite.
	1'11"	11 -		
	1'24"	12 -		Subordinate honeycomb chert from below 14m.
	1'31"	13 -		
	1'28"	14 -		Variable sequence of chert rubble in a clayey waddy matrix.
	0'56"	15 -		
	1'48"	16 -		
	1'51"	17 -		
<10	1'44"	18 -		Dark grey, slightly weathered to weathered, **CHERT** and honeycomb **CHERT** fragments in a minor matrix of dark brown, clayey silt; residual dolomite.
	1'55"	19 -		
	1'17"	20 -		
	1'41"	21 -		
	1'59"	22 -		
<15	1'06	23 -		Grey, slightly weathered, **CHERT** and subordinate **SHALE** fragments in a trace matrix of dark brown and reddish brown silty clayey and grey silt; residual dolomite.
	1'17	24 -		
	1'31"	25 -		
	1'40"	26 -		
	1'52"	27 -		
	1'57"	28 -		
	1'43"	29 -		Dark grey, slightly weathered to weathered, **CHERT** fragments in a minor matrix of dark brown, silty clay and some black silt (wad); residual dolomite.
		30 -		

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Borehole Profile

Project: Holdings 231 & 232, Lyttelton A. H. **Hole No.** 3
Machine: Super Rock(22,7m³/min; 17Bar) **Logged:** es **Date:** 23/04/01
Contractor: Bennett Drilling **Rest Level:** DRY
Date: 12/04/01 **Date:** 12/04/2001

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<15	1'14"	30 -		Dark grey slightly weathered to weathered, **CHERT** fragments in a minor matrix of dark brown, silty clay and some black silt (wad); residual dolomite.
	2'57"	31 -		Dark grey, slightly weathered, hard rock **DOLOMITE** and traces of traces of black, slightly weathered chert.
	3'02"	32 -		
	3'10"	33 -		
<10	3'07"	34 -		
	2'59"	35 -		
	2'55"	36 -		
		37 -		**EOH**
		-		
		-		
		-		
		-		
		-		
		-		
		-		**NOTES:**
		-		1) Hole stopped at 37m after penetrating 6m of solid dolomite rock (as requested).
		-		2) Ground water not encountered during drilling operations.
		-		3) Hole dry immediately after completion.
		-		
		-		
		-		
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		-		
		-		
		-		

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Borehole Profile

Project: DIE HOEWES EXT 163, (LAH 231 & 232) **Hole No.** 4

Machine: SUPER ROCK (19 Bar 800cfm) **Logged:** es **Date:** 15/06/2007

Contractor: H Erwee Drilling **Rest Level:** Dry

Date: 15/06/2007 **Date:** 19/06/07 **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
	0'27"	1		White stained brown, highly weathered, **CHERT** fragments in a trace matrix of brown, silty sand; colluvium.
	0'34"	2		
	0'31"	3		Grey, brown and translucent, weathered, **CHERT** fragments in a trace matrix of dark brown, slightly clayey, sandy silt and trace amounts of brown silt (wad); residual dolomite
	0'38"	4		
	0'25"	5		
	0'21"	6		Grey stained dark brown, weathered, **CHERT** fragments in a minor matrix of dark brown silt (wad); residual dolomite.
<15	0'30"	7		
	0'19"	8		
	0'28"	9		
	0'24"	10		
	0'33"	11		
	0'30"	12		
	0'26"	13		Dark brown, sandy **SILT (WAD)** with traces of grey, weathered and grey stained brown, highly weathered, chert fragments; residual dolomite.
<5	0'18"	14		
	0'23"	15		
	0'21"	16		No samples recovered below 15m.
	0'32"	17		
	0'26"	18		
	0'34"	19		
	0'40"	20		
	0'31"	21		
	0'10"	22		
0	0'24"	23		
	1'21"	24		
	0'38"	25		
	0'07"	26		
	0'33"	27		
	0'54"	28		
	0'51"	29		
	1'05"	30		

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Collar Elevation: 1421 mamsl **Coords (LO29): Y:** 81 850 **X:** 2 859 928

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232) **Hole No.** 4 (Contd.)
Machine: SUPER ROCK (19 Bar; 800cfm) **Logged:** es **Date:** 15/06/2007
Contractor: H Erwee Drilling **Rest Level:**
Date: 15/06/2007 **Date:** **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
	0'55"	31		No samples recovered below 15m.
	1'02"	32		
	0'52"	33		
	1'14"	34		
	3'10"	35		Interpreted as solid dolomite below 34m.
	3'11"	36		
	3'16"	37		
	3'21"	38		
	3'17"	39		
	3'04"	40		
EOH				
				NOTES:
				1) Hole stopped at 40m after penetrating 6m of "assumed" dolomite bedrock (as requested).
				2) Ground water not encountered during drilling operations.
				3) Hole dry when backfilled a few days later

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Borehole Profile

Project: DIE HOEWES EXT 163, (LAH 231 & 232). **Hole No.** 05

Machine: SUPER ROCK (19 Bar; 800cfm) **Logged:** es **Date:** 28/06/2007

Contractor: H Erwee Drilling **Rest Level:** Dry

Date: 15/06/2007 **Date:** 19/06/07 **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<10	019"	1		Reddish brown, silty **SAND** with traces of white and brown, highly weathered, chert fragments; colluvium.
<15	0'22"	2		Grey, weathered and brown and white, highly weathered, **CHERT** fragments in a trace matrix of reddish brown, sandy silt; residual dolomite?
	0'32"	3		
	0'40"	4		Brown, "powdery" **SILT** with traces of brown, highly weathered, honeycomb, chert fragments and scattered, grey, weathered, dolomite fragments; residual dolomite (possibly boulders).
<10	0'34"	5		Grey, weathered, hard rock, **DOLOMITE** fragments and grey and translucent, weathered, **CHERT** fragments in a trace matrix of light brown, "powdery", slightly sandy, silt and trace amounts of brown silt (wad); residual dolomite.
	0'43"	6		
	0'14"	7		
	0'12"	8		Grey weathered brown, weathered to highly weathered, hard rock, **DOLOMITE** fragments and subordinate grey, weathered, **CHERT** fragments in a trace matrix of brown, slightly clayey, sandy silt and traces of brown silt (wad); residual dolomite (interpreted as boulders in a silty matrix).
	0'38"	9		
	0'23"	10		
<15	0'27"	11		
	0'41"	12		
	0'51"	13		Grey weathered brown, weathered to highly weathered, hard rock, **DOLOMITE** fragments and subordinate grey, weathered, **CHERT** fragments in a trace matrix of dark brown, clay (wad); residual dolomite (interpreted as boulders in a silty matrix).
	0'48"	14		
	0'54"	15		
	3'14"	16		Grey to light grey, weathered to slightly weathered, hard rock **DOLOMITE** with intercalated lenses of grey, slightly weathered chert. Interpreted as a fractured zone within solid bedrock between 16m and 17m.
	0'51"	17		
	3'11"	18		
<10	3'19"	19		
	3'04"	20		
	3'17"	21		
	3'15"	22		
	3'08"	23		
EOH				

NOTES:

1) Hole stopped at 23m after penetrating 6m of solid dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled a few days later

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Collar Elevation: 1415 mamsl **Coords (LO29): Y:** 81 838 **X:** 2 859 958

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 06
Machine: SUPER ROCK (19 Bar; 800cfm) **Logged:** es **Date:** 05/09/2007
Contractor: H Erwee Drilling **Rest Level:** Dry
Date: 27/08/2007 **Date:** 31/07/09 **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
	0'28"	1		White and brown, highly weathered, **CHERT** fragments in a trace matrix of brown, sandy silt; colluvium.
	0'30"	2		Light grey, weathered and some brown, highly weathered, **CHERT** fragments in a trace matrix of greyish brown, sandy silt; colluvium(?).
	0'26"	3		
	0'29"	4		
	0'24"	5		Brown, light grey and dark grey, weathered to highly weathered, **CHERT** fragments in a minor matrix of light brown, sandy silt; residual dolomite.
	0'22"	6		
	0'26"	7		Greyish brown, weathered, **CHERT** fragments in a trace matrix of brown, sandy silt and trace amounts of brown silt (wad); residual dolomite.
Water added below 8m.	0'28"	8		
	0'23"	9		Dark grey stained brown, weathered, **CHERT** fragments in a trace matrix of dark blackish brown, sandy silt (wad); residual dolomite.
<15	0'25"	10		
	0'27"	11		Grey stained brown and brown, weathered, **CHERT** fragments in a trace matrix of brown, slightly clayey, sandy silt and minor dark brown silt (wad); residual dolomite.
	0'30"	12		
	0'33"	13		
	0'27"	14		Consistent profile of grey stained brown chert in dark brown to chocolate brown clayey silt (wad).
	0'29"	15		
	0'24"	16		
	0'26"	17		
	0'28"	18		
	0'30"	19		
	0'25"	20		
	0'23"	21		
	0'27"	22		
	0'31"	23		
	0'35"	24		
<10	0'37"	25		
	0'51"	26		
	0'55"	27		
	1'50"	28		Dark grey, weathered, **CHERT** fragments and light grey, weathered **DOLOMITE** fragments in a trace matrix of chocolate brown, clayey silt (wad); residual dolomite (samples recovered as slurry).
	0'56"	29		
	0'51"	30		[Interpreted as boulders of dolomite and chert in a waddy soil matrix].

