The Secretary for Water Affairs

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MMABATHO

8681

MOTHIBISTAD : NEW EXTENSION OF 200 HOUSES WITH RETICULATED SERVICES : DOLOMITIC STABILITY ANALYSIS

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1 - 11/91

JANUARY 1992

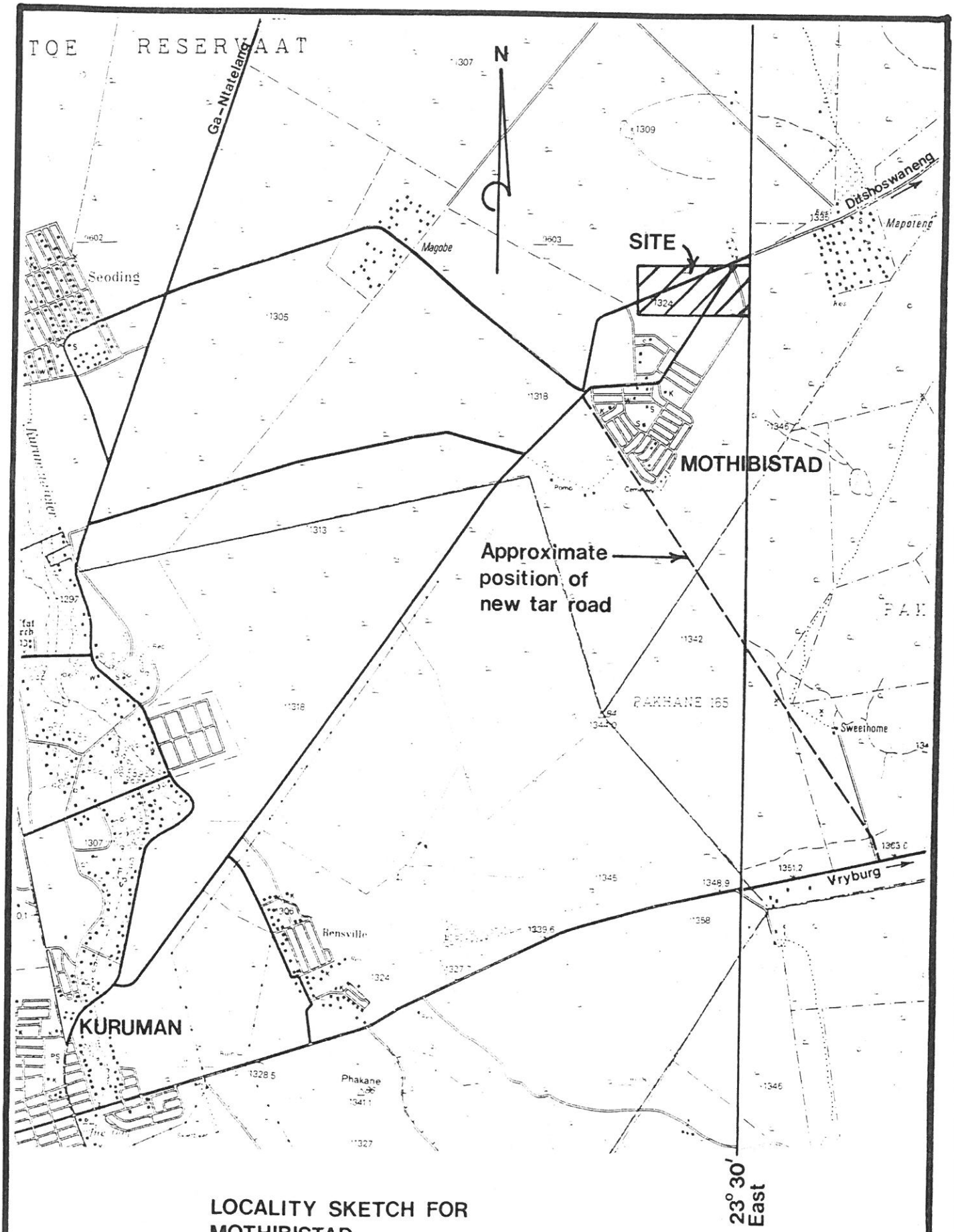
1. INTRODUCTION

At a meeting held in the Boardroom of the Bophuthatswana Department of Water Affairs on the 2nd December 1991, Mr. S.J. Malherbe, Director of the Bophuthatswana Geological Survey, reported on the the results of a gravimetric survey carried out within the area of the new 200 stand development in Mothibistad by members of his staff. In the light of these results it was agreed by the meeting that a risk of sinkhole formation might exist within the area, and Partridge, Maud and Associates were requested to liaise with member of staff of the Bophuthatswana Geological Survey in undertaking the necessary additional geophysical and drilling investigations to better define the extent of this risk. This report presents the findings of these investigations and should be read in conjunction with the two maps on which gravity and residual gravity contours, magnetic traverses, borehole positions and zones of inferred different levels of risk are shown in relation to the proposed township layout.

2. GENERAL DESCRIPTION OF THE SITE

The town of Mothibistad is situated approximately 9,0 km north-east of Kuruman and falls within the Kudumane District (Taung Region) of the Republic of Bophuthatswana (FIGURE 1). The survey area is situated due north of Mothibistad and comprises some 36 hectares; it is rectangular in shape and bounded to the south by the existing township of Mothibistad.

The site occupies the flank of a gently sloping hill which slopes toward the Kuruman river in the west. The site already has a number of structures erected on it, mainly churches, and some infrastructure in the form of gravel roads traverse the area.



LOCALITY SKETCH FOR MOTHIBISTAD

SCALE 1:50 000

Figure 1

3. FIELDWORK

3.1 General

The fieldwork undertaken by ourselves was conducted in two phases; the first phase involved the running of magnetic traverses across various parts of the site, while the second phase comprised the drilling of nine percussion boreholes at selected positions within the site.

3.2 Magnetic traverses

Six magnetic traverses, following an east-west orientation, were run across various parts of the site. The purpose of these traverses was to determine whether linear anomalies revealed by the gravimetric surveys were associated with intrusive dykes, which could have significance with regard to local geohydrological relationships and patterns of karst weathering.

Magnetic traversing was done using a Chemtron G4 Proton Magnetometer; the initial observation point spacing was 25 m. However, this was later reduced locally to 5 m so as to permit identification of smaller anomalies between the original observed points.

3.3 Percussion drilling

A total of nine percussion boreholes was drilled at selected localities within the site to calibrate the gravity survey and to obtain information on the hydrogeological characteristics of the area; the boreholes were also useful in determining the depth to bedrock beneath the site, in addition to which a rough assessment of the physical characteristics of the various soils and rocks could be made. It should be noted, however, that owing to the disturbed and often

pinnacled dolomite.

5.2 Percussion drilling

5.2.1 General

The results from the nine percussion boreholes used to calibrate the geophysical data are summarized in Table 1. Detailed percussion logs for the individual boreholes are included in Appendix B of this report.

Of note is the fact that a marked loss of air while drilling, indicating cavernous weathering conditions, was encountered at a depth of 11,0 m in borehole 13-86277A; the loss of air precluded the further deepending of this hole. A second borehole (13-86277B) was subsequently drilled 12,5 m north of this position to a depth of 11,0 m.

