REPORT

OF THE

KLIP RIVER INVESTIGATION COMMISSION

Presented to both Houses of Parliament by Command of His Excellency the Governor

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The Klip River Investigation Commission.

TO HIS EXCELLENCY THE GOVERNOR.

MAY IT PLEASE YOUR EXCELLENCY :

We, the undersigned Commissioners, having been appointed under Commission issued by Your Excellency dated the 29th August, 1908, for the purpose hereinafter mentioned, have the honour to submit the following report.

PREFACE.

1. The Terms of Reference to Your Excellency's Commissioners were to inquire into, and report on, the following matters :—

1. The present position of the perennial flow of the Klip River (near Johannesburg).
2. The alleged diminution of or interference with such flow, and the causes thereof.
3. What action, if any, is necessary or desirable with reference to such diminution, or interference with the flow, if it has occurred.

INSPECTIONS.

Your Commissioners inspected the Klip River Valley, the course of the river, its tributaries and its springs, on seventeen days, viz. : 1st, 2nd, 7th, 8th, 9th, 10th, 24th, 25th, 28th, and 29th September, 20th November, 1908 ; 4th June, 28th July, 7th August, and 3rd and 4th December, 1909.

During these inspections the valley was seen

(*a*) at the end of what was asserted to be a period of comparatively dry years :
(*b*) after the drought had been broken up by abnormal rains ;
(*c*) towards the close of the year 1909, when it may be assumed that normal conditions were to some extent restored.

SURVEY.

It was found necessary for the purposes of the Commission, and in order to establish an unchallengeable record of the topographical and statistical conditions, to obtain a complete cadastral survey of the Klip River Basin.

Accordingly, at the suggestion of Your Commission, addressed to the Honourable the Minister of Lands, the Surveyor-General of the Transvaal deputed Surveyor Pizzighelli to undertake this work. The survey was commenced in October, 1908, and the plans were received by us in August, 1909, and are now registered and recorded in the office of the Land and Irrigation Department.

Your Commission found it desirable also to have a series of tests carried out, under the supervision of the Government Analyst, the results of which will be more fully referred to later.

PREVIOUS REPORTS.

Part of the subject matter of the Commission's Terms of Reference had previously been dealt with, to a certain extent, either incidentally or directly, by two Commissions, viz., the Witwatersrand Water Supply Commission (1901-02) and the Inter-Colonial Irrigation (1905-07).

It was also extensively referred to in the proceedings of the Rand Water Board Arbitration Court (1901-05).

The evidence given before these bodies, notably that adduced by experts (called with reference to the water supply of the Witwatersrand) was of great assistance to us, but it was advisable to have the views of such experts, based upon the knowledge of facts known at the time, brought up to date; and there were many features in connexion with the present inquiry which had not been previously considered.

SITTINGS.

Your Commission, therefore, sat for the hearing of evidence on twenty days, during which eighty-seven witnesses were examined.

The full evidence accompanies this report, but has not been printed; a précis of it, on points of special importance, is attached in different appendices.

INTRODUCTION.

Klip River Catchment Area.

As will be seen from Appendix "A" to this report, the geographical catchment of the Klip River and its tributaries has been estimated at from 818 to 880 square miles, of which from 261 to 327 square miles are believed to be on dolomite formation. It is impossible to obtain exact information on this point, as the extent of the geological catchment area does not necessarily coincide with that of the surface; and it is equally impossible to give the exact extent of the dolomite area, owing to the absence of a reliable geological map of this part of the country.

A very large section of the Witwatersrand, viz., all that portion of it between Kleinfontein and Krugersdorp, is included within this area. The different spruits which form the Klipspruit, the largest tributary of the Klip River, as also the Natal (Riet) Spruit, have their sources in the Witwatersrand formation.

Through this basin the Klip River flows for a distance of fifty miles. For the first twenty miles of its course it runs from west to east, practically parallel to the Witwatersrand. It then, at Kromvlei, turns to the south until it reaches the Vaal River, about one and a half miles above Vereeniging.

The valley through which the Klip River runs is very fertile and closely populated. The eighteen farms which it touches in its course contain a white population of approximately 2180 persons, who almost exclusively derive their existence from the cultivation of the riparian lands.

Of the area of these riparian farms, viz., 68,752 morgen, some 1641 morgen are irrigated at present, while an additional 766 morgen could be brought under irrigation by the use of water furrows. A considerable proportion of the remaining area is being used for dry land cultivation; this area could be extended to 20,000 or 30,000 morgen.

A fuller statement of the information given in the last preceding paragraph is appended (Appendix "B").

GEOLOGICAL FEATURES.

As will be seen from the appended geological plan and report, prepared by Dr. Humphreys, B.A., Ph.D., and appended (Appendices "C" and "D"), the centre of the Klip River Valley consists of Dolomite underlain on the north by Black Reef Series and Amygdaloidal Diabase, which latter forms the hills known as Klipriversberg. To the south the Dolomite area is bordered by overlying sandstones and shales of the Pretoria Series, forming the range known as Gatsrand. In the Dolomite are interstratified bands of Chert, the outcrops of which are very numerous especially in the upper portions of the series. Igneous dykes intersect the Dolomite at different places.