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Collar Elevation: 1415 mamsl **Coords (LO29): Y:** 81 949 **X:** 2 859 926

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 06(Contd.)
Machine: SUPER ROCK (19 Bar; 800cfm) **Logged:** es **Date:** 05/09/2007
Contractor: H Erwee Drilling **Rest Level:**
Date: 27/08/2007 **Date:** **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<10	1'15"	31		Dark grey, weathered, **CHERT** fragments and light grey, weathered **DOLOMITE** fragments in a trace matrix of chocolate brown, clayey silt (wad); residual dolomite (samples recovered as slurry).
	1'10"	32		
	1'56"	33		[Interpreted as boulders of dolomite and chert in a waddy soil matrix].
	3'20"	34		
	0'19"	35		Dark chocolate brown, slightly clayey **SILT** with traces of dark grey, highly weathered, chert fragments, grey, weathered, dolomite fragments and occasional brown, highly weathered, honeycomb, chert fragments and traces of brown silt (wad); residual dolomite (poor sample recovery).
	0'14"	36		
	0'11"	37		
	0'20"	38		
	0'17"	39		
<15	0'14"	40		
	0'10"	41		
	0'25"	42		
	1'17"	43		
	1'01"	44		
	0'30"	45		
	3'18"	46		Interpreted as solid dolomite bedrock below 45m. Samples highly contaminated - recovered as brown slurry with scattered dark grey, chert fragments and occasional light grey, dolomite fragments.
	3'37"	47		
	3'39"	48		
<5	3'41"	49		
	3'43"	50		
	3'45"	51		
EOH				

NOTES:
1) Hole stopped at 51m after penetrating 6m of "assumed" dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled a few days later

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Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 07

Machine: SUPER ROCK (19 Bar; 800cfm) **Logged:** es **Date:** 04/09/2007

Contractor: H Erwee Drilling **Rest Level:** Dry

Date: 22/08/2007 **Date:** 31/08/07 **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<10	0'282"	1		White stained brown, highly weathered, **CHERT** fragments in a trace matrix of slightly sandy, clayey silt; colluvium.
	0'26"	2		
	0'29"	3		Grey to light grey, weathered, **CHERT** fragments in a trace matrix of brown, sandy silt; residual dolomite.
<15	0'25"	4		
	0'20"	5		Grey stained brown, weathered, **CHERT** fragments in a trace matrix of dark chocolate brown, clayey silt (wad); residual dolomite.
0	0'17"	6		No samples recovered between 5m and 7m.
	0'15"	7		
<10	3'17"	8		Light grey stained light brown in places, weathered, hard rock **DOLOMITE**.
	3'30"	9		
	3'27"	10		
	3'25"	11		Intercalated lenses of grey to light grey slightly weathered chert below 11m.
	3'29"	12		
EOH	3'32"	13		

NOTES:

1) Hole stopped at 13m after penetrating 6m of dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled a few days later

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Collar Elevation: 1415 mamsl **Coords (LO29): Y:** 81 750 **X:** 2 859 973

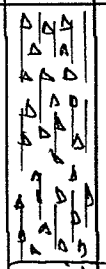
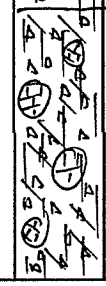
Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 08

Machine: SUPER ROCK (19 Bar; 800cfm) **Logged:** es **Date:** 06/09/2007

Contractor: H Erwee Drilling **Rest Level:** Dry

Date: 27/08/2007 **Date:** 31/08/07 **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<15	0'36"	1 -		White stained brown, highly weathered, **CHERT** fragments in a minor matrix of light brown, sandy silt; colluvium.
	0'33"	2 -		
	0'35"	3 -		
<5	0'39"	4 -		Some fine translucent chert fragments below 3m.
	0'37"	5 -		
<10	0'47"	6 -		Light grey, off white and translucent, weathered, **CHERT** fragments in a trace matrix of brown, silty sand; residual dolomite.
	0'44"	7 -		
Water added below 8m.	0'30"	8 -		
	0'24"	9 -		Dark grey stained dark brown, weathered, solid and brown, highly weathered, honeycomb, **CHERT** fragments in a minor matrix of chocolate brown, clayey silt (wad); residual dolomite (matrix recovered as a slurry).
	0'22"	10 -		
	0'20"	11 -		
	0'27"	12 -		
	0'30"	13 -		
	0'25"	14 -		
<15	0'27"	15 -		Dark and light grey stained brown, weathered, **CHERT** fragments in a trace matrix of brown to chocolate brown, clayey silt (wad); residual dolomite.
	0'23"	16 -		
	0'21"	17 -		
	0'31"	18 -		
	0'28"	19 -		Consistent profile although colour of chert varies from dark grey to translucent.
	0'32"	20 -		
	0'34"	21 -		
<10	0'38"	22 -		
	0'51"	23 -		
	0'53"	24 -		
	0'44"	25 -		
<15	0'54"	26 -		Grey stained brown, weathered, solid and some brown, highly weathered, **CHERT** fragments and traces of grey to light grey, weathered, **DOLOMITE** fragments in a trace matrix of chocolate brown, clayey silt (wad); residual dolomite. (Interpreted as chert and dolomite boulders).
	0'48"	27 -		
	0'57"	28 -		
<10	0'55"	29 -		
	0'49"	30 -		

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Collar Elevation: 1418 mamsl **Coords (LO29): Y:** 81 700 **X:** 2 859 933

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 08(Contd.)
Machine: SUPER ROCK (19 Bar 800cfm) **Logged:** es **Date:** 06/09/2007
Contractor: H Erwee Drilling **Rest Level:**
Date: 27/08/2007 **Date:** **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<15	0'27"	31		Grey stained brown, weathered, solid and some brown, highly weathered, **CHERT** fragments and traces of grey to light grey, weathered, **DOLOMITE** fragments in a trace matrix of chocolate brown, clayey silt (wad); residual dolomite. (Interpreted as chert and dolomite boulders).
	0'30"	32		
	0'32"	33		
	0'41"	34		
<10	0'29"	35		
	0'33"	36		
	0'25"	37		
	1'15"	38		— — — —
	3'20"	39		Interpreted as solid dolomite although samples as above except scattered dark grey, weathered to slightly weathered, dolomite fragments below 38m. (Samples highly contaminated).
	3'28"	40		
<15	3'30"	41		
	3'27"	42		
	3'32"	43		
	3'36"			
EOH		44		

NOTES:
1) Hole stopped at 44m after penetrating 6m of "assumed" dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled a few days later

Prepared by: R.M.S P O Box 32107, GLENSTANTIA 0010 Tel: 012 993 2049 Cell: 082 551 6034

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 09

Machine: SUPER ROCK (19 Bar; 800cfm) **Logged:** es **Date:** 15/06/2007

Contractor: H Erwee Drilling **Rest Level:** Dry

Date: 15/06/2007 **Date:** 19/06/07 **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<15	0'34"	1		White, highly weathered, **CHERT** fragments in a trace matrix of light grey, silty sand; colluvium.
	0'40"	2		White and brown, highly weathered, **CHERT** fragments in a trace matrix of reddish brown, clayey silt; colluvium.
	0'50"	3		
	0'56"	4		Brown and some grey stained brown, weathered, **CHERT** fragments in a trace matrix of reddish brown, sandy silt; residual dolomite?
<10	0'49"	5		
	0'51"	6		
<5	0'32"	7		Brown, slightly sandy **SILT** with scattered fine, quartz grains and black, manganocrete nodules; residual syenite(?).
	0'20"	8		
<10	0'32"	9		Light grey and translucent, weathered, **CHERT** fragments in a trace matrix of reddish brown, slightly sandy, clayey silt; residual dolomite.
	0'40"	10		
	0'37"	11		
	0'54"	12		
	0'33"	13		Grey and translucent, weathered, **CHERT** fragments in a trace matrix of brown, silty sand (some crushed chert); residual dolomite.
	0'46"	14		
	0'34"	15		Grey stained brown, weathered, **CHERT** fragments in a trace matrix of dark brown, sandy silt (wad); residual dolomite.
	0'48"	16		
	0'31"	17		Dark grey, weathered, **CHERT** fragments and some light grey, highly weathered, **SHALE** fragments in a minor matrix of off-white silt; residual dolomite.
	0'52"	18		
	0'38"	19		Grey and some brown, weathered, **CHERT** fragments in a trace matrix of brown to light brown, clayey silt and traces of brown silt (wad); residual dolomite.
	0'42"	20		
	0'51"	21		
	0'44"	22		
	0'48"	23		
	0'39"	24		
	0'41"	25		Grey stained dark brown, weathered, **CHERT** fragments in a trace matrix of brown, clayey silt; residual dolomite.
	0'46"	26		
	0'44"	27		
	0'52"	28		
	0'54"	29		
	0'47"	30		

Prepared by: **R.M.S P O Box 32107, GLENSTANTIA 0010 Tel: 012 993 2049 Cell: 082 551 6034**

Collar Elevation: 1421 mamsl **Coords (LO29): Y:** 81 923 **X:** 2 859 911

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 09(Contd.)
Machine: SUPER ROCK (19 Bar 800cfm) **Logged:** es **Date:** 15/06/2007
Contractor: H Erwee Drilling **Rest Level:**
Date: 15/06/2007 **Date:** **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
Water added below 31m	0'54"	31		Grey stained dark brown, weathered, **CHERT** fragments in a trace matrix of brown, clayey silt; residual dolomite.
<10	0'44"	32		
	0'53"	33		Samples recovered as a slurry below 33m.
	1'07"	34		
	1'12"	35		
	0'54"	36		
<15	0'57"	37		Consistent profile to 45m although decrease in chip recovery with depth.
	0'49"	38		
<10	0'38"	39		
	0'19"	40		
▼ Water strike 40-41m <10	0'10"	41		
	0'08"	42		
	0'29"	43		
<5	0'45"	44		
	0'58"	45		— —
	3'24"	46		Dark grey to black, weathered, **CHERT** fragments in a trace matrix of dark chocolate brown silt (wad); residual dolomite (samples recovered as a slurry - no evidence of dolomite bedrock but dolomite bedrock assumed below 45m).
	3'41"	47		
<15	3'17"	48		
	4'14"	49		
	4'18"	50		
EOH				

NOTES:

1) Hole stopped at 50m after penetrating 6m of "assumed" dolomite bedrock (as requested).