5.2.2 Water rest levels

Standing water levels were recorded in all boreholes at completion of drilling, and water strikes were recorded during drilling operations; in three of the holes, which were cased and sealed for monitoring purposes (boreholes 13-86275, 13-86276 and 13-86278), repeat water level measurements were made three weeks after drilling; water rest levels are summarized in Table 2.

The water rest levels are mostly shallow (2,70 - 3,60 m below ground level); this level corresponds in broad terms with a zone of slow seepage at the top of, or within, the upper layers of a widely developed calcrete horizon which overlies leached dolomite in the central and eastern parts of the project area. The calcrete is covered by transported soil and gravel

(see Section 5.2.3 below), and it is clear that this seepage represents a perched water table whose level is controlled by the relatively impervious calcrete.

TABLE 1 : SUMMARY OF PERCUSSION DRILLING RESULTS

Borehole number [m]	Depth of transported material [m]	Depth of hardpan calcrete [m]	Depth of calcified residual dolomite [m]	Depth of residual dolomite [m]	Depth of dolomite bedrock [m]
13-86275	0.0-3.0		3.0-8.0		8.0-16.0 [EOH]
13-86276	0.0-3.0		3.0-5.0		5.0-16.0 [EOH]
13-86277A	0.0-2.0	2.0-11.0 [EOH]			
13-86277B	0.0-1.0	1.0-5.0	5.0-9.0		9.0-11.0 [EOH]
13-86278	0.0-4.0			12.0-15.0	4.0-12.0 15.0-26.0 [EOH]
13-86279	0.0-5.0		5.0-8.0		8.0-19.0 [EOH]
13-86280	0.0-3.0		3.0-6.0		6.0-14.0 [EOH]
13-86281	0.0-3.0		3.0-7.0		7.0-14.0 [EOH]
13-86282	0.0-2.0			2.0-9.0	9.0-16.0 [EOH]

TABLE 2 : SUMMARY OF WATER REST LEVELS

Borehole number	Water rest levels		
	15(6)/12/91	17/12/91	07/01/92
13-86275		3.06	2.70
13-86276		3.36	3.10
13-86277A	3.60		
13-86277B		3.40	
13-86278		13.47	13.20
13-86279	17.71	11.55	
13-86280	13.20	12.81	
13-86281	9.51	3.00	
13-86282		15.70	

By contrast, the western part of the project area has much deeper water rest levels (11.55 - 15.70 m below ground level). The calcrete horizon is absent or poorly developed in this area, a factor which probably accounts for the absence of a perched water table and the consequently deeper water rest levels measured in the three boreholes sunk in this area. Water rest levels in this western part of the project area do, however, correspond well to the regional piezometric surface as identified by A.S. Harley and J.P.Davis in their report on the groundwater of the Mothibistad-Seoding area (Reference 1). Their findings indicated that the permanent water table in this area was in excess of 10.0 m below ground level.

5.2.3 Subsoils and bedrock

The various materials encountered during the drilling investigations are discussed briefly below :-

a) Hillwash - This material usually comprises orange-brown, silty sand with scattered fine gravels. The horizon is never very thick, attaining a maximum thickness of some 2,0 m.

b) Pebble marker/colluvium - This material comprises abundant coarse, medium and fine sub-rounded to subangular gravels of predominantly chert, with some vein quartz, densely packed in a matrix of orange-brown, silty sand. The thickness of the pebble marker is likely to vary from 1,0 - 2,0 m while the colluvium is likely to range up to 3,0 m in thickness.

c) Hardpan calcrete/calcified residual dolomite - This material has formed as a result of pedogenic processes cementing the host material; the resulting material is highly variable and comprises varying proportions of calcified sand, gravels and boulders. The consistency of the material is likely to vary conciderably, although where it has been identified as hardpan, the consistency is likely to be at least dense.

d) Dolomite - Dolomite bedrock was encountered in all of the boreholes, except 13-86277A, and in most instances the holes were extended at least 7,0 m into dolomite bedrock. The dolomite generally comprises a pale grey, slightly leached, very fine grained, hard rock.

5.3 Preparation of residual gravity map

A residual gravity map (MAP 2) was prepared from the original gravity data and the results of the drilling investigations in order to eliminate regional gravity trends and to highlight local features of potential significance for the identification and delineation of risk zones.

5.4 Interpretation of results

The residual gravity map (MAP 2) indicates the presence of three conspicuous gravity lows in the area, which have been delineated and labelled A, B, and C. Within these lows the results of the drilling confirm that weathering /solution of the dolomite bedrock extends to generally greater depths (7,0 - 15,0 m) than in the intervening areas. In general the water rest levels are shallow (2,7 - 3,4 m below ground level); however, in area C the water rest levels are much deeper (11,5 - 15,7 m below ground level).

The remainder of the survey area outside of the limits of A, B and C is relatively featureless from a gravimetric point of view. Bedrock depths are generally less than 5,0 m and a blanketing calcrete horizon with a shallow, perched water table is present (see Sections 5.2.2 and 5.2.3)

Important from the point of view of the interpretation of dolomitic stability within the area are :-

- depth to bedrock and karst development.
- the position of the water table.
- the distribution of the relatively impermeable calcrete layer.

impervious calcrete blanket, but the precautions relative to waterborne services and the surface ponding of water should nonetheless be rigorously applied during the construction phase and careful attention paid to the maintenance of services, roads, stormwater drains etc. in a state which precludes the possible occurrence of concentrated seepage.

- all roads should, if possible, be surfaced.

- bulk water supply lines should be routed along roads rather than between houses.

- Feeder lines and sewer lines should be routed along stand boundaries with the shortest possible connection lengths to houses.

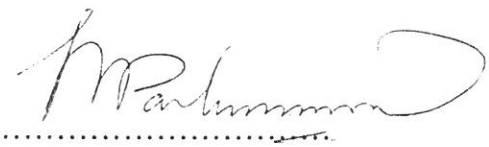
- service trenches should be kept as shallow as possible, in any event above the level of the main calcrete horizon.

6.3 Additional concideration

Several other points need to be stressed. Since it is possible that existing residential areas in Mothibistad (and in nearby settlements such as Mapoteng, Magobe, Seodin, Mokala-Mosesane, Batlharos and Maruping) are located within high risk areas, the precautions mentioned above and those contained in Appendix C should be strictly observed throughout these settlements. Since pit latrines are a source of concentrated seepage and hence a potential cause of sinkhole development (as well as constituting a pollution hazard in respect of valuable dolomitic water resources), consideration should be given to installing water-borne sewage systems in these areas at the earliest possible opportunity. Before future extensions are permitted in any of these settlemetns dolomitic stability investigations should be carried out routinely to ensure that high risk areas are

avoided and land-use is matched in the most appropriate way to subsurface conditions.

