

GEOHYDROLOGICAL INVESTIGATION

MIDDELBURG, C.P.

by

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I. INTRODUCTION

A geophysical survey was carried out on the Townlands of Middelburg and on the surrounding farms to determine where potable groundwater could be developed for municipal supplies.

The investigation was carried out in an area with Middelburg as centre, extending approximately 10 km in all directions.

Previous investigations concerning the water supply of the town are described in the following reports:-

1. "Increasing water supply by drilling on the Townlands of Middelburg, C.P." by Dr. Frommurze (14.12.45).
2. "Boorplekke vir water, Munisipaliteit, Middelburg, K.P." by S.J. van Graan (15.2.46).
3. "Water supply: Middelburg, C.P." by J.F. Gordon-Welsh.
4. "Photo-Inferred aquifers near Middelburg, Cape" by Dr. B.N. Temperley (1.9.70.)

II. PHYSIOGRAPHY

A. Rainfall

The average annual rainfall in this area as measured at the Grootfontein College of Agriculture from 1916 to 1973, is 350 mm per year.

B. Topographical Relief

The south-eastern part of the area consists of a peneplain at an altitude of approximately 1 250 m, while the north-western and south-western portion consist of dissected country which rises to approximately 1 800 m A.M.S.L., this giving a relief of about 550 m. The peneplain descends to 1 200 m where the Klein Brakrivier leaves the area investigated, while Middelburg

Town lies at an altitude of approximately 1 250 m above mean sea-level.

C. Drainage

The Klein-Brakrivier drains from west to east through the southern investigated portion. It is the left bank tributary of the Groot-Visrivier which it joins far outside the investigated area.

III. GEOLOGY

The following geological formations are found in the investigated area:

Sediments

Tertiary to Recent - Alluvium and surface limestone.
Karoo System - Beaufort Series

Intrusions

Dolerite dykes and sills.

A. Karoo System

According to a survey of the country south-east of Middelburg by the Southern Oil Exploration Corporation Limited, most of the area is underlain by the Lower Beaufort beds. The Middle Beaufort beds outcrop on the farms Buffels Valey, Mignon, north-eastern portion of Grootfontein, Vleipoort and Bangor.

The Lower Beaufort beds consist mostly of bands of fine to medium-grained sandstones, alternating with thick bodies of blue and light-green mudstones and shales. The Middle Beaufort beds consist mainly of purple mudstones with bluish to yellowish sandstones.

B. Intrusions

The Beaufort sediments are intruded by numerous dolerite dykes and sheets.

Middelburg is situated in a slightly distorted combination of a ring-dyke and a cone sheet. The western portion mapped indicates the same type of structure but twice as large.

One major dyke runs from south-east to north-west across the area for a distance of more than 30 km, and is faulted on the northern edge.

C. Alluvium and Surface limestone

The Klein-Brakrivier and its larger tributaries are deeply incised in extensive deposits of alluvium which attains a thickness of more than 15 m consisting of silt, clay, sand and gravel intermingled with surface limestone. The most important occurrences are on the farms Buffels Valey, The Glen, Grootfontein, Rusoord and probably Matjieskloof and the Ou Vlei portion of the Townlands.

IV. WATER SUPPLY

The existing water supply are:-

(a) Ou Vlei (Nr. 13)

According to Dr. Frommurze's report, 3 boreholes were drilled at or just above the original spring, a short distance above a masonry weir. These boreholes were from 15 to 24 metres in depth, and encountered dolerite at the bottom. The water flows from the weir by means of a 305 mm pipe line which is fitted with a valve from where it gravitates to the town's reticulation system.

Fig. 1 indicates the amount of groundwater which flowed from the above-mentioned system, and the rest-level hydrograph for the same period.

(b) Nuwe Vlei

These two boreholes are extracting their water from the same source as the Ou Vlei boreholes, and the same aquifers, namely alluvium and dolerite contact. They are situated approximately 300 m north-west of the Ou Vlei boreholes.

According to long term pumpage data, the average combined yield of the two boreholes varies between 512 and 1 287 m³/day. Exceptionally high abstraction occurs during dry periods as for instance December 1969. The ~~depth of the~~ boreholes (No. 4 and 5) according to a previous report, were drilled to 46 and 27 m respectively.

(c) Newman borehole (No. 12)

The depth of this borehole is (according to the consulting engineer's report) 100 m, and yields 23 m³/h.