3) Hole dry when backfilled a few days later

4) Samples highly contaminated below water table.

Prepared by: R.M.S P O Box 32107, GLENSTANTIA 0010 Tel: 012 993 2049 Cell: 082 551 6034

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 10

Machine: SUPER ROCK (19 Bar; 800cfm) **Logged:** es **Date:** 28/06/2007

Contractor: H Erwee Drilling **Rest Level:** Dry

Date: 15/06/2007 **Date:** 19/06/07 **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<15	030"	1		White stained brown and light brown, highly weathered, **CHERT** fragments in a trace matrix of brown, silty sand; colluvium.
<25	0'29"	2		Grey, weathered and scattered, white, highly weathered, **CHERT** fragments in a trace matrix of light reddish brown, sandy silt; colluvium(?).
<15	0'36"	3		
	0'40"	4		
	0'27"	5		
	0'49"	6		
	0'30"	7		
	0'15"	8		Grey stained brown, weathered, **CHERT** fragments in a trace matrix of brown, slightly sandy silt and trace amounts of brown silt (wad); residual dolomite.
<10	0'12"	9		
	0'03"	10		No samples recovered below 9m.
	0'06"	11		
	0'04"	12		
	0'03"	13		
0	3'59"	14		Interpreted as solid dolomite below 13m.
	3'41"	15		
	3'20"	16		
	3'49"	17		
EOH				

NOTES:

1) Unable to drill further. Air return via another "old" borehole (possibly BH 4/16).
2) Drilled 4m into solid bedrock.

Prepared by: **R.M.S P O Box 32107, GLENSTANTIA 0010 Tel: 012 993 2049 Cell: 082 551 6034**

Collar Elevation: 1422 mamsl **Coords: Y:** 81 894 **X:** 2 859 885

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 11
Machine: SUPER ROCK (19 Bar; 800cfm) **Logged:** es **Date:** 22/06/2007
Contractor: H Erwee Drilling **Rest Level:** Dry
Date: 14/06/2007 **Date:** 19/06/07 **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<10	0'29"	1 -		White, highly weathered, **CHERT** fragments and subordinate dark brown, manganocrete nodules in a minor matrix of light brown, sandy silt; colluvium.
	0'44"	2 -		Some light grey weathered chert fragments below 1m.
	0'30"	3 -		
	0'29"	4 -		Grey and some translucent, weathered, **CHERT** fragments in a trace matrix of light brown, sandy silt; colluvium(?).
	0'21"	5 -		Matrix dark reddish brown below 5m.
<15	0'35"	6 -		
	0'50"	7 -		Grey, weathered, **CHERT** fragments in a trace matrix of brown, sandy silt; residual dolomite(?).
<10	0'40"	8 -		
	0'34"	9 -		Grey stained brown, weathered, **CHERT** fragments in a trace matrix of brown, slightly clayey, sandy silt; residual dolomite.
<15	0'39"	10 -		
	0'27"	11 -		
	0'20"	12 -		Traces of waddy silt below 12m.
	0'15"	13 -		
0	0'06"	14 -		No samples recovered between 13m and 15m.
	0'28"	15 -		
<10	3'18"	16 -		Grey to light grey, weathered, fractured(?), hard rock **DOLOMITE** with lenses of dark grey, weathered chert.
	3'41"	17 -		
<5	2'46"	18 -		
0	0'09"	19 -		No samples recovered below 18m.
	0'36"	20 -		
	1'03"	21 -		
	1'21"	22 -		
	0'16"	23 -		
	0'55"	24 -		
	0'39"	25 -		
	1'03"	26 -		
	1'16"	27 -		
	1'56"	28 -		
	1'42"	29 -		
	3'09"	30 -		Interpreted as lens of solid dolomite between 29m and 30m.

Prepared by: **R.M.S P O Box 32107, GLENSTANTIA 0010 Tel: 012 993 2049 Cell: 082 551 6034**

Collar Elevation: 1423 mamsl **Coords (LO29): Y:** 81 850 **X:** 2 859 865

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 11(Contd.)
Machine: SUPER ROCK (19 Bar; 800cfm) **Logged:** es **Date:** 22/06/2007
Contractor: H Erwee Drilling **Rest Level:**
Date: 14/06/2007 **Date:** **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
	1'32"	31		No samples recovered below 18m
	1'01"	32		
	0'31"	33		
	4'13"	34		Interpreted as solid dolomite between 33m.
0	3'49"	35		
	3'56"	36		
	3'55"	37		
	3'10"	38		
	3'51"	39		
EOH				

NOTES:
1) Hole stopped at 39m after penetrating 6m of "assumed" dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled a few days later

Prepared by: R.M.S P O Box 32107, GLENSTANTIA 0010 Tel: 012 993 2049 Cell: 082 551 6034

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 12

Machine: SUPER ROCK (19 Bar; 800cfm) **Logged:** es **Date:** 28/06/2007

Contractor: H Erwee Drilling **Rest Level:** Dry

Date: 14 /06/2007 **Date:** 19/06/07 **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<15	0'22"	1		White stained brown, highly weathered, **CHERT** fragments in a trace matrix of reddish brown, sandy silt; colluvium.
<5	1'26"	2		Grey stained brown, weathered, **CHERT** fragments in a minor matrix of reddish brown, slightly clayey silt; colluvium(?).
	1'29"	3		
	1'13"	4		Dark grey, weathered, **CHERT** fragments in a trace matrix of reddish brown, silty sand and some crushed chert ; colluvium(?).
	1'18"	5		
	1'25"	6		
	1'59"	7		
	1'48"	8		
<10	1'34"	9		Reddish brown to brown, slightly clayey, **SILT** with scattered grey, weathered, chert fragments; residual syenite(?) (Samples slightly contaminated).
	2'13"	10		
	1'26"	11		
	1'10"	12		
	1'12"	13		
	1'15"	14		Beige, grey and translucent, weathered, **CHERT** fragments in a trace matrix of reddish brown to brown, clayey silt; residual dolomite.
<15	1'24"	15		
	1'12"	16		
	1'15"	17		
<10	1'37"	18		
	0'36"	19		Dark brown, silty **CLAY** with traces of dark brown clay (wad) and dark grey stained dark brown, weathered to highly weathered, chert fragments; residual dolomite.
	0'19"	20		
<15	0'24"	21		
	0'34"	22		
	0'46"	23		Grey, dark grey and translucent, weathered, **CHERT** fragments in a minor matrix of dark brown, clayey silt (wad); residual dolomite.
	0'39"	24		
	0'36"	25		
<10	0'22"	26		
	0'59"	27		
	1'01"	28		Consistent profile to 37m.
	1'16"	29		
	1'22"	30		

Prepared by: **R.M.S P O Box 32107, GLENSTANTIA 0010 Tel: 012 993 2049 Cell: 082 551 6034**

Collar Elevation: 1422 mamsl **Coords (LO29): Y:** 81 783 **X:** 2 859 877

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 12(Contd.)
Machine: SUPER ROCK (19 Bar; 800cfm) **Logged:** es **Date:** 28/06/2007
Contractor: H Erwee Drilling **Rest Level:**
Date: 14/06/2007 **Date:** **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<15	0'36"	31 -		Grey, dark grey and translucent, weathered, **CHERT** fragments in a minor matrix of dark brown, clayey silt (wad); residual dolomite.
	0'44"	32 -		Some honeycomb chert below 31m.
	0'39"	33 -		
	1'20"	34 -		
	0'20"	35 -		
	0'10"	36 -		
	0'08"	37 -		
0	0'06"	38 -		No samples recovered below 37m.
	0'34"	39 -		
	0'20"	40 -		
	0'26"	41 -		
	0'10"	42 -		
	0'09"	43 -		
	0'05"	44 -		
	0'05"	45 -		
	0'09"	46 -		
	0'15"	47 -		
	0'18"	48 -		
	0'05"	49 -		
	4'18"	50 -		Interpreted as solid dolomite below 49m.
	3'59"	51 -		
	3'39"	52 -		
	4'16"	53 -		
	4'12"	54 -		
EOH	4'39"	55 -		
		-		**NOTES:**
		-		1) Hole stopped at 55m after penetrating 6m of "assumed" dolomite bedrock (as requested).
		-		2) Ground water not encountered during drilling operations.
		-		3) Hole dry when backfilled a few days later
		-		

Prepared by: R.M.S P O Box 32107, GLENSTANTIA 0010 Tel: 012 993 2049 Cell: 082 551 6034

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH231 & 232). **Hole No.** 13
Machine: THOR (16 Bar; 800cfm) **Logged:** es **Date:** 03/09/2007
Contractor: H Erwee Drilling **Rest Level:** Dry
Date: 01/08/2007 **Date:** 13/08/07 **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<10	0'39"	1		White highly, weathered and grey, weathered, **CHERT** fragments in a trace matrix of greyish brown, silty sand; colluvium.
<15	0'44"	2		White, highly weathered, **CHERT** fragments in a trace matrix of brown, silty sand; colluvium.
	0'39"	3		Dark brown, clayey **SILT** with traces of white, highly weathered, chert fragments and traces of dark brown silt (wad); residual dolomite.
	0'16"	4		Grey, weathered, **CHERT** fragments in a trace matrix of dark brown, clayey silt and minute traces of brown silt (wad); residual dolomite.
	0'20"	5		Dark brown speckled red, silty **CLAY** with traces of dark brown clay (wad) and grey, weathered, chert fragments; residual dolomite.
	2'08"	6		Dark grey and grey, weathered, **CHERT** and some siliceous, shale fragments in a trace matrix of greyish, brown silt; residual dolomite (possibly breccia?).
	3'18"	7		Brown and grey stained brown, weathered, **CHERT** fragments in a minor matrix of brown, slightly clayey silt; residual dolomite.
	1'03"	8		
<10	1'10"	9		
	1'15"	10		
	1'16"	11		
	1'10"	12		Some shaly chert below 12m.
	1'50"	13		
	1'22"	14		
	1'19"	15		Dark grey stained dark brown, weathered, **CHERT** fragments in a trace matrix of brown, clayey silt and traces of brown silt (wad); residual dolomite.
	1'01"	16		
	1'07"	17		Consistent profile to 31m.
	1'12"	18		
	0'39"	19		
	0'42"	20		
	0'53"	21		
<15	1'03"	22		
	1'15"	23		
	1'03"	24		
	1'10"	25		
	1'03"	26		
	1'10"	27		
	1'03"	28		
	1'10"	29		
	1'16"	30		