H.J. SCHURINK, BSc.(Hon)



T.C. PARTRIDGE, Sci.Nat., Ph.D

References

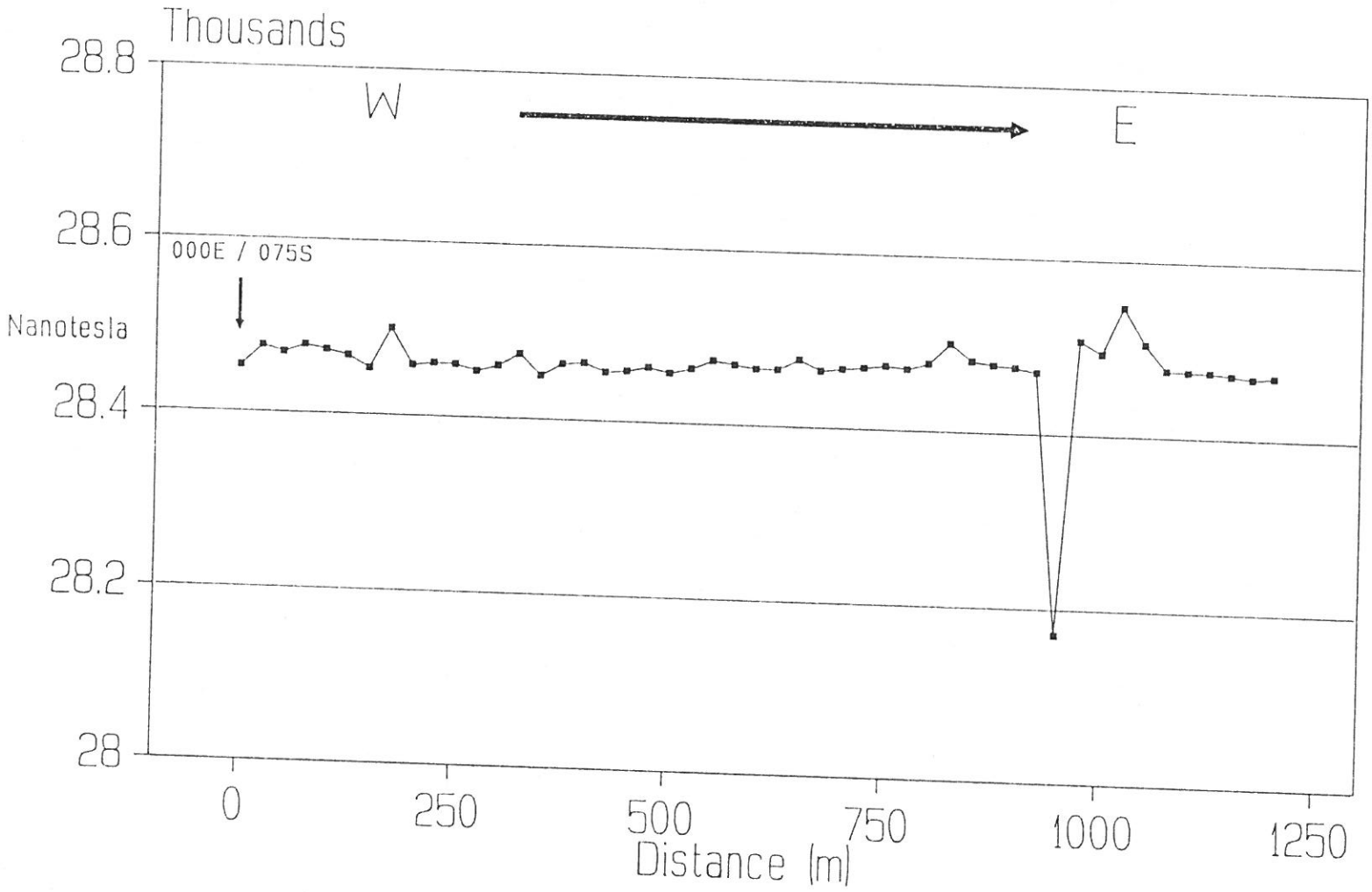
1. Harley, A.S. and Davies, J.P., 1982. Feasibility Study on Groundwater Supplies Mothibistad-Seodin, Bophuthatswana. Geustyn, Forsyth and Joubert Inc.

2. Buttrick, D.B. 1991. Parameters and Standardized Terminology for Sinkhole Size and Risk in Stability Evaluation : Tentative Proposals. Ground Profile No.55, July 1988.