According to topographical and geological features this borehole extracts groundwater which can be considered as water which is leaking through the Ou Vlei poort, since the annual rainfall infiltration on ^{the} catchment area of this borehole is less than the yearly abstraction.

(d) Matjieskloof Vlei (No. 1 - 4)

Boreholes were selected by the Geological Survey (S.J.v.Graan) and drilled to 30 m, 24 m, 11 m and 24 m respectively. Dolerite was struck at the bottoms of the boreholes. At present boreholes 1 and 2 are in use and the maximum rate at which they have been pumped amounts to 1 389 m³/day.

(e) Midros (No. 8 and 9)

The depths of these boreholes are both 50 m, and yield 28 m³/h and 27 m³/h, and are only used during the summer and dry periods.

Old supplies

(a) Toring pump (No. 11)

This borehole was drilled to 77 metres and yielded 43,5 m³/h during a 24 hour test with a rest level at 13,7 m (date unknown). During January 1970 this borehole was tested again and the yield was found to be 16,4 m³/h. This borehole is situated in the same catchment area as the Newman borehole (No. 12), and extracts most of its water from groundwater leakage through the poort. It is thus logical to reason that the yield of the Toring borehole must fluctuate considerably in dry periods when the water level will decrease in the Ou Vlei poort, and thus the leakage decreases. The Toring pump then only extracts water which has seeped passed the Newman pump. This borehole (No. 11) can thus be considered unreliable when pumped simultanuously with the Newman borehole.

(b) Hospital pump (No. 1 and 2)

The depth is unknown, and the water level originally rose to 13,7 m from the surface. These boreholes delivered 2,1 m³/h during a 24 hour test during January 1970. These sites were not correctly selected, and were drilled 110 m from the dyke contact which dips in the opposite direction. This dyke contact can be considered as a future drilling site.

Boreholes 6, 7 and 10 are fitted with windmills. No information could be supplied regarding their drilling results. Boreholes 6 and 7 have been sited near dolerite dykes and could have a high enough potential for future development.

According to information supplied by the Dept. of Water Affairs, no additional water can be supplied to Middelburg from the Teebus Conway ^{canal} channel, and an estimate of the future requirements of the town is 1 156 000 m³/y for 1980, and 2 004 000 m³/y for 1990.

On the following pages an attempt is made to determine the potential of the boreholes at present in use, in order to determine the probable future shortage.

From GHP 4381, 4382, 4383 and 4384 the following conclusions can be made:

The long term trend of the water level of borehole 14 (Nuwe Vlei) shows a gradual decrease in level from 1966 to 1971, where it stabilises around a level of 10 m. It is apparently caused by a period of below average rainfall in which recharge was insufficient. This statement is justified by comparing the hydrograph with the monthly rainfall cumulative departure curve, which fluctuates almost in sympathy with the groundwater rest levels. The graph and histograms also indicate that when a sudden high rate of discharge takes place for one month, the water level is drawn down within the same month while recovery to the original level takes from 15 to 30 days, depending on the quantity pumped.

The recharge from precipitation effects the water level approximately 30 days after the rain has occurred.

From the hydrograph it can be seen that a total quantity of 283 100 m³ were extracted from boreholes 4 and 5 during 1973 while the water level remained constant in a year of below mean rainfall, indicating that the potential of these two boreholes ^{is} are in excess of the quantity pumped. The high precipitation which occurred during January and February 1974 resulted in a rise of 3 m in water level as indicated on the hydrograph and indicates that the stored water in the aquifer increases considerably with a shallower water level. (Compare above-mentioned recharge with increase of water level of a period such as March and April 1972).

The long term trend of the hydrograph of the Ou Vlei (Bh 13), indicates a slight increase in level from 1971 to 1973 although an amount of 368 000 m³ was abstracted during 1971.

If considering that the Ou Vlei borehole and the Nuwe Vlei boreholes are only situated approximately 300 m apart, and that water level fluctuations and long term trends differ at periods such as 1971 - 1972 without any indication that a dyke or other structure divides them in two different compartments, more boreholes sited 500 m apart should not have any major detrimental effect on the existing supplies when selected with care as to the direction of recharge of the existing boreholes. Such selections can be derived at by constructing a water level contour map of the area.

The maximum quantity of water which has been abstracted from this catchment area, (ignoring one windmill) amounts to 538 150 m³ for 1971. It is contended that the average annual recharge in the catchment areas of these boreholes exceeds by far the annual amount abstracted.