Prepared by: R.M.S P O Box 32107, GLENSTANTIA 0010 Tel: 012 993 2049 Cell: 082 551 6034

Collar Elevation: 1421 mamsl **Coords (LO29): Y:** 81 886 **X:** 2 859 906

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 13(Contd.)
Machine: THOR (16 Bar; 800cfm) **Logged:** es **Date:** 03/09/2007
Contractor: H Erwee Drilling **Rest Level:**
Date: 01/08/2007 **Date:** **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
	0'25"	31 -		Interpreted as solid dolomite below 31m.
	3'01"	32 -		
	3'36"	33 -		Grey, weathered, hard rock **DOLOMITE** with grey, weathered, chert fragments in a trace matrix of dark brown silt (wad). (Interpreted as solid bedrock).
<10	3'58"	34 -		
	3'42"	35 -		
	3'39"	36 -		
	3'42"	37 -		
EOH		-		

NOTES:
1) Hole stopped at 37m after penetrating 6m of solid dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled a few days later.

Prepared by: R.M.S P O Box 32107, GLENSTANTIA 0010 Tel: 012 993 2049 Cell: 082 551 6034

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 14

Machine: THOR (16 Bar; 800cfm) **Logged:** es **Date:** 21/08/2007

Contractor: H Erwee Drilling **Rest Level:** Dry

Date: 01/08/2007 **Date:** 13/08/07 **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<10	0'29"	1		Brown, sandy **SILT** with abundant, brown, manganocrete nodules and white, highly weathered, chert fragments; colluvium.
	0'37"	2		White, highly weathered and grey, weathered, **CHERT** fragments in a minor matrix of light brown silt; colluvium.
	0'49"	3		Beige and brown, weathered to highly weathered, **CHERT** fragments in a trace matrix of reddish brown, slightly clayey silt; colluvium(?).
	0'52"	4		
	0'42"	5		
<15	1'03"	6		Grey to dark grey, weathered, **CHERT** fragments in a trace matrix of reddish brown, clayey silt; residual dolomite.
	1'43"	7		
	0'27"	8		
	0'18"	9		
	0'10"	10		No samples recovered below 9m.
	0'09"	11		
	0'15"	12		Interpreted as solid dolomite below 12m.
	4'18"	13		
	3'40"	14		
	2'56"	15		
0	0'29"	16		Probably fracture zone within bedrock between 15m and 16m.
	3'42"	17		
	3'56"	18		
	3'49"	19		
	4'16"	20		
	3'56"	21		
	3'56"	22		
EOH				

NOTES:

1) Hole stopped at 22m after penetrating 6m of "assumed" dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled a few days later.

Prepared by: R.M.S P O Box 32107, GLENSTANTIA 0010 Tel: 012 993 2049 Cell: 082 551 6034

Collar Elevation: 1423 mamsl **Coords (LO29): Y:** 81 899 **X:** 2 859 844

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 15

Machine: THOR (16 Bar; 800cfm) **Logged:** es **Date:** 21/08/2007

Contractor: H Erwee Drilling **Rest Level:** Dry

Date: 01/08/2007 **Date:** 13/08/07 **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<20 Water added between 2m & 4m	0'25"	1		White, highly weathered, **CHERT** fragments in a trace matrix of brown, silty sand; colluvium.
	0'31"	2		White, highly weathered, grey and light grey, weathered, **CHERT** fragments in a trace matrix of brown, clayey silt; residual dolomite.
<15	0'42"	3		
	0'56"	4		
	3'56"	5		Light grey, weathered, hard rock **DOLOMITE** with lenses of grey to dark grey, slightly weathered chert.
	3'37"	6		
	4'03"	7		
<10	3'18"	8		Dark grey dolomite between 7m and 8m.
	3'55"	9		
	3'49"	10		
EOH				

NOTES:

1) Hole stopped at 10m after penetrating 6m of solid dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled a few days later

Prepared by: R.M.S P O Box 32107, GLENSTANTIA 0010 Tel: 012 993 2049 Cell: 082 551 6034

Collar Elevation: 1423 mamsl **Coords (LO29): Y:** 81 878 **X:** 2 859 869

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 16

Machine: THOR (16 Bar; 800cfm) **Logged:** es **Date:** 03/09/2007

Contractor: H Erwee Drilling **Rest Level:** Dry

Date: 01/08/2007 **Date:** 13/08/07 **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<10	0'18"	1		White, highly weathered, **CHERT** fragments in a trace matrix of light brown, silty sand; colluvium.
<20	0'16"	2		Grey, weathered, **CHERT** fragments in a trace matrix of brown, silty sand; colluvium.
Water added below 3m. <15	0'14"	3		Grey stained dark brown, weathered and some white, highly weathered, **CHERT** fragments in a trace matrix of brown, clayey silt; residual dolomite(?).
	0'16"	4		
	0'10"	5		
	0'29"	6		
<10	0'36"	7		
	0'18"	8		Grey, weathered to highly weathered, **CHERT** fragments in a trace matrix of brown to dark brown, sandy silt and traces of dark brown silt (wad); residual dolomite,
	0'21"	9		
	0'15"	10		
	0'09"	11		
	0'07"	12		Consistent profile to 15m.
<15	0'12"	13		
	0'14"	14		
	0'08"	15		
	0'08"	16		No samples recovered between 15m and 20m.
	0'10"	17		
0	0'20"	18		
	0'36"	19		
	0'34"	20		
<10	3'44"	21		Grey, weathered to highly weathered, **CHERT** fragments in a trace matrix of brown to dark brown, sandy silt and traces of dark brown silt (wad); residual dolomite,
	3'55"	22		No samples recovered below 21m. Interpreted as solid dolomite below 21m.
	3'18"	23		
0	3'42"	23		
	3'18"	25		
	3'16"	26		
EOH				

NOTES:

1) Hole stopped at 26m after penetrating 6m of "assumed" dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled a few days later

Prepared by: **R.M.S P O Box 32107, GLENSTANTIA 0010 Tel: 012 993 2049 Cell: 082 551 6034**

Collar Elevation: 1422 mamsl **Coords (LO29): Y:** 81 852 **X:** 2 859 889

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 17

Machine: SUPER ROCK (19 Bar; 800cfm) **Logged:** es **Date:** 01/09/2007

Contractor: H Erwee Drilling **Rest Level:** Dry

Date: 01/08/2007 **Date:** 13/08/07 **Job No:** 07151Lah231

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
	3'17"	1		Grey to light grey, weathered, hard rock **DOLOMITE** with scattered brown, clayey wad.
	3'27"	2		
<10	0'59"	3		Grey and brown, weathered, **DOLOMITE** and some grey, weathered, **CHERT** fragments in a trace matrix of dark brown, clayey silt (wad); residual dolomite. (Interpreted as fracture zone within bedrock)
	0'53"	4		
	3'19"	5		Light grey to grey, weathered to slightly weathered, hard rock **DOLOMITE** with scattered lenses of grey and dark grey, slightly weathered chert.
	3'26"	6		
<15	3'32"	7		
	3'30"	8		
	3'33"	9		
<10	3'37"	10		
EOH				

NOTES:

1) Hole stopped at 10m after penetrating 6m of solid dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled a few days later

Prepared by: R.M.S P O Box 32107, GLENSTANTIA 0010 Tel: 012 993 2049 Cell: 082 551 6034

Collar Elevation: 1423 mamsl **Coords (LO29): Y:** 81 772 **X:** 2 859 830

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 18

Machine: SUPER ROCK (19 Bar; 800cfm) **Logged:** es **Date:** 03/09/2007

Contractor: H Erwee Drilling **Rest Level:** Dry

Date: 24/08/2007 **Date:** 30/08/07 **Job No:** 07151Lah231

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<15	0'19"	1		Grey and translucent, weathered, **CHERT** fragments in a trace matrix of brown, sandy silt; colluvium.
<5	0'24"	2		Brown to dark brown, clayey **SILT** with occasional fine, white and translucent, highly weathered, chert fragments; colluvium(?).
	0'22"	3		
	0'28"	4		Translucent and light grey, weathered, **CHERT** fragments in a trace matrix of brown, slightly clayey, sandy silt; residual dolomite(?).
	0'26"	5		
<10	0'24"	6		
	0'29"	7		
	0'36"	8		Grey and translucent, weathered and brown, highly weathered, **CHERT** fragments in a trace matrix of dark brown, sandy silt (wad); residual dolomite. Some light grey highly weathered "shaly" chert between 9m and 10m.
	0'48"	9		
	0'27"	10		
<15	0'33"	11		
	2'52"	12		Grey to light grey, weathered, hard rock **DOLOMITE**.
	3'19"	13		
	3'29"	14		
	0'44"	15		Dark grey, light grey and brown, weathered to highly weathered, **CHERT** fragments in a trace matrix of brown, silty sand; residual dolomite.
<10	0'30"	16		
	0'25"	17		
	0'17"	18		No samples recovered between 17m and 21m..
	0'09"	19		
0	0'07"	20		
	0'12"	21		
	1'06"	22		Dark grey, weathered, **CHERT** fragments and subordinate grey, weathered, **DOLOMITE** fragments in a trace matrix of brown silt (wad); residual dolomite. (Interpreted as solid dolomite below 22m - samples highly contaminated).
	3'20"	23		
	3'25"	24		
<15	3'20"	25		Grey, weathered, hard rock **DOLOMITE** and light and dark grey, weathered, **CHERT** fragments in a trace matrix of brown, sandy silt. (Interpreted as solid dolomite - samples slightly contaminated below 25m).
	3'33"	26		
	3'31"	27		
	3'35"	28		**NOTES:**
EOH				1) Hole stopped at 28m after penetrating 6m of solid dolomite bedrock (as requested).
				2) Ground water not encountered during drilling operations.
				3) Hole dry when backfilled a few days later