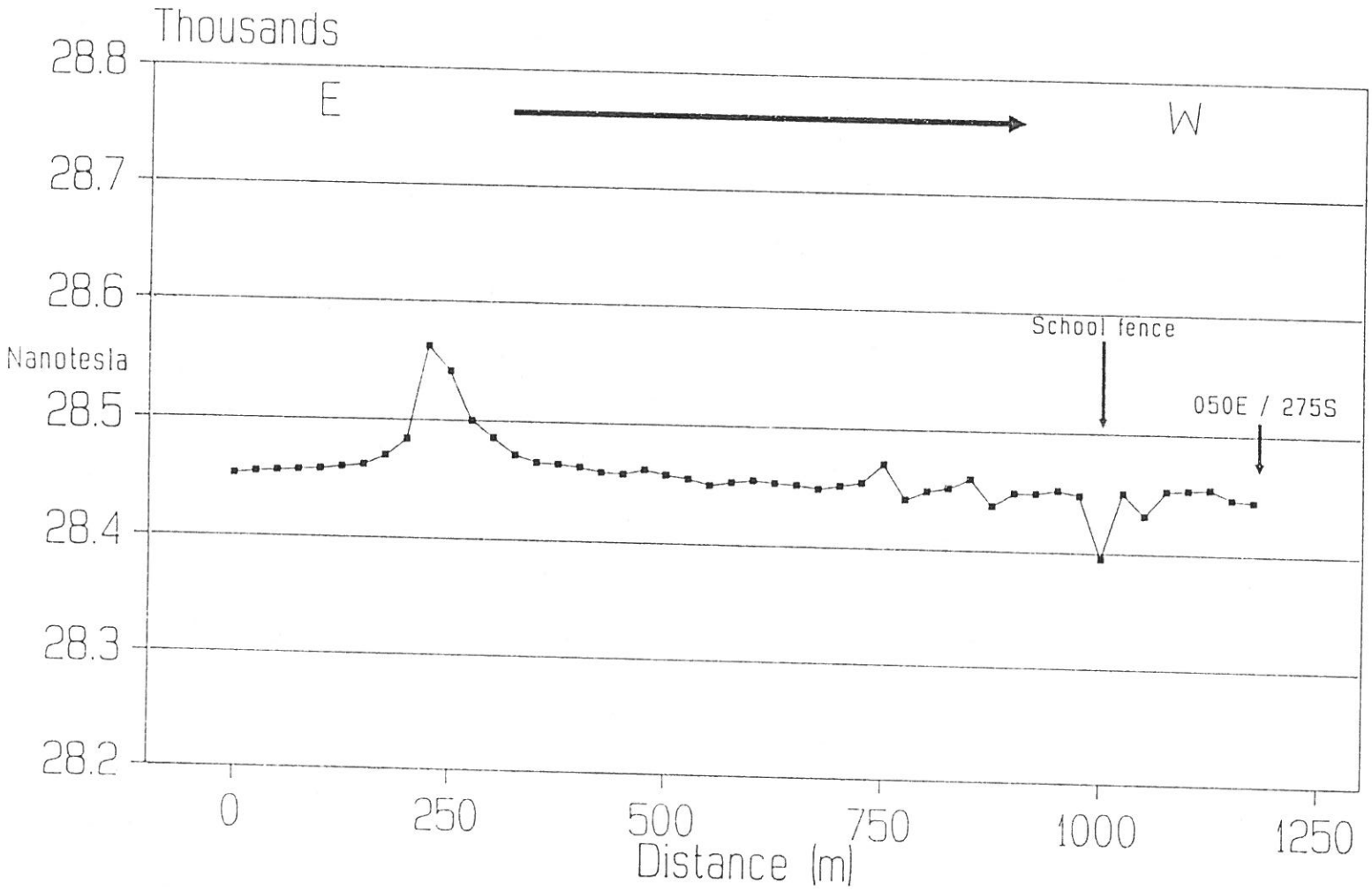
APPENDIX A

MAGNETIC TRAVERSES

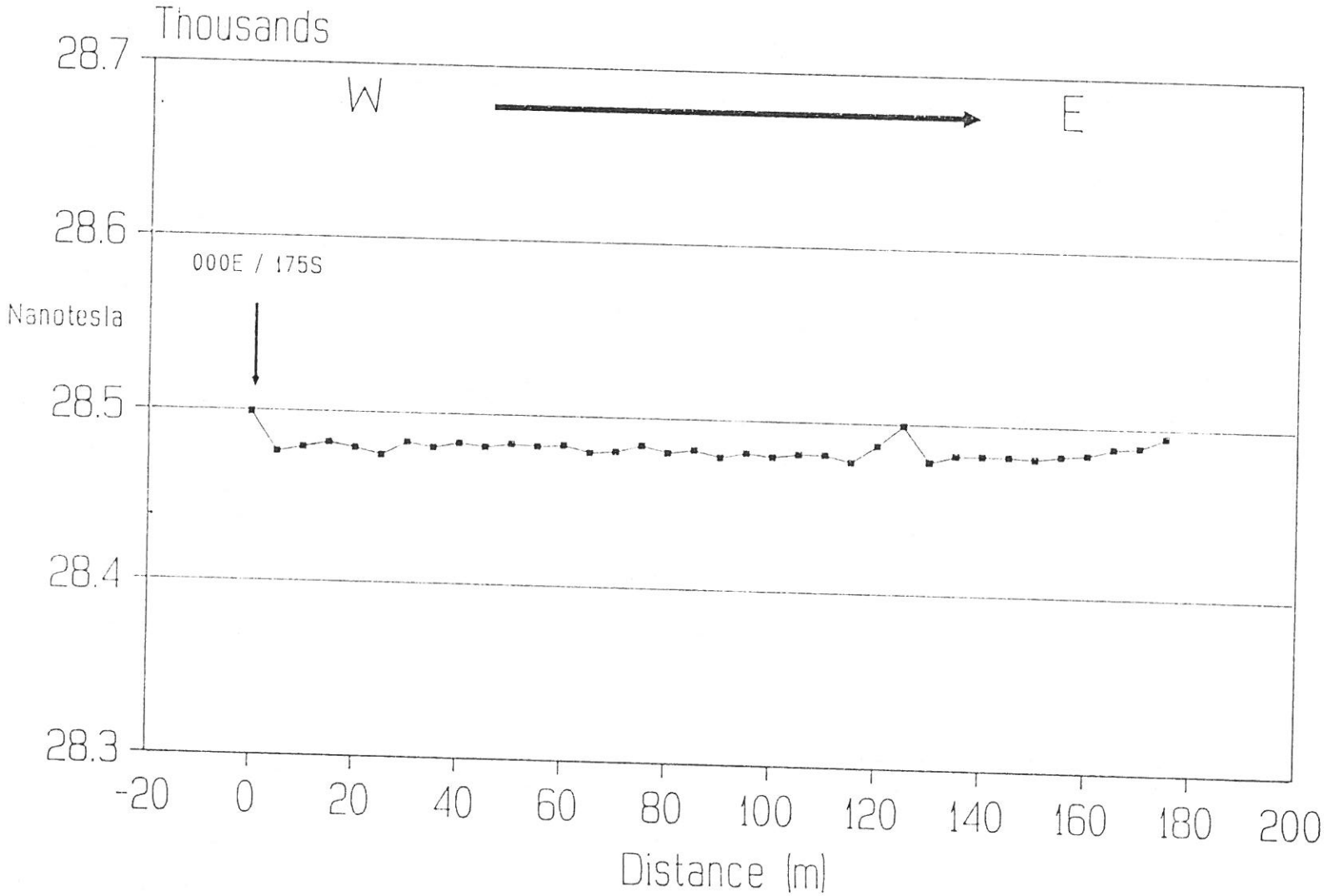
Magnetic Traverse T#1
District: Kudumane
Locality: Mothibistad



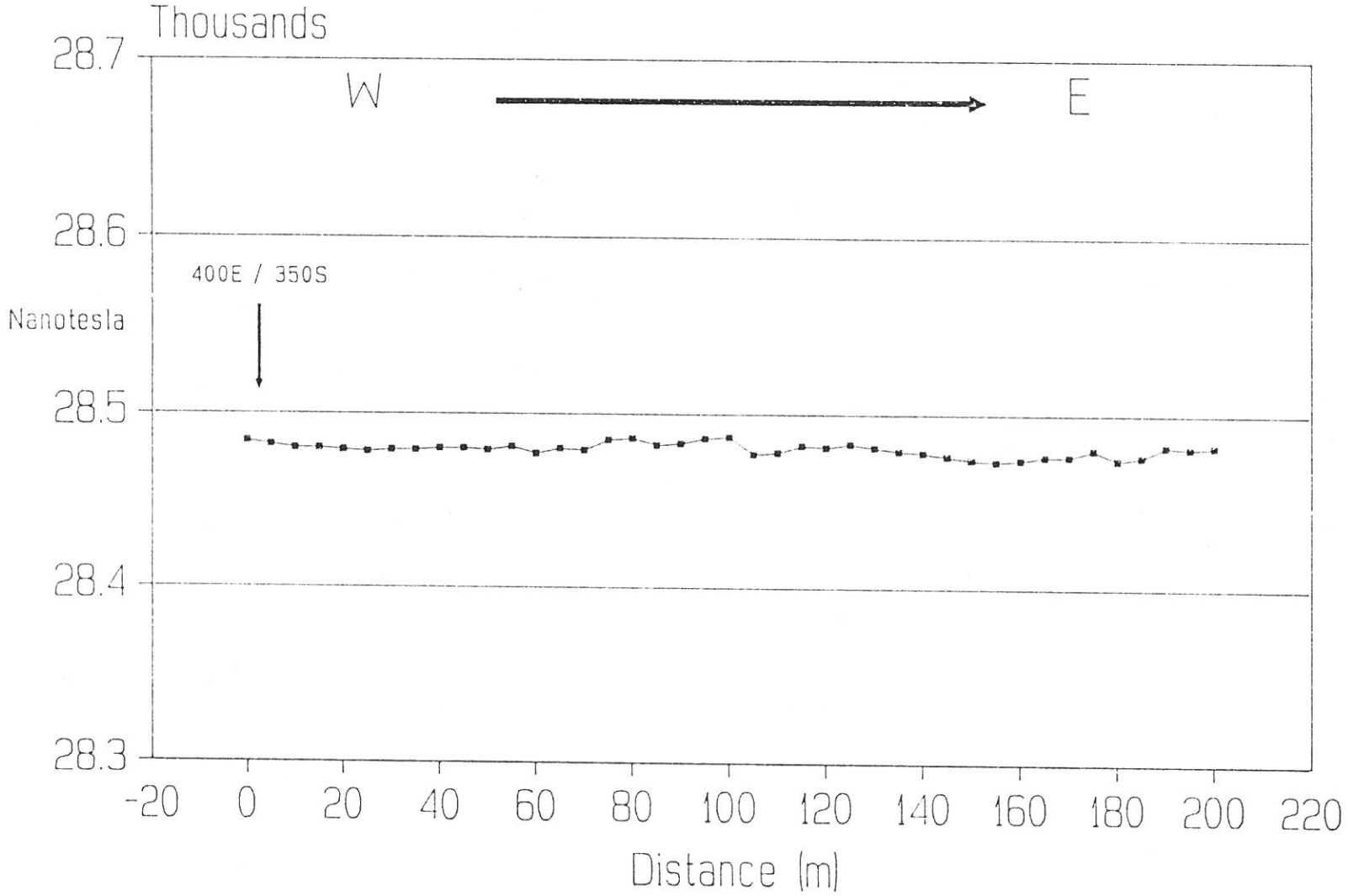
Magnetic Traverse T#2
District: Kudumane
Locality: Mothibistad