A rough estimation of the safe yield of the Ou Vlei and Nuwe Vlei boreholes are 370 000 m³/y and 190 000 m³/y, respectively.

No estimation can be made concerning the safe yield of borehole No. 3 since the borehole has only been used intermittently for a short period, but it seems to be a very promising future groundwater source. Recharge takes place rapidly. A total amount of 117 650 m³ was abstracted from September to December 1973 during which a drawdown of 3,2 m occurred. This amounts to an average discharge of 96 m³/h for 10 hours a day, while very little recharge took place since precipitation was at a minimum.

From abstraction figures during October 1972 to January 1973, the potential of these boreholes can roughly be estimated as 330 000 m³/y for a below average rainfall year.

Fig. 4 shows the quantity pumped from the Newman pump, Midros 1 and 2 and the total amount from all existing supplies. Since no information and water levels on these boreholes are available, their potential could be estimated on the quantity pumped during years of below mean precipitation.

Newman	54 000 m ³ /y
Midros 1	60 000 "
Midros 2	115 000 "
Ou Vlei	370 000 "
Nuwe Vlei	190 000 "
Matjieskloof	330 000 "
Total amount available	<u>1 119 000 "</u>

According to the estimate of the Dept. of Water Affairs an additional 37 000 m³/y will most probably be required by 1980 and another 885 000 m³/y by 1990.

V. GEOHYDROLOGY OF THE MIDDELBURG DISTRICT AND COMMONAGE

Besides an aerial photographic interpretation, a borehole survey was made in the vicinity of Middelburg, the results of which are given in table I. The positions of the boreholes are plotted on plan GHP 4380.

From the above-mentioned data and field investigations, the following areas are selected for future development of groundwater resources.

A. Middelburg Commonage

Since the alluvium is an aquifer at Matjeskloof and the Ou Vlei areas, more water could be developed in these areas in order to tap the alluvial aquifer at suitable sites.

A major dolerite intrusion (partly dyke and partly sill) near the Zonneboom boundary on the Commonage could act as an good aquifer since it has a thick baked zone from which a small

spring emerges.

Near the eastern boundary the same type of structure is encountered which could also be a good groundwater prospect.

Eight other possible drilling sites are marked on plan GHP 4380 where sites could be selected on dyke contacts. The area in the vicinity of boreholes 1 and 2 (Hospital pump) is considered to be a prospective ~~included~~ area for further development as they are situated too far from the dyke (± 100 m) which is dipping in the opposite direction.

B. Bultfontein (south of Matjeskloof)

Geohydrologically the same quantity of water could be found on this farm as on Matjeskloof. The same types of aquifers are involved while private boreholes selected non-scientifically have proven that high yield boreholes can be developed.

C. Buffels Valey and Dunblane (eastern portion of map)

Extensive deposits of alluvium occur on these farms attaining thicknesses of more than 11,0 m in which boreholes which are situated very close together and pumped simultaneously yield from 227 m³/h to 364,0 m³/h. This farm has the highest yielding boreholes in the investigated area. The catchment area is also very large, and recharge conditions should be such that high pumping rates could be maintained.

On the farm Dunblane a large amount of dykes occur on which no borehole have been drilled. These dykes have well-baked zones and have the potential for high yield boreholes. On a portion near the Buffels Valey boundary thick deposits of alluvium occur which should also be good aquifers.

VI. CHEMICAL CHARACTERISTICS OF THE GROUNDWATER IN THE
MIDDELBURG DISTRICT AND COMMONAGE

The chemical analyses are plotted on the Piper diagram (fig. 1) in order to find the characteristics of the groundwater.

From the above-mentioned diagram, the groundwaters can be classified as follows:

Calcium—Magnesium—Bicarbonate water

Sample 59 - 74 Borehole 2, Tweefontein.

Sample 63 - 74 Borehole 2, Bultfontein.

Sample 67 - 74 Borehole 6, The Glen.

Calcium—Magnesium—Sodium—Bicarbonate water

Sample 69 - 74 Borehole 6, Rusoord.

Sample 60 - 74 Borehole 8, Rusoord.

Sample 71 - 74 Borehole 5, Ravensbourne.

Sample 66 - 74 Borehole 3, Matjieskloof.

Calcium—Magnesium—Sodium—Sulphate—Bicarbonate water

Sample 74 - 74 Borehole 13, Matjiesvlei - Middelburg Commonage.

Sample 61 - 74 Borehole 8, Midros - Middelburg Commonage.