Prepared by: **R.M.S P O Box 32107, GLENSTANTIA 0010 Tel: 012 993 2049 Cell: 082 551 6034**

Collar Elevation: 1422 mamsl **Coords (LO29): Y:** 81 730 **X:** 2 859 865

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 19

Machine: SUPER ROCK (19 Bar; 800cfm) **Logged:** es **Date:** 03/09/2007

Contractor: H Erwee Drilling **Rest Level:** Dry

Date: 24/08/2007 **Date:** 30/08/07 **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<10	0'30"	1 -		Light grey, weathered and white, highly weathered, **CHERT** fragments in a trace matrix of light brown, silty sand; colluvium.
<15	0'44"	2 -		
<10	0'55"	3 -		
	1'11"	4 -		Dark brown, slightly clayey, sandy **SILT** with occasional fine, chert and manganocrete nodules and traces of brown silt (wad); residual dolomite.
	1'32"	5 -		
<5	1'29"	6 -		
	1'33"	7 -		
	0'32"	8 -		
	0'50"	9 -		Grey and greyish brown, weathered, solid and brown, highly weathered, honeycomb, **CHERT** fragments in a trace matrix of dark brown, slightly clayey, sandy silt and trace amounts of brown silt (wad); residual dolomite.
	0'27"	10 -		
	0'24"	11 -		
<15 Water added below 13m	0'19"	12 -		
	0'17"	13 -		Some matrix lost below 13m.
	0'43"	14 -		
	0'20"	15 -		
	0'12"	16 -		No samples recovered between 15m and 40m.
	0'10"	17 -		
	0'20"	18 -		
	0'24"	19 -		
	0'24"	20 -		
	0'22"	21 -		
	0'31"	22 -		
0	0'34"	23 -		
	0'37"	24 -		
	0'41"	25 -		
	0'44"	26 -		
	0'50"	27 -		
	0'55"	28 -		
	0'20"	29 -		
	0'28"	30 -		

Prepared by: R.M.S P O Box 32107, GLENSTANTIA 0010 Tel: 012 993 2049 Cell: 082 551 6034

Collar Elevation: 1419 mamsl **Coords (LO29): Y:** 81 652 **X:** 2 859 914

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232) **Hole No.** 19(Contd.)
Machine: SUPER ROCK (19 Bar 800cfm) **Logged:** es **Date:** 03/09/2007
Contractor: H Erwee Drilling **Rest Level:**
Date: 24/08/2007 **Date:** **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
0	0'52"	31 -		No samples recovered between 15m and 40m.
	0'34"	32 -		
	0'21"	33 -		
	0'58"	34 -		
	0'22"	35 -		
	0'19"	36 -		
	1'25"	37 -		
	0'52"	38 -		
	0'55"	39 -		
	0'57"	40 -		
<10	1'30"	41 -		Dark brown, silty **CLAY (WAD)** with scattered grey, weathered, chert fragments and occasional grey, weathered, dolomite fragments; residual dolomite. Interpreted as solid bedrock below 41m - samples highly contaminated (recovered as a dark brown slurry).
	3'35"	42 -		
	3'33"	43 -		
	3'30"	44 -		
	3'34"	45 -		
	3'36"	46 -		
EOH	3'38"	47 -		

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Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 20

Machine: SUPER ROCK (19 Bar; 800cfm) **Logged:** es **Date:** 06/09/2007

Contractor: H Erwee Drilling **Rest Level:** Dry

Date: 27/08/2007 **Date:** 30/08/07 **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<15	0'24"	1		White stained brown, highly weathered, **CHERT** and subordinate brown, manganocrete nodules in a minor matrix of light brown, sandy silt; colluvium.
	0'26"	2		
	0'31"	3		
<5	0'35"	4		Brown to dark brown, slightly clayey, sandy **SILT** with traces of fine, dark brown, manganocrete nodules and occasional light grey, weathered chert fragments below 6m; residual dolomite(?).
	0'23"	5		
	0'25"	6		
	0'21"	7		
<10 Water added 10m to 12m	0'19"	8		Grey stained brown and brown, weathered to highly weathered, **CHERT** fragments in a trace matrix of dark brown, sandy silt and traces of dark brown silt (wad); residual dolomite.
	0'17"	9		
	0'20"	10		
	0'24"	11		
	0'27"	12		Dark grey, weathered, **CHERT** fragments in a trace matrix of dark brown, sandy silt and dark brown silt (wad); residual dolomite.
	1'22"	13		Light grey, weathered, hard rock **DOLOMITE** with lenses of grey, slightly weathered chert. (Interpreted as dolomite boulder).
	3'29"	14		
Water added below 16m.	0'56"	15		Dark grey stained dark brown, weathered, **CHERT** fragments and scattered, light grey dolomite fragments (possible contamination from above); residual dolomite.
	0'40"	16		
	0'22"	17		
	0'25"	18		
	0'26"	19		
<15	0'23"	20		Grey, weathered **CHERT** fragments in a trace matrix of dark chocolate brown, clayey silt (wad); residual dolomite.
	0'20"	21		
	0'39"	22		
	0'42"	23		
	0'50"	24		
	0'48"	25		
	0'44"	26		Some beige and translucent weathered chert fragments below 25m.
	0'52"	27		
	0'55"	28		
	0'53"	29		Grey and translucent, weathered, **CHERT** fragments and light grey stained (weathered) light brown, weathered, **DOLOMITE** fragments in a trace matrix of chocolate brown, clayey silt (wad); residual dolomite (interpreted as discrete dolomite boulders).
	0'33"	30		

Prepared by: **R.M.S P O Box 32107, GLENSTANTIA 0010 Tel: 012 993 2049 Cell: 082 551 6034**

Collar Elevation: 1420 mamsl **Coords (LO29): Y:** 81 703 **X:** 2 859 914

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 20(Contd.)
Machine: SUPER ROCK (19 Bar; 800cfm) **Logged:** es **Date:** 06/09/2007
Contractor: H Erwee Drilling **Rest Level:**
Date: 27/08/2007 **Date:** **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
	0'29"	31		Grey and translucent, weathered, **CHERT** fragments and light grey stained (weathered) light brown, weathered, **DOLOMITE** fragments in a trace matrix of chocolate brown, clayey silt (wad); residual dolomite (interpreted as discrete dolomite boulders).
	0'56"	32		
	1'17"	33		Beige, light grey and some pink, weathered to highly weathered, **DOLOMITE** fragments in a trace matrix of chocolate brown silt (wad); residual dolomite. (Interpreted as solid dolomite - samples highly contaminated).
	3'25"	34		
	0'54"	35		Zone of very closely fractured bedrock(?) between 34m and 36m. (No change in sample composition).
<15	0'59"	36		
	3'10"	37		Beige, light grey sand some pink, weathered to highly weathered, **DOLOMITE** fragments in a trace matrix of chocolate brown silt (wad); residual dolomite. (Interpreted as solid dolomite bedrock below 36m).
	3'27"	38		
	3'29"	39		
	3'32"	40		
	3'30"	41		
EOH	3'33"	42		

NOTES:
1) Hole stopped at 42m after penetrating 6m of "assumed" dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled a few days later

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Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 21

Machine: SUPER ROCK (19 Bar 800cfm) **Logged:** es **Date:** 03/09/2007

Contractor: H Erwee Drilling **Rest Level:** Dry

Date: 24/08/2007 **Date:** 30/08/07 **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<10	0'29"	1 -		White stained brown, highly weathered, **CHERT** fragments in a minor matrix of light brown, sandy silt; colluvium. Some grey chert fragments below 1m.
	0'41"	2 -		
	0'46"	3 -		Dark grey and grey, weathered, **CHERT** fragments in a trace matrix of brown, sandy silt; colluvium?
<5	0'50"	4 -		Dark brown, slightly clayey, sandy **SILT** with traces of grey, weathered, chert fragments and some fine, manganocrete nodules; residual dolomite(?).
	0'54"	5 -		
<10	0'56"	6 -		
	0'58"	7 -		Dark grey, weathered, solid and occasional highly weathered, honeycomb, **CHERT** fragments and some grey, "shaly", **CHERT** fragments in a minor matrix of brown, sandy silt; residual dolomite. Trace amounts of brown silt (wad) below 8m.
	0'44"	8 -		
	0'42"	9 -		
Water added below 10m	0'25"	10 -		Dark grey, weathered, solid and brown, highly weathered, honeycomb, **CHERT** fragments in a trace matrix of brown, "powdery" silt and traces of dark brown silt (wad); residual dolomite.
	0'20"	11 -		
	0'18"	12 -		
	0'27"	13 -		
<15	0'49"	14 -		Grey and dark grey, weathered, **CHERT** fragments in a trace matrix of brown, clayey silt and traces of brown silt (wad); residual dolomite. (Some matrix lost because of addition of water to facilitate sample recovery).
	0'52"	15 -		
	0'44"	16 -		
	0'48"	17 -		
	0'40"	18 -		
	0'46"	19 -		
	0'53"	20 -		
	0'51"	21 -		
	0'43"	22 -		Consistent profile of grey, weathered chert in a chocolate brown slurry below 21m.
	0'40"	23 -		
	0'45"	24 -		
	0'43"	25 -		
	0'47"	26 -		
	0'50"	27 -		
	0'56"	28 -		
	0'47"	29 -		
	0'53"	30 -		

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Collar Elevation: 1420 mamsl **Coords (LO29): Y:** 81 797 **X:** 2 859 927

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 21(Contd.)
Machine: SUPER ROCK (19 Bar 800cfm) **Logged:** es **Date:** 03/09/2007
Contractor: H Erwee Drilling **Rest Level:**
Date: 24/08/2007 **Date:** **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
	0'48"	31		
	3'16"	32		Grey and light grey, weathered, hard rock, **DOLOMITE** fragments and grey, weathered, **CHERT** fragments in a trace matrix of dark brown silt; residual dolomite. (Interpreted as solid dolomite - samples highly contaminated).
	3'20"	33		
<15	3'27"	34		Samples recovered as slurry.
	3'30"	35		
	3'32"	36		
	3'34"	37		
EOH				

NOTES:
1) Hole stopped at 37m after penetrating 6m of "assumed" dolomite bedrock (as requested).
2) Ground water not encountered during drilling operations.
3) Hole dry when backfilled a few days later.