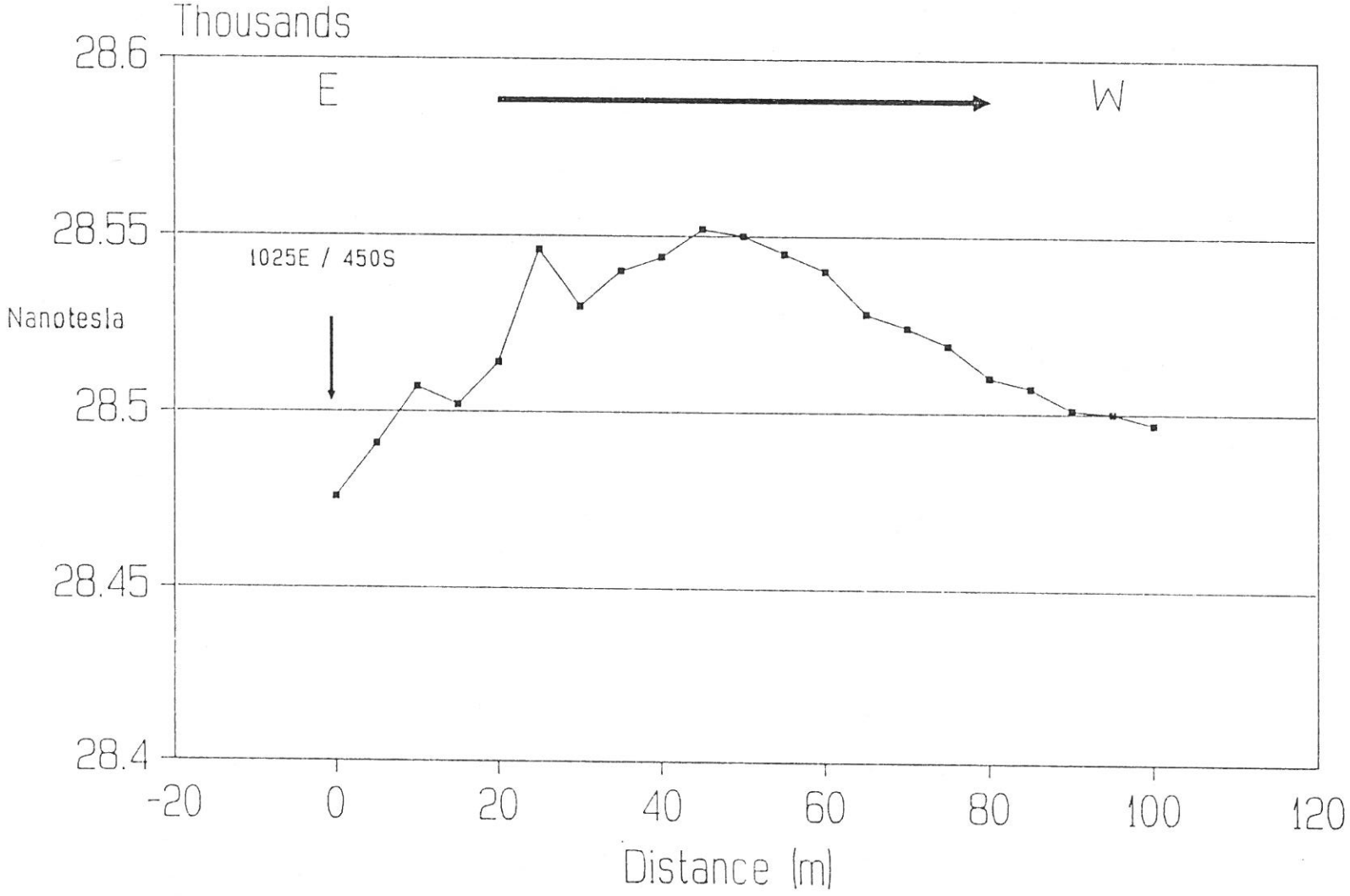
Magnetic Traverse T#3
District: Kudumane
Locality: Mothibistad



Magnetic Traverse T#4
District: Kudumane
Locality: Mothibistad



Magnetic Traverse T#5
District: Kudumane
Locality: Mothibistad



APPENDIX B

PERCUSSION BOREHOLE LOGS

T.C. PARTRIDGE, Consultant in the Earth Sciences

PERCUSSION DRILLING RECORD

Fig.No.

PROJECT: MOTHIBISTAD TOWNSHIP
BOREHOLE NO: 13-86276
MACHINE TYPE: Percussion rig + 18 bar compressor
DRILLED BY: Mmabatho Drillers
DRILLING STARTED: 16/12/91
DRILLING COMPLETED: 16/12/91
LOGGED BY: M.G.K.