Calcium—Magnesium—Sodium—Chloride—Sulphate—Bicarbonate water

Sample 73 - 74 Borehole 1, Kalkfontein.

Sample 68 - 74 Borehole 2, Marianda.

Sodium—Magnesium—Chloride—Sulphate—Bicarbonate water

Sample 64 - 74 Borehole 3, Buffels Valey.

Sample 70 - 74 Borehole 15, Dunblane.

Sodium—Magnesium—Bicarbonate water

Sample 65 - 74 Borehole 11, Vleipoort.

Sample 72 - 74 Borehole 3, Zonnebloem.

Sodium—Bicarbonate water

Sample 62 - 74 Borehole 5, Middelpos.

According to specifications of the South African Bureau of Standards for domestic water supplies, all the water samples collected from boreholes in the investigated area comply with the requirements, except for sample 61 - 74 from borehole 8 on the Commonage (Midros).

It is unsuitable due to abnormally high magnesium, sulphate and nitrate content.

The high nitrate content in the sample of borehole 8 is probably derived from organic sources such as open pit sewage and a nearby cemetery.

The Council should not allow the use of this water for drinking purposes, as it is a potential danger to infants, and other safe sources should be exploited.

VII. CONCLUSIONS AND RECOMMENDATIONS

A. Since the (additional water) requirements of Middelburg should be of the order of 950 000 m³/year by 1990 (excluding Midros I), a certain quantity of the future water resources will have to be developed on farms in the vicinity of Middelburg, to cope with the probable shortage by the year 2000.

B. A chemical analysis should be done of the water in borehole 9 (Midros II) in order to determine whether any contamination is present like at No. 8. The chances that the water of No. 9 is contaminated are very high.

C. Further water resources can be developed on the Commonage in the areas marked with a circle on plan Ghp 4380.

D. Groundwater can be developed on the farms Bultfontein, Dunblane and Buffels Valey. These farms have numerous drilling sites and have a great groundwater potential.

E. Further groundwater development should be done by the Department of Water Affairs under the control of the Geological Survey.

Geological Survey
PRETORIA

February 1975

2	NO ₃ ⁻	N ⁻	SO ₄ ⁻⁻	HCO ₃ ⁻	(CO ₃) ⁻⁻	NaHCO ₃	Temp. hardness as CaCO ₃	Perm. hardness as CaCO ₃	pH	T. D. S. at 105° (mg/l)	Electri Conductivity at 20°C (umhos)
0	46	10	34	351	0	0	288	83	7,4	465	700
0	7	2	72	473	0	12	380	0	8,0	610	900
0	<u>56</u>	<u>13</u>	<u>432</u>	817	0	0	670	343	7,8	1590	2000
0	19	4	106	470	0	290	203	0	8,0	692	950
0	0	0	38	332	0	0	273	38	7,8	390	650
0	0	0	341	476	60	0	390	315	8,3	1140	1500
0	19	4	46	470	72	0	385	113	8,0	768	900
0	0	0	<u>73</u>	390	0	49	291	0	8,0	843	820
0	0	0	36	256	30	0	210	73	8,0	332	530
0	0	0	262	427	0	0	360	195	7,8	1023	1450
0	19	4	33	372	0	0	302	0	7,9	415	625
0	19	4	182	427	24	0	350	54	8,2	1059	1600
0	0	0	29	159	0	23	117	0	8,2	178	550
0	0	0	122	640	30	119	454	0	8,0	974	1400
1	43	10	97	329	42	0	270	226	8,1	739	1100
,2	9	2	252	366	0	0	300	188	7,9	740	1100