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Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 22

Machine: SUPER ROCK (19 Bar 800cfm) **Logged:** es **Date:** 04/09/2007

Contractor: H Erwee Drilling **Rest Level:** Dry

Date: 24/08/2007 **Date:** 30/08/07 **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<15	0'23"	1		White, highly weathered and some light grey, weathered, **CHERT** fragments in a minor matrix of brown, sandy silt; colluvium.
	0'38"	2		
	0'40"	3		Light brown and translucent, weathered, **CHERT** fragments in a trace matrix of brown, sandy silt; colluvium.
	0'46"	4		
<10	0'51"	5		Translucent, grey and some brown, weathered, **CHERT** fragments in a trace matrix of brown, sandy silt; colluvium(?).
	0'47"	6		
	0'39"	7		Dark brown, slightly sandy, clayey **SILT** with traces of brown and some grey, weathered to highly weathered, chert fragments and traces of dark brown silt (wad); residual dolomite.
	0'56"	8		
<5	0'54"	9		
	0'50"	10		Grey to dark grey, weathered, **CHERT** fragments in a trace matrix of brown, sandy silt and trace amounts of brown silt (wad); residual dolomite.
<10	0'33"	11		
	0'30"	12		
	0'35"	13		
	0'25"	14		Consistent profile to 19m.
<15	0'27"	15		
	0'29"	16		
	0'41"	17		
	0'37"	18		
<10	0'45"	19		
	0'34"	20		Becoming darker in colour below 19m. Slight increase in brown silt (wad) content.
Water added below 21m.	0'39"	21		
	0'28"	22		Dark grey, grey and translucent, weathered, **CHERT** fragments in a minor matrix of chocolate brown, clayey silt (wad); residual dolomite.
<15	0'31"	23		Some scattered brown, highly weathered, honeycomb, chert fragments below 22m.
	1'15"	24		
	1'22"	25		
<10	1'25"	26		
	1'16"	27		
<15	0'57"	28		
	0'55"	29		
<10	0'48"	30		
	0'52"			

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Collar Elevation: 1420 mamsl **Coords (LO29): Y:** 81 737 **X:** 2 859 916

Borehole Profile

Project: DIE HOEWES EXT 163 (LAH 231 & 232). **Hole No.** 22(Contd.)
Machine: SUPER ROCK (19 Bar; 800cfm) **Logged:** es **Date:** 04/09/2007
Contractor: H Erwee Drilling **Rest Level:**
Date: 24/08/2007 **Date:** **Job No:** 07151Lah163

Chip Size(mm)	Pen. Speed	Depth (m)	Profile	Description
<10	0'52" 1'20" 0'41"	31 - 32 - 33 -		Dark grey, grey and translucent, weathered, **CHERT** fragments in a minor matrix of chocolate brown, clayey silt (wad); residual dolomite. Some scattered brown, highly weathered, honeycomb, chert fragments below 22m.
0	1'27" 3'28" 3'25" 3'30" 3'32" 3'34" 3'36"	34 - 35 - 36 - 37 - 38 - 39 - 40 -		No samples below 33m. Interpreted as solid dolomite below 34m.
EOH				**NOTES:** 1) Hole stopped at 40m after penetrating 6m of "assumed" dolomite bedrock (as requested). 2) Ground water not encountered during drilling operations. 3) Hole dry when backfilled a few days later

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GENERAL PRECAUTIONARY MEASURES

General measures to be implemented on all dolomitic sites (minimum requirements - NHBRC Standards)

1. Wet services of entire development and individual stands

a. All wet services should be of good quality in order to ensure low maintenance.

b. Piping materials selected should also be appropriate to local subsurface conditions. If clay pipes are utilized in areas of shallow dolomite, a higher standard of pipe bedding is recommended e.g. stabilized bedding or over-excavation and re-compaction with an approved material (minimum specification to be G7 material) in layers of 150 mm thickness, compacted to 93% mod AASHTO. Some soils may have low pH values, which will render the use of ferrous material for underground services unsuitable. Chapter II in 'A Technical Guide to Good House Construction' NBRI of the CSIR (July 1984) should be consulted concerning the potential corrosion of pipes.

c. The NHBRC[1] makes the following recommendations: Water piping materials shall be one or more of the following:

* High impact PVC pipes with vitualic joints.
* Other flexible (as defined in SABS 0102, Part 1) water pipes with flexible, self anchoring connections.

Pipes having a diameter of less than 75 mm.

* HDPE type IV.
* Polypropylene.

Pipes should be flexible, while joints should be minimised.

d. Water pipes entering buildings should either be fitted with flexible couplings or kinked with a Z to allow opportunity for relative movement. A flexible connection at the junction with all outlet pipes should be used, which includes WC pan connections.

e. Pressure release systems tend to leak after a couple of years. This leaking water must flow directly into the storm- or sewerage water system.

f. Water reticulation to houses should be kept at a minimum depth of 500 mm up to the structure and above ground wherever possible along the structure.

g. As many services as possible should be placed within a single trench.

h. Encasement of pipes in concrete or soilcrete should be avoided. Preferably place pipes in sleeves. If this cannot be achieved, care must be taken to ensure that differential movement can still be accommodated without the pipe breaking.

i. All storm water, sewerage and water pipes and channels must be watertight. All laid wet services should be tested for leakage on installation using the air test (see NBRI Info Sheet X/BOU 2-34) for water pipes, and the water test for sewerage pipes.

[1] *1 National Home Builders Registration Council*

j. Placement of wet services below the footprint of structures must be avoided. No plumbing and drainage pipes should be placed under floor slabs, as far as practicable. Where this situation is unavoidable, reasons must be cited and the pipes must be placed in a sleeve to permit monitoring.

k. Where practical, pipes running parallel to structures should be kept at a distance of at least 5 m from the structure.

l. Each stand should have a rodding-eye or some similar access to the sewer connection in addition to the inspection eye.

m. Each stand/unit should have a water meter at a suitable location so that testing of the stand/unit specific water supply is possible. Water leakage testing must be undertaken regularly, as set out in the risk management system.

n The roots of trees planted in close proximity to the line of water-bearing services often cause leaks in or malfunctioning of the services. Care should therefore be taken to avoid the unfortunate positioning of trees and other plants.

o. Residents should be informed of where services traverse their garden so that accidental puncturing of pipes can be avoided.

2. Entire development

a. The design of wet services should be governed by the need to create low maintenance systems. Wherever possible keep services above ground to facilitate detection of leaks, maintenance and repair.

b. The stability of the centre-line of all bulk water services should be considered.

c. Piping used in mains and communication pipes should be flexible, while joints should be minimised and, where required, self anchoring type (i.e. not reliant on thrust blocks for their anchorage at fittings, except at valves and end caps).

d. The relevant provision of SABS 1200 DB, L, LB, LC, LD and LE shall be observed in the installation of all underground services.

e. Water mains shall be laid only in road reserves.

f. Provision for future connections shall be made in order to minimise the cutting into pipes to provide such connections.

g. Water pipe entries into the building shall be in accordance with those of the JSD's code of practice [2].

h. The use of pre-manufactured, unjointed manholes are preferred. The manhole should be placed on a properly prepared foundation.

i. Use flexible couplings on either side of manholes.

j. Water-borne sewerage reticulation must be installed. French drains are unacceptable.

k. A detailed sanitation and water reticulation plan should be drawn up for the development

[2] *JSD Code of Practice reference*

according to the local geological setting and engineering geological characteristics. The plan must be incorporated into the services management system of the local authority.