KEY
- Standing Water
- Water Seepage
- Air Loss
- Casing
- Test and Position

Casing and drill diam.	Penetration (mins/metre)	Chip size Range (mm.)	Additional Data	Geological column	Depth (m)	DESCRIPTION
165 mm	0'20"	1 - 3			1	0,0 - ±2,0 m. Orange brown, SILTY coarse medium and fine SAND with occasional fine gravels and calcareous concretions; hillwash.
	0'25"					
	1'48"	1-10			2	±2,0 - ±3,0 m. Abundant coarse medium and fine GRAVELS of chert and vein quartz, probably densely packed in a matrix of reddish brown, SILTY fine SAND; pebble marker.
	5'46"	2 - 40			3	
216 mm	5'57"				4	±3,0 - ±5,0 m. Abundant, slightly leached, chert-rich, hard rock dolomite boulders, densely packed and cemented with hardpan calcrete; calcified residual dolomite.
	8'30"				5	
165 mm	3'33"	4 - 50			6	±5,0 - ±16,0 m. Bluish grey unweathered, very fine grained, hard - very hard rock, DOLOMITE.
	4'45"				7	
	4'40"				8	
	5'19"				9	
	4'56"				10	
	4'57"				11	
	5'37"				12	
	5'20"				13	
	6'23"				14	
	6'37"				15	
					16	
					17	
					18	
					19	
					20	

NOTES:-

1. Borehole drilled to 16,0 m.
2. Standing water level 3,36 m on 17/12/91.
3. Standing water level 3,10 m on 7/1/92.

T.C. PARTRIDGE, Consultant in the Earth Sciences | PERCUSSION DRILLING RECORD | Fig.No.

PROJECT: MOTHIBISTAD TOWNSHIP
BOREHOLE NO: 13-86277(A)
MACHINE TYPE: Percussion rig + 18 bar compressor
DRILLED BY: Mmabatho Drillers
DRILLING STARTED: 15/12/91
DRILLING COMPLETED: 15/12/91
LOGGED BY: H.J.S.

KEY
- ▼ Standing Water
- ▽ Water Seepage
- ↕ Air Loss
- ⊔ Casing
- ■ Test and Position

Casing and drill diam.	Penetration (mins/metre)	Chip size Range(mm.)	Additional Data	Geological column	Depth(m)	DESCRIPTION
165 mm	0'10"	2-5	▼		1	0,0 - ±1,0 m. Orange brown, SILTY fine SAND with occasional fine gravels; hillwash.
	0'21"	1-60			2	±1,0 - ±2,0 m. Pale yellowish brown, SILTY coarse medium and fine SAND with abundant calcareous concretions (up to 50 mm in diameter); powder and nodular calcrete.
	2'18"				3	
	2'26"		▽		4	
	1'09"				5	
	2'50"				6	±2,0 - ±11,0 m. Buff, hardpan calcrete with occasional chert gravels and cobbles and probably dolomite boulders; overall consistency very dense; hardpan calcrete.
	2'37"	2 - 30			7	
	2'32"				8	
	2'10"				9	
	1'53"				10	
	2'24"				11	
					12	
					13	
					14	
					15	
					16	
					17	
					18	
					19	
					20	

NOTES:-

1. Driller has said that this hole cannot be continued as a result of loss of air - will not help if it is cased.
2. Water rest level 3,60 m ±15 hours after drilling.

GARAMOND

T.C. PARTRIDGE, Consultant in the Earth Sciences

PERCUSSION DRILLING RECORD

Fig.No.

PROJECT: MDTHIBISTAD TOWNSHIP
BOREHOLE NO: 13-86277(B)
MACHINE TYPE: Percussion rig + 18 bar compressor
DRILLED BY: Mmabatho Drillers
DRILLING STARTED: 16/12/91
DRILLING COMPLETED: 16/12/91
LOGGED BY: M.G.K.

KEY
- ▼ Standing Water
- ▽ Water Seepage
- ↕ Air Loss
- ⊔ Casing
- ■ Test and Position

Casing and drill diam.	Penetration (mins/metre)	Chip size Range (mm.)	Additional Data	Geological column	Depth (m)	DESCRIPTION
216 mm		1-15			1	0,0 - ±1,0 m. Orange brown, SILTY SAND with occasional fine gravels and calcareous concretions; hillwash.
	0'57"	1 - 30			2	±1,0 - ±5,0 m. Buff, probably dense; hardpan calcrete.
	1'13"		▼		3	
	0'55"				4	
	0'54"		▽		5	
	7'33"	2 - 35			6	±5,0 - ±9,0 m. Abundant hard rock, dolomite, BOULDERS, densely packed and cemented with hardpan calcrete; calcified residual dolomite.
	7'10"				7	
	4'50"				8	
	4'27"		▽		9	±9,0 - ±11,0 m. Pale grey, slightly leached, very fine grained, hard rock, DOLOMITE.
	5'37"	2 - 30			10	
	4'46"				11	
					12	NOTES:-
					13	1. Borehole drilled to a depth of 11,0 m.
					14	2. Standing water level 3,0 m on 17/12/91.
					15	
					16	
					17	
					18	
					19	
					20	

GAAAMONO

T.C. PARTRIDGE, Consultant in the Earth Sciences

PERCUSSION DRILLING RECORD

Fig.No.

PROJECT: MOTHIBISTAD TOWNSHIP
BOREHOLE NO: 13-86278
MACHINE TYPE: Percussion rig + 18 bar compressor
DRILLED BY: Mmabatho Drillers
DRILLING STARTED: 16/12/91
DRILLING COMPLETED: 16/12/91
LOGGED BY: M.G.K.

KEY
- Standing Water
- Water Seepage
- Air Loss
- Casing
- Test and Position

Casing and drill diam.	Penetration (mins/metre)	Chip size Range(mm.)	Additional Data	Geological column	Depth(m)	DESCRIPTION
216 mm	0'18"	0,5-4			1	0,0 - ±1,0 m. Orange-brown, SILTY SAND with numerous fine gravels; hillwash.
	0'29"	1 - 40			2	±1,0 - ±4,0 m. Abundant coarse medium and fine GRAVELS? and occasional cobbles of predominantly chert in a matrix as above; chert residuum.
	0'34"				3	
	3'06"				4	
	4'41"	2 - 15			5	±4,0 - ±12,0 m. Grey, slightly leached, very fine grained hard rock; CHERT RICH DOLOMITE.
	4'40"				6	
	3'31"				7	
165 mm	3'13"	2 - 15			8	±7,0 - ±12,0 m. Grey, slightly leached, very fine grained hard rock, DOLOMITE.
	2'27"				9	
	3'15"				10	
	2'42"				11	
	2'59"				12	±12,0 - ±15,0 m. Grey and buff, calcareous cemented CLAYEY SAND with scattered highly leached dolomite boulders; residual dolomite.
	1'12"	2 - 7			13	
	1'43"		▽?		14	
	2'27"				15	±15,0 - ±26,0 m. Grey, slightly leached, very fine grained, probably hard rock, DOLOMITE.
	3'04"	2 - 7			16	
	2'29"				17	
	3'08"				18	
	2'39"				19	
	3'04"				20	

T.C. PARTRIDGE, Consultant in the Earth Sciences | PERCUSSION DRILLING RECORD | Fig.No.