Table 1.- Borehole Information

Borehole Number on GHP 4380	Farm	Owner	Depth (m)	Yield (m ³ /h)	Water Struck (m)	Water level (m)	Formation	Type of pump	Remarks
1-8	Good Hope and Marianda	A J de Reiter	±30,0	±2,7	?	?	Sediments	Windmill	
9	"	"	46,0	68,3	?	?	Alluvium and sediments	"	
10-11	"	"	30,0	2,7	?	?	"	"	
12	"	"	30,0	68,3	?	4,5	"	Turbine	
13	"	"	21,0	27,3	?	?	Sediments	"	
F1	"	"	-	+1,0	-	-	-	-	
1	Oranje Platberg	J J Muller J v Lingen	No information	-	New owner	?	Alluvium and sediments	Windmill	
2	"	"	?	22,8	?	?	Alluvium and Baked sed.	Turbine	
3	"	"	?	2,3	?	?	Sediments	"	
4	"	"	?	2,3	?	?	"	Windmill	
1	Kalkfontein	D S Marais	30,0	2,7	?	21,0	Alluvium and sediments	"	
2	"	"	24,0	Stronge	?	12,0	"	"	
3-9	"	"	30,0	±5,5	?	2,4	Alluvium and sediments	"	
10	"	"	34,0	2,7	?	21,0	Sediments	"	
11	"	"	30,0	Stronge	?	3,0	Baked sediments	"	
12	"	"	30,0	4,6	?	3,0	"	"	
13	"	"	30,0	4,0	?	3,0	"	"	
14	"	"	18,0	27,3	?	0,0	"	Not equipped	
15	"	"	18,0	17,0	?	0,0	"	Turbine	
16	"	"	18,0	17,0	?	0,0	"	"	
17	"	"	27,0	Stronge	?	0,0	"	Not equipped	
F1	"	"	-	0 -	-	-	"	Spring	
1-3	Vleiport	Y Marais	15,0	295,0 Stronge?	?	?	Alluvium and baked sediments	Windmill	
4	"	"	15,0	54,6	?	6,0	"	Turbine	
5	"	"	15,0	7,3	?	6,0	"	Windmill	
6	"	"	15,0	4,6	?	6,0	"	"	
7	"	"	15,0	4,6	?	6,0	"	"	
8	"	"	12,0	3,6	?	9,0	"	"	
9	"	"	12,0	3,6	?	9,0	"	"	
10	"	"	12,0	3,6	?	9,0	"	"	

Not

Well No.	Location	Owner	Depth (ft)	Remarks	Notes
14	"	"	30,0	"	"
15	"	"	37,0	"	"
16	"	"	24,0	"	"
17	"	"	18,0	"	"
F1	"	"	-	"	"
F2	"	"	-	"	"
1	Rusoord	J H Woolman	55,0	136,5	100,0
2	"	"	55,0	31,9	
3	"	"	24,0	13,7	
4	"	"	18,0	41,0	
5	"	"	67,0	45,6	
6	"	"	46,0	31,9	
7	"	"	55,0	68,3	
8	"	"	6,0	22,8	
9	"	"	46,0	182,0	
10	"	"	Spring	318,5	
11	"	"	18,0	22,8	
12	"	"	24,0	13,7	
13	"	"	22,0	Weak	
14	"	"	30,0	13,7	
15	"	"	30,0	Weak	
16	"	"	30,0	Weak	
17	"	"	?	13,7	
18	"	"	40,0	1,4	
19	"	"	?	4,6	
20	"	"	15,0	4,6	
F1	"	"	-	22,8	
1	Waterkloof I	F A Bennie	20,0	1,8	
2	"	"	24,0	2,3	
3	"	"	24,0	4,6	
4	"	"	24,0	4,6	
5	"	"	24,0	4,0	
6	"	"	27,0	4,0	
F1	"	"	-	4,6	
1	Zonnebloem	E A Bennie	14,0	204,8	13,7
2	"	"	14,0	3,6	
3	"	"	14,0	3,6	

Well No.	Location	Owner	Depth (ft)	Remarks	Notes
10	"	"	13,7	1,4	
11	"	"	9,0	6,0	
12	"	"	6,0	6,0	
13	"	"	?	?	
14	"	"	?	?	
15	"	"	?	?	
16	"	"	?	?	
17	"	"	?	?	
18	"	"	?	?	
19	"	"	?	?	
20	"	"	?	?	
F1	"	"	?	?	
1	"	"	18,0	16,7	
2	"	"	14,0	14,0	
3	"	"	14,0	14,0	
4	"	"	14,0	16,0	
5	"	"	-	-	
6	"	"	5,5	5,5	
F1	"	"	8,3	8,3	
1	"	"	8,0	8,0	