3. Storm water drainage

a. No accumulation of surface water is to be permitted and the entire development must be properly drained.

b. A minimum gradient of 1:150 should be maintained along storm-water systems.

c. Brick and pre-cast concrete walls must be so designed as to provide drainage ports at ground level permitting passage of maximum probable volumes of water.

d. When courtyards are designed the free flow of surface water should be ensured. Where gutter downpipes are to be found in such a courtyard, a lined canal should permit passage of water into a drain or onto the lawn away from the structure. The courtyard should preferably be paved and no garden beds should be created at gutter discharge points. Lawns must be graded in such a way to facilitate drainage.

e. In order to deal with rainwater run-off from the roofs of structures the following is recommended:

- Down-pipes should discharge into a lined or pre-cast furrow. This furrow should remove the water from the structure. The storm water should be trained, without ponding, off the property and into the municipal storm water system.
- If no guttering is to be utilized (not recommended), then a sealed surface with a width of 1,5m should be cast along those walls of the structure where water will be discharged from the roof. Roof water will cascade off this sloping roof onto the apron into a lined or pre-cast furrow. The storm water should be drained, without ponding, off the property and into the municipal storm water system.
- The ground immediately against the buildings shall be shaped to fall in excess of 75 mm over the first 1,5 m beyond the perimeter of the building, from where it shall drain freely away from housing units. Apron slabs, where provided, shall have the same fall.

f. All ponds, watercourses and road surfaces shall be rendered impervious.

g. No trees shall be planted within 1,5 times their eventual height from the line of storm water services.

h. The storm water drainage system shall incorporate measures to ensure water tightness of conduits and other compartments. Whenever possible, storm water should be channeled in lined, surface canals.

i. Concrete non-pressure pipes should be of the spigot and socket type with rubber ring seals. Joints in box culverts, channels etc should be sealed.

j. Storm water drainage conduits shall be constructed at gradients that will not permit the deposition of silt, or sand, of the type present in the catchment area

4. Trenching

a. Trenches and excavation works should be opened and closed as rapidly as possible. Avoid leaving trenches open over weekends or holidays. All trenches and excavation works must be properly backfilled and compacted according to specifications given in subclause 5.2.4 of SABS 1200 DA, but specifically to ground surface to prevent them acting as French drains. Once services/cables are installed and backfilling is completed, it must be ensured that ground surface is graded to match the slope of the surrounding area. No rocks in the top layer.

b. Berms should be constructed on the up-slope side of trenches to prevent the inflow of water during storms.

c. The fall of trenches shall be away from buildings. Wherever practical, service trenches shall not be excavated along the length of housing units within the first 3 m beyond the perimeter of such units.

d. No ponding of surface water is to be permitted over, in, or in the vicinity of trenches and excavations.

5. Roads

a. Ensure that roadways are in fact placed below the site level so as to facilitate drainage. If the road network is the sole storm water system, in a township, care must be taken that the roads are surfaced.

b. Ponding of surface water on or next to roads that are not tarred should be avoided.

c. Roadways which have a gradient of less than 1:80 shall be surfaced/sealed.

d. The velocity of the 1 in 20 year storm water, flowing along unsurfaced roadways shall not exceed 1,5 m/s.

6. Water features/Swimming pools

The following minimum requirements must exist:

Construction:

a. The design, construction and use of the swimming pool/feature should at all times be to the satisfaction of the local city engineer, who should be aware of the requirements of swimming pools/water features in dolomitic areas.

b. The swimming pool must be designed as an *independent unit, which will not give way or distort*. The sides or floor of the pool/feature should not crack in the event of any ground movement underneath or nearby the swimming pool/feature.

c. The swimming pool/feature may be constructed from concrete, metal or any other suitable material on condition that the design conforms to condition (7a) above.

d. All water pipes, pumps and connections should be installed either in the open, on the surface, or in service canals where these may be inspected or repaired without access problems.

e. The swimming pool/feature should be built so as to prevent any rain water flowing into or towards the pool/feature.

Maintenance and responsibilities

f. All back wash water must be discharged *directly* into the main storm water line.

g. Any abnormal loss of water from the pool/feature as well as any noticeable ground movement (cracks forming in the ground or in the pool/feature) must be reported by the stand owner to the Home Owners Association or Body Corporate and the local council.

h. It is important to note that the responsibility of checking pipes to and from the pool, the handling of run-off water from the pool/feature as well as the repairing of cracks in the pool/feature and replacing of leaking pipes lies solely with the stand owner. Negligence could result in instability.

A GENERALISED DOLOMITE RISK MANAGEMENT PLAN FOR AN OFFICE PARK ON DIE HOEWES EXTENSIONS 285 AND 286, CENTURION, PRETORIA (TSHWANE METRO).

1. INTRODUCTION

A office park is to be developed on Die Hoewes extensions 285 and 286 (originally Holdings 231 and 232) in the Lyttelton Agricultural Holdings, Centurion (Tshwane Metro). The site lies within an area designated as a "dolomitic environment" and it is therefore necessary that a Dolomite Risk Management Program (DRMP) be implemented. The geology dictates that the DRMP be initiated throughout the property. This DRMP is of a general nature and a detailed plan will be submitted with a site development plan for the first office block. The plan will be ammened as each new office block comes on stream.

A DRMP is based on the information given by the competent persons involved in the risk assessment and assumes that each party has to fulfill their obligations. This DRMP deals with all wet services associated with this particular development. The management is a part of the DRMP and has a responsibility to fulfill the requirements as set out in the DRMP.

The DRMP must therefore be seen as a program which is managed and audited by management and an appointed, responsible person through whom a number of parties work together to ensure the long-term safety and stability of the site.

2. PARTIES INVOLVED IN THE DEVELOPMENT PROCESS.

The following parties have been involved in the guardhouse development and the DRMP is based on information obtained from their contributions:

Relly Milner and Shedden: Dolomite stability report.

Council for Geoscience: Providing geological comment and support for the office park development.

Abland: Owners of the property.

3. PARTIES INVOLVED IN THE DOLOMITE RISK MANAGEMENT PROGRAM.

The following parties are involved in and co-responsible for the implementation and maintenance of the DRMP

- The owner of the office park.
- The management of the office park.
- Responsible person appointed by management.
- Tshwane Metropolitan Municipality: Ownership and maintenance of the bulk sewer and water serving Die Hoewes Ext 285 and 286.

4. DOLOMITE RISK MANAGEMENT PROGRAM

The Dolomite Risk Management Program (DRMP) will be implemented by the owner and managed by an appointed representative.

The DRMP consists of the following elements:

4.1 Existing information

4.2 Management system (including monitoring)

4.2.1 Groundwater

4.2.2 Water

4.2.2 Sewer

4.2.3 Storm water

4.2.4 Occurrences and incidences

4.2.5 Education and vigilance

4.1 Existing Information

4.1.1 Geological report

A dolomite stability investigation was conducted and a report (F303) compiled by this firm for Holdings 231 and 232 in 2007. Additional drilling to meet footprint investigation requirements

was undertaken by this firm in 2013.

4.1.2 Correspondence from Council for Geoscience (CGS)

All correspondence received from the CGS should be put on file (letter dated 18 October 2007 - Ms J Grobler 012 8411152).

4.1.3 Construction report

No construction report has been prepared.

4.1.4 Local Authority

The local authority is the Tshwane Metropolitan Municipality.

4.1.5 As-built drawings of water, sewer and storm water.

All wet services should be indicated on a plan and will need to be integrated into the existing services.

4.2 Risk Management System

The risk management plan may be divided into two main functions:

- *Monitoring:* The visual inspection of the stands must be undertaken on a regular basis. (i.e. once a month, annual (seasonal) or biennial). Initially the intervals should be fairly close but may be extended with time if performance warrants it. The inspections should take place at least once a month in the wet season and once every three months in the dry season. The inspections in the wet season should be undertaken after heavy showers to assess the effectiveness of surface drainage measures. Any untoward conditions such as excessive ponding on pavements must be recorded and, if necessary, appropriate remedial action must be taken.
- *Recording:* A continual record will allow an assessment to be made as to whether the problem is a recurring one (poor design and/or construction) and needs professional

attention. The inspections must be undertaken by the responsible person delegated by the management. The records should be retained as hardcopies for a reasonable period (5 years) and should be passed on if the property is sold.

4.2.1 Groundwater

The groundwater table lies within the bedrock below the site and does not pose a risk to the stability even if drawn down. Nevertheless, boreholes should not be drilled nor existing boreholes be used for the withdrawal of ground water unless permission is granted by the relevant authority.

4.2.2 Water

The management will be responsible for repairing and maintaining the water network within the property.

The responsible person will carry out the following yearly inspections and maintenance:

- Clean the water valve manhole and inspect for leakages. The valve must be closed and opened again to make sure the mechanism is in good working condition.
- Mark the position of the water valve on the kerb of the road or on the sidewalk.
- Test the water line by closing off all taps and checking the water meter. The cause of any unexplained water loss should be sought immediately. This exercise should be undertaken every two months in the first year then at least each quarter thereafter.

4.2.3 Sewer

The management will be responsible for repairing and maintaining the sewer network.

All reported sewer line blockages and the reasons for the blockages, if known, must be recorded on the data base by the management. Should tree roots cause blockages or if blockages occur regularly in the same areas, the management must immediately investigate the problem. The management must appoint a competent person to inspect the line and to rectify the problem as

soon as possible.

Inspection manholes (if installed) should be opened and the flow of water must be confirmed in both sewer and storm water lines.

The sewer-line may require inspection by camera at biennial intervals, particularly if regular problems are associated with these services.

4.2.4 Storm water

The internal storm water network must be maintained by the management.

The management will carry out the following yearly inspections and maintenance:

- Clear all storm water outlets on boundary walls (if applicable) of sediment, grass and other waste.
- Visually inspect all storm water pipes, channels and manholes.

4.2.6 Garden beds and parking areas

The responsible person must inspect the "open" ground as part of routine maintenance/monitoring. Results of inspections must be recorded whether or not problems are identified.

- Excessive ponding of surface water must be reported particularly against boundary walls. Where ponding occurs the situation should be remedied. All these actions need to be recorded to ensure a proper audit trail if any instability should occur.
- Any signs of cracking either in structures or in the earth are indicative of some movement. These cracks are often the precursor to more serious instability. The cause of cracking should be sought without delay. The management must be notified.
- Areas of unnaturally vibrant growth may be indicative of excessive moisture in the soil from leaking, buried wet services.

4.2.8 Occurrences and incidences

The following occurrences and incidences must be recorded and put on the database:

- Sewer blockages.
- Subsidences.
- Sinkholes.
- Leakages (water, sewer and storm water systems)
- Flooding (after heavy rains) and ponding
- Damage to structures

4.2.9 Education and vigilance

The owner must institute an education program for all occupants in the office block.

5 EMERGENCY REACTION PLAN

The emergency reaction plan forms part of the education program and the employees must be continually informed of the procedures and emergency contact numbers.