PROJECT:
BOREHOLE NO: 13-86278 (contd.)
MACHINE TYPE:
DRILLED BY:
DRILLING STARTED:
DRILLING COMPLETED:
LOGGED BY:

KEY
- Standing Water
- Water Seepage
- Air Loss
- Casing
- Test and Position

Casing and drill diam.	Penetration (mins/metre)	Chip size Range(mm.)	Additional Data	Geological column	Depth(m)	DESCRIPTION
165 mm	3'40"	2 - 7 mm			21	
	3'30"				22	±15,0 - ±26,0 m. Grey slightly leached, very fine grained, probably hard rock, DOLOMITE.
	3'28"				23	
	3'20"				24	
	3'18"				25	
	3'44"				26	
					27	
					28	
					29	
					30	
					31	
					32	
					33	
					34	
					35	
					36	
					37	
					38	
					39	
					40	

NOTES:-

1. Borehole drilled to a depth of 26,0 m.
2. Standing water level 13,47 m on 17/12/91.
3. Standing water level 13,20 m on 7/1/92.

GARAMOND

T.C. PARTRIDGE, Consultant in the Earth Sciences | PERCUSSION DRILLING RECORD | Fig.No.

PROJECT: MOTHIBISTAD TOWNSHIP
BOREHOLE NO: 13-86279
MACHINE TYPE: Percussion rig + 18 bar compressor
DRILLED BY: Mmabatho Drillers
DRILLING STARTED: 16/12/91
DRILLING COMPLETED: 16/12/91
LOGGED BY: M.G.K.

KEY
- Standing Water
- Water Seepage
- Air Loss
- Casing
- Test and Position

Casing and drill diam.	Penetration (mins/metre)	Chip size Range(mm.)	Additional Data	Geological column	Depth(m)	DESCRIPTION
165 mm	0'08"	2 - 30			1	
	0'26"				2	0,0 - ±2,0 m. Orange-brown, SILTY SAND with occasional coarse medium and fine gravels of chert, vein quartz, and small ferruginous concretions; hillwash.
	0'31"	2 - 40			3	±2,0 - ±5,0 m. Abundant coarse medium and fine GRAVELS and COBBLES of chert and vein quartz; colluvium.
	0'50"				4	
	1'35"				5	
	1'46"	1 - 10			6	±5,0 - ±8,0 m. Abundant coarse medium and fine GRAVELS of chert and vein quartz, probably cemented with calcrete; calcified chert residuum.
	1'54"				7	
	2'38"				8	
	2'02"	1 - 10			9	±8,0 - ±11,0 m. Grey, leached, very fine grained, probably soft rock, DOLOMITE.
	1'04"				10	
	1'46"		▽		11	
	2'26"	1 - 10	▼		12	±11,0 - ±19,0 m. Light grey, slightly leached, very fine grained, hard rock, DOLOMITE.
	2'59"				13	
	2'47"				14	
	2'38"				15	
	3'08"				16	
	3'00"				17	
	2'54"				18	
	2'48"				19	
					20	

NOTES:-

1. Borehole drilled to a depth of 19,0 m.
2. Standing water level 17,71 m on 16/12/91.
3. Standing water level 11,55 m on 17/12/91.

GARAMOND

T.C. PARTRIDGE, Consultant in the Earth Sciences

PERCUSSION DRILLING RECORD

Fig.No.

PROJECT: MOTHIBISTAD TOWNSHIP

BOREHOLE NO: 13-86280

MACHINE TYPE: Percussion rig + 18 bar compressor

DRILLED BY: Mmabatho Drillers

DRILLING STARTED: 16/12/91

DRILLING COMPLETED: 16/12/91

LOGGED BY: M.G.K.

KEY

- ▼ Standing Water
- ▽ Water Seepage
- ↕ Air Loss
- ⊔ Casing
- ■ Test and Position

Casing and drill diam.	Penetration (mins/metre)	Chip size Range(mm.)	Additional Data	Geological column	Depth(m)	DESCRIPTION
165 mm	0'09"	1-5			1	0,0 - ±1,0 m. Orange brown, SILTY coarse medium and fine SAND with occasional fine gravels; hillwash.
	0'14"	8 - 40			2	±1,0 - ±3,0 m. Abundant coarse medium and fine GRAVELS of chert and vein quartz loosely packed in a matrix of orange-brown SILTY SAND; pebble marker.
	0'31"				3	
	1'25"	2 - 15			4	±3,0 - ±6,0 m. Abundant chert GRAVELS loosely packed and cemented with calcrete; overall consistency dense; calcified chert residuum.
	1'27"				5	
	1'51"				6	
	2'04"	2 - 10			7	±6,0 - ±14,0 m. Grey, very slightly leached, very fine grained, probably hard rock; DOLOMITE.
	3'00"				8	
	2'25"				9	
	2'32"				10	
	2'59"		▽		11	
	2'30"				12	
	3'04"		▼		13	
	3'12"				14	
					15	
					16	
					17	
					18	
					19	
					20	

NOTES:-

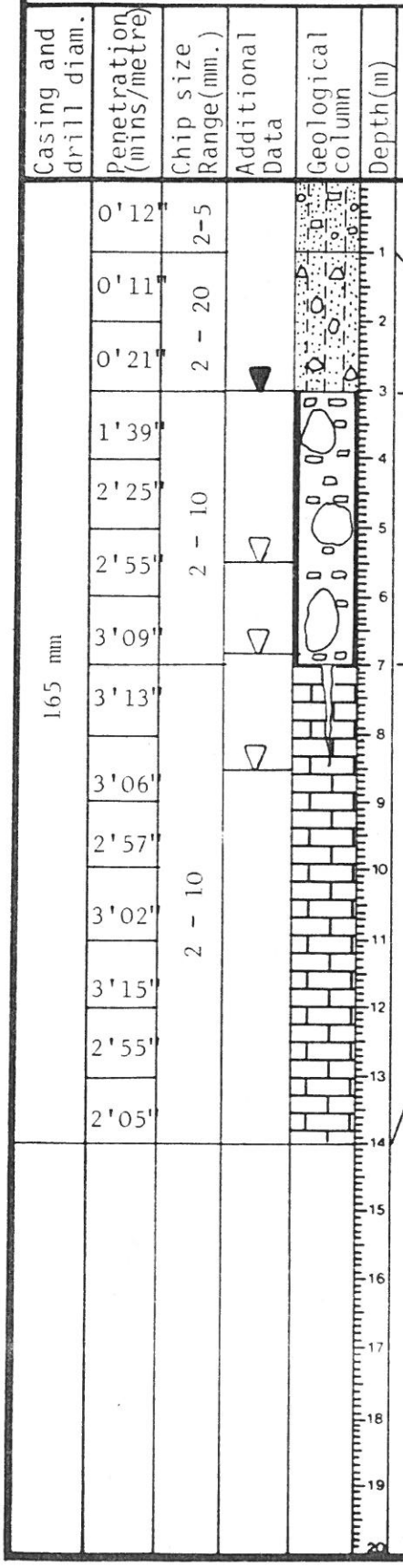
1. Borehole drilled to a depth of 14,0 m.
2. Standing water level 13,2 m on 16/12/91.
3. Standing water level 12,81 m on 17/12/91.

GAMMOND

T.C. PARTRIDGE, Consultant in the Earth Sciences	PERCUSSION DRILLING RECORD	Fig.No.