3 bore-
holes
close to
each
other

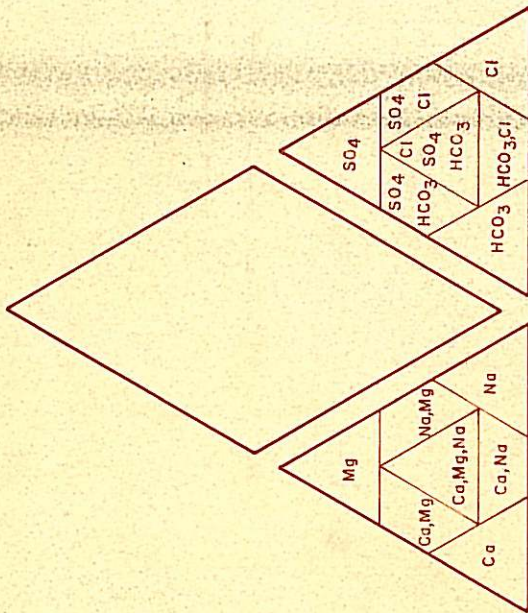
Borehole Number on GHP 4380	Farm	Owner	Depth (m)	Yield (m ³ /h)	Water Struck (m)	Water Level (m)	Formation	Type of pump	Remarks
4	Zonnebloem	E A Bennie	14,0	3,2	?	8,0	Alluvium and sed.	Windmill	
5	"	"	14,0	3,2	?	8,0	"	Not equipped	
6	"	"	21,0	28,0	?	11,5	"	Windmill	
1	Ravensbourne	K W Openshaw	18,0	22,8		12,0	Alluvium and sed.		
2	"	"	40,0	3,6		30,0	Baked sed. Sediments		
3	"	"	40,0	3,6		30,0	"	"	
4	"	"	18,0	2,3		12,0	"	"	
5	"	"	30,0	6,8		18,0	Alluvium and sed.	"	
6	"	"	30,0	6,8		9,0	"	"	
7	"	"	30,0	22,8		12,0	"	"	
8	"	"	18,0	54,6		0,0	"	Turbine Not equipped	
9	"	"	?	Strong		3,5	"	"	
F1	"	"	?	1,8	-	-	Sediments	Spring	
F2	"	"	-	1,8	-	-	"	"	
F3	"	"	-	1,8	-	-	"	"	
F4	"	"	-	91,0-	-	-	Alluvium and sed.	"	
1	Dunblane	E A Gallith	?	273,0	?	?		Windmill	
2	"	"	?	2,7	?	14,0	Baked sed. Sediments	"	
3	"	"	26,0	3,6	?	17,0	"	"	
4	"	"	19,0	2,3	?	?	"	"	
5	"	"	30,0	4,6	?	14,0	"	"	
6	"	"	30,0	4,6	?	26,0	"	"	
7	"	"	30,0	4,6	?	12,0	"	"	
8	"	"	18,0	4,6	?	12,0	"	"	
9	"	"	?	2,3	?	12,0	"	"	
10	"	"	?	2,7	?	12,0	Baked sed.	"	
11	"	"	30,0	9,1	?	18,0	Sediments	"	
12	"	"	27,0	45,6	?	18,0	Baked sed.	Turbine	
13	"	"	30,0	4,6	?	9,0	Baked sed.	"	
14	"	"	30,0	4,6	?	9,0	"	"	
15	"	"	18,0	59,2	?	14,0	Baked sed.	"	
16	"	"	31,0	3,6	?	14,0	"	"	
17	"	"	9,0	4,0	?	6,0	Sediments	"	
18	"	"	28,0	9,1	?	14,0	"	"	
F1	"	"	-	3,6	-	-	Baked sed.	Fountain	
1	Middelpos	N Smit	18,0	2,7	?	3,0	Sediments	Windmill	
2	"	"	18,0	4,6	?	4,6	"	"	
3	"	"	15,0	9,1	?	6,0	"	"	
4	"	"	15,0	9,1	?	6,0	"	"	

Borehole Number on GHP 4380	Farm	Owner	Depth (m)	Yield (m ³ /h)	Water Struck (m)	Water Level (m)	Formation	Type of	Remarks
2	Grootfontein	College of Agriculture	43,0	0,1		32,0	Sediments	Windmill	
3	"	"	47,0	13,6	40,0	12,0	"	"	
4	"	"	56,0	0,2	21,0	17,0	"	"	
5	"	"	46,0	1,8	?	?	"	"	
6	"	"	34,0	9,1	-	20,0	"	"	
7	"	"	76,0	0		-	"	"	
8	"	"	46,0	10,5	38,0	7,5	"	"	
9	"	"	31,0	2,1	19,0	10,0	"	"	
Information on rest of boreholes not known									

PIPER — DIAGRAM

FIG.1

Classification of water



Total dissolved solids

Name	ppm
Fresh water	0-1000
Brackish water	1000-10,000
Salty water	10,000-100,000
Brine	More than 100,000