The emergency procedures are as follow:

5.1 For a sinkhole:

- Contact the management and the emergency services of the Tshwane Metro immediately.
- An area of 20 metres around a sinkhole must be evacuated immediately.
- A sinkhole must be cordoned off to prevent any unsuspecting people from getting too close to the area.
- The water supply must be closed off if related to the cause of the sinkhole.
- No person must be allowed to climb into the sinkhole
- The management (or appointed professional) will investigate the cause of the sinkhole and set a plan in motion for rehabilitation. The sinkhole must be repaired as soon as possible to prevent further damage to the area or structures.

5.2

For a subsidence (doline):

- Contact the management and the emergency services of the Tshwane Metro immediately.
- An area of 20 meters around a subsidence must be evacuated immediately.
- A subsidence must be cordoned off to prevent any unsuspecting people from getting too close to the area.
- The water supply must be closed if related to the cause of the subsidence.
- The management (or appointed professional) will investigate the cause of the subsidence and set a plan in motion for rehabilitation. The area must be repaired as soon as possible to prevent the development of a sinkhole and further damage to services or structures.

Emergency contact numbers are:

- Tshwane Metropolitan Municipality: Emergency services
- Office Park: Maintenance manager
  Caretaker/maintenance official (TBA).
- Tshwane Metropolitan Municipality:
  Dolomite Risk Management – Ms A Sudu 012 358 3206

6 REHABILITATION PLAN

The management will be responsible for the rehabilitation of any sinkhole, subsidence or damage caused by any service under their ownership.

The rehabilitation of a sinkhole or subsidence and the repair of damaged services will be handled on an Ad Hoc basis. If a rehabilitation project is the responsibility of the management, the appointed consultant/competent person of the management must advise and supervise the project.

The management must be responsible for providing funds for the following:

- Maintenance and repair of storm water network.
- Investigating the cause of any subsidence or sinkhole in the storm water network.
- Repairing any damage caused by internal services and the rehabilitation of an affected

area.

7 DATABASE

The database is system (preferably electronic) that maintains records of all incidences relating to the overall stability of the site. The database must be kept up to date on a monthly basis. The database must contain the following:

- All existing information (geological and engineering): Layout plan of all services (water, sewer, storm water, electrical and Telkom).
- Occurrences and incidences: Occurrences and incidences such as blocked sewers, water leaks etc, as set out in clause 4.2.7 must recorded on the database.
- Education and vigilance: The education program as set out in clause 4.2.8 must be recorded on the database.

8 REASSESSMENT

In order to ensure that the Dolomite Risk Management Program is functional and addresses all known and new issues, reassessment of the DRMP on a five yearly basis is essential. This exercise will involve the evaluation of the present DRMP methodology in the context of future standards and requirements. Notes should be made of weaknesses in the program as well as necessary additions which may become evident over the five-year period.

9 SUMMARY

The Dolomite Risk Management program must be managed and maintained by the management and inspection interval are as follows:

Element	Party responsible	Inspection intervals
9.1. Existing information	Management	Continuous
9.2. Management system		
9.2.1 Ground water:		
▪ Monitoring borehole water level (if applicable)		Six monthly
9.2.2 Water:		

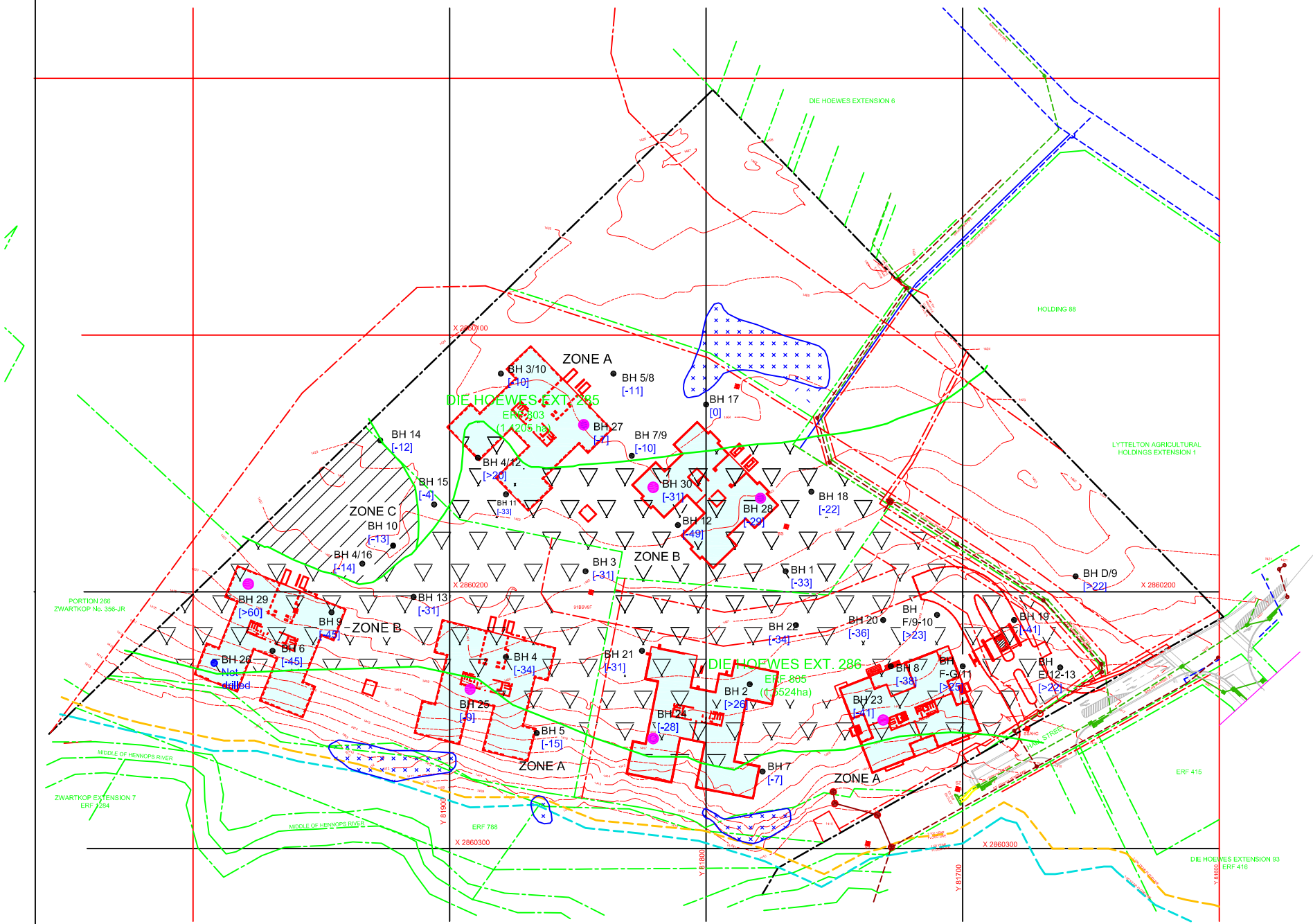
▪ Valve inspection	RP	Yearly
▪ Monitoring	RP	Monthly
▪ Maintenance and repair	RP	Continuous
9.2.3 Sewer:		
▪ Monitoring	RP	Continuous
▪ Maintenance and repair	RP	Continuous
9.2.4 Open ground:		
▪ Inspection	RP	Monthly (initially)
▪ Maintenance and repair	RP	Continuous
9.2.5 Storm Water:		
▪ Inspection and cleaning	RP	Annually (prior to wet season)
▪ Maintenance and repair	RP	` Continuous
9.2.7 Occurrences and incidence (Recording, investigate and planning of rectification):		
	RP	Continuously
9.2.8 Education and vigilance:	Management	Six monthly
9.2.9 Emergency reaction plan:	Management	Continuous
9.2.10 Rehabilitation plan:		
▪ Investigate and plan repair	Management	Ad Hoc
▪ Funds	Management	Continuous
9.2.11 Data base:	Management	Monthly
9.2.12 Reassessment:	Management	Monthly/5 years

RP = Responsible person (appointed by management).

Inspection periods may be extended from monthly to two monthly and later six monthly if records indicate an absence of problems.

E Shedden (Pr Sci Nat)

RELLY MILNER AND SHEDDEN **JULY 2013**



LEGEND

BH 24 — Borehole position and number (2013).

BH 3 — Borehole position and number (1983-2007).

Zone boundary.

Office block footprint.

INHERENT RISK CHARACTERISATION (Buttrick et al 2001)

ZONES	RISK CLASS	SMALL SINKHOLE	MEDIUM SINKHOLE	LARGE SINKHOLE	VERY LARGE SINKHOLE	Risk of Doline Formation	Recommended type of development in accordance with SANS 1936 [2012] Table 2.
	Sinkhole Diameter	<2m	>2m - <5m	>5m - <10m	>15m		
A	CLASS 3(5,6)	MEDIUM(-HIGH)	MEDIUM(-HIGH)	LOW	LOW	MEDIUM-HIGH	Commercial development C2-3, 6 and 8 is permitted provided cognisance is taken of a 10m loss of support. Appropriate water precautionary measures and Dolomite Risk Management Plan (DRMP) must be implemented. A D4 process is required for development of C1,4,5&7.
B	CLASS 4(6)	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	Commercial development C1-3 and C5-8 is permitted provided cognisance is taken of a 10m loss of support. Appropriate water precautionary measures and Dolomite Risk Management Plan (DRMP) must be Implemented. A D4 process Is required for development of C1,4,5&7.
C	CLASS 7	HIGH	HIGH	MEDIUM	LOW	LOW-MEDIUM	Commercial development is only possible if a D4 process is followed. Appropriate water precautionary measures and Dolomite Risk Management Plan (DRMP) must be implemented.

LOCALITY:
DIE HOEWES 285 and 286,
HALL STREET, CENTURION.

TITLE:
RISK CHARACTERISATION MAP.

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SCALE	DATE
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