PROJECT: MOTHIBISTAD TOWNSHIP
BOREHOLE NO: 13-86281
MACHINE TYPE: Percussion rig + 18 bar compressor
DRILLED BY: Mmabatho Drillers
DRILLING STARTED: 16/12/91
DRILLING COMPLETED: 16/12/91
LOGGED BY: M.G.K.

KEY
- ▼ Standing Water
- ▽ Water Seepage
- ↕ Air Loss
- ⊔ Casing
- ■ Test and Position



DESCRIPTION

0,0 - ±1,0 m. Orange brown, SILTY coard medium and fine SAND with occasional fine gravels and calcareous concretions; hillwash.

±1,0 - ±3,0 m. Abundant coarse medium and fine sub-rounded, GRAVELS of presominantly chert in a matrix of orange-brown, SILTY SAND; pebble marker.

±3,0 - ±7,0 m. Abundant leached dolomite BOULDERS, densely packed and cemented with calcrete; overall consistency probably very dense; calcified residual dolomite.

±7,0 - ±14,0 m. Dark grey, slightly leached, very fine grained, probably hard rock; DOLOMITE.

NOTES:-

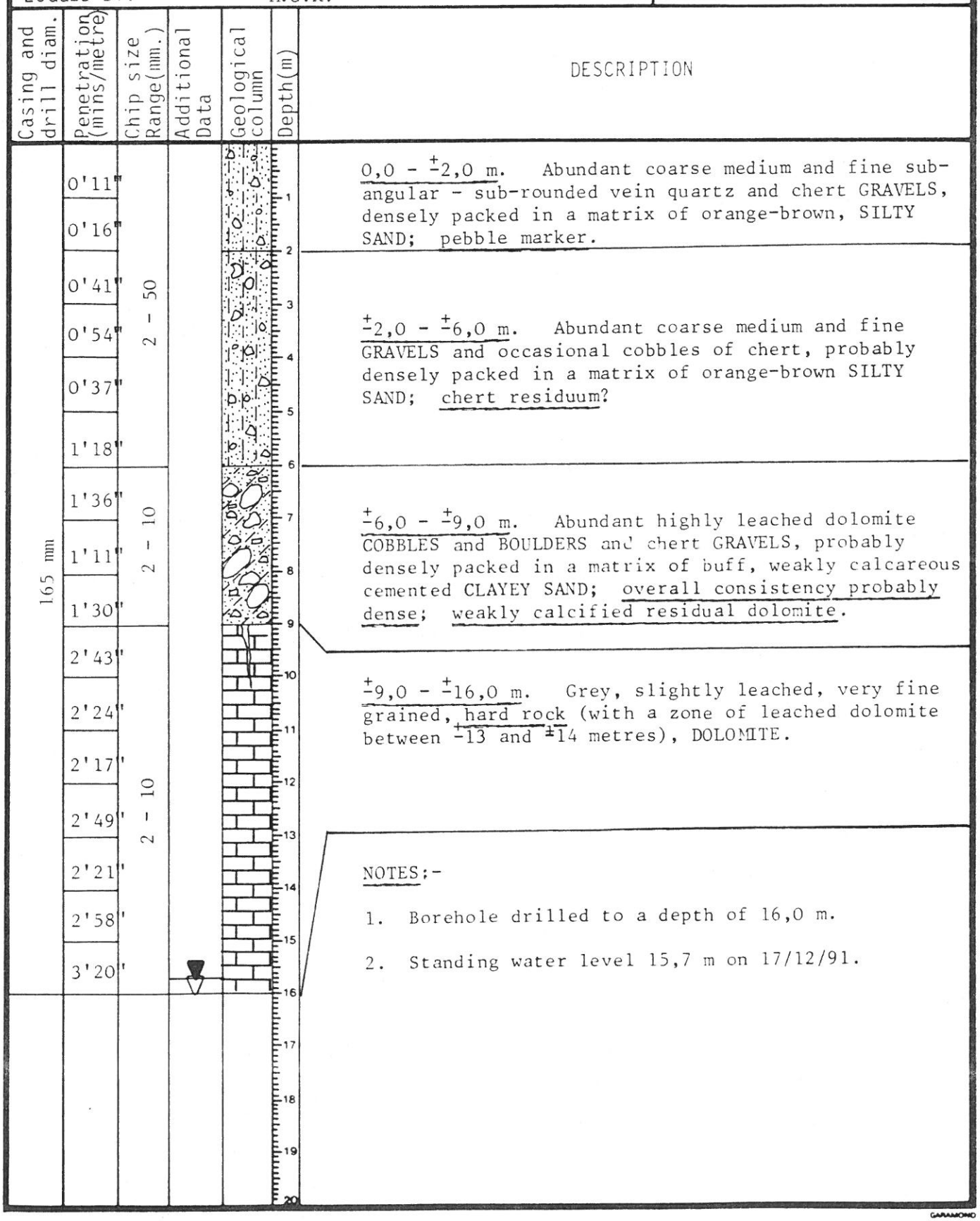
1. Borehole drilled to a depth of 14,0 m.
2. Standing water level 9,51 m on 16/12/91.
3. Standing water level 3,00 m on 17/12/91.

T.C. PARTRIDGE, Consultant in the Earth Sciences	PERCUSSION DRILLING RECORD	Fig.No.

PROJECT:	MOTHIBISTAD TOWNSHIP
BOREHOLE NO:	13-86282
MACHINE TYPE:	Percussion rig + 18 bar compressor
DRILLED BY:	Mmabatho Drillers
DRILLING STARTED:	17/12/91
DRILLING COMPLETED:	17/12/91
LOGGED BY:	M.G.K.

KEY

- ▼ Standing Water
- ▽ Water Seepage
- ↕ Air Loss
- ⊔ Casing
- ■ Test and Position



APPEND C

GENERAL PRECAUTIONS TO BE IMPLEMENTED WHEN BUILDING IN AREAS UNDERLAIN BY DOLOMITE

(7) In the event that there are structures which are not founded directly on dolomite or chert then, because of the possible presence of weak soils beneath foundations, the following measure should be applied : No plants, trees, shrubs, flowerbeds or open soil areas should be situated within four metres of the foundation walls of any structure; lawns are acceptable. The purpose is to avoid the development of wet conditions or moisture gradients near foundations.

(8) Where it is necessary to lay water-bearing pipes beneath the ground surface then the following points must be attended to :

8.1 The NBRI air test for leaks should be conducted on all underground sewerage and drainage pipes laid (see NBRI Information Sheet X/Bou 2-34).

8.2 Corrosion of pipes: Because of the danger of leakage resulting from corrosion of metal pipes in areas where stray electric currents occur, special precautions must be taken.

Under less severe condition, the use of galvanized steel pipes remains the first choice. Proper treatment of such pipes under electro-chemically corrosive conditions is very important in dolomite areas.

For buried, small diamter reticulation within stands, high density poly-ethylene pipes joined by the Plasson-type treaded compression fittings may be used in areas subjected to stray electrical currents. This type of pipe should be laid at least 1.3 m deep to prevent damage from gardening or other activities.