An Addendum to this report embodies the views of Dr. E. Jorissen on the character and the water storage of the Dolomite of the Klip River. These views are accepted by the Commission and are supported on many points by the evidence and by the results obtained during the boring operations of the Rand Water Board.

HYDROGRAPHIC FEATURES.

(*a*) The Klip River and its Tributaries.

Klip River.

The Klip River has its origin at the eastern extremity of the Zuurbekom basin. This basin is filled with coal measures consisting of a layer of dwyka conglomerate overlaid by alternate layers of sandstone and shale covered by red soil. The greatest depth of the basin so far known is 530 feet; it is estimated to have a superficial area of some eighty or ninety square miles. As the basin is flanked to the north and south by higher ground, its catchment area is increased by another seventy square miles. This catchment area lies partly in Pretoria Series (Gatsrand) to the south, and Black Reef Series and Amygdaloidal Diabase to the north.

There are no streams running into the basin so that it obtains its store of water from rainfall only. On its western extremity are found the Gemsbokfontein springs, forming part of the sources of the Wonderfontein Loop.

The first sources of the Klip River are immediately below the eastern edge of this basin. A large number of springs known collectively as Klipriversoog, form a large vlei, which extends to the east for some four or five miles, its average width being perhaps 400 to 500 yards. It is joined some three and a half miles down by a smaller vlei which forms the lower portion of the Klipspruit. It is probable that the river receives additions from further springs in the vlei; and below the latter, on the farm Misgund, some very strong springs known as Bennett's appear in and close to the course of the river, as does another (unnamed) lower down. Bennett's springs are in the vicinity of a dyke which crosses the river below them. The Klip River then passes Jackson's Drift; about a mile below that drift there is another spring known as Van Zyl's, not far from the southern edge of the vlei through which Klip River runs. This vlei extends for some five or six miles past the farms Petrusvlei, Kromvlei, and Allwynspoort (where some further springs rise in the river banks and in its course), and through Zwartkopjes.

Emerging from the latter, near the southern boundary of Zwartkopjes, the river is crossed by the railway and, passing the Klip River Station, runs through the farm Waterval. It then crosses the farm Witkop, on the northern portion of which (Schalkwyk's) a very strong spring formerly existed, a few hundred yards above (west of) the course of the river.

The river then traverses the farms Witkop, Witkoppies, and Slangfontein, on all of which smaller springs are found in or near its banks. Some five miles lower another very strong spring, know as Kookfontein, is found some hundred yards west of its course. The river then crosses Waldrift and Klipplaatdrift and joins the Vaal River above Vereeniging. At Vereeniging itself, springs are found on the northern banks of the Vaal River, the strongest of which is used for the water supply of the town.

In addition to the vleis mentioned, smaller ones are found in the course of the river at different places.

At Henley-on-Klip, on the farm Slangfontein, the river is dammed back for a considerable distance, by a large dam, and some other dams have been constructed below Zwartkopjes within the last four or five years.

Tributaries.

Klip River is joined below the Oog by the Doornkop Spruit, which is not of much importance as its volume is (and has been for many years) absorbed for agricultural purposes during average seasons on the farms (notably on Doornkop and Vlakfontein) which it traverses.

The second, and by far the most important of the tributaries is the Klipspruit, which consists of a number of smaller spruits, having their origin on the farms Turffontein, Langlaagte, and others. Its two chief sources are the streams known as "Booysens" and "Langlaagte", which join above the large dam known as the Canada Dam. Some distance below this reservoir, another spruit, known as "Florida Loop", joins the Klipspruit, and it is also joined by other streamlets of less importance before it reaches, between Klipriversoog and Olifantsvlei, the large vlei which joins the vlei of the Klip River below the Oog, as explained before.

The Klip River receives no other tributaries of any importance until it is joined by Rietspruit (Natal Spruit) from the east (at Waterval), and the Nooitgedacht Loop from the west, on the farm Witkop.

The whole of the valley of the Klip River catchment area is drained solely by the Klip River and its above-mentioned tributaries, subject, however, to two considerations which will be dealt with later, viz.:—

(i) The outflow from the Zuurbekom basin at Gemsbokfontein.

(ii) Underground drainage.

(*b*) Water Resources of the Klip River Catchment Area.

As the great height above sea level of this area, and the large distances which separate it from higher formations, appear to preclude the probability of any extraneous sources, the Commission has been at great pains to obtain the latest and most reliable information on the subject of the replenishment of the basin, which was also closely inquired into by the previous Commissions referred to.

The first matter to be considered in this connexion is that of the annual rainfall.

Mr. H. E. Wood, Chief Assistant of the Transvaal Meteorological Department, has prepared for this purpose three tables, which are attached (Appendix "E"), together with the reports accompanying the same.

From the first of these it appears that the average rainfall of the whole of the Transvaal from the year 1895, since when general observations have been made, works out at 32·11 inches.

The second table gives the records obtained at Joubert Park, Johannesburg, for twenty years from the year 1888 to 1908.

The third gives the annual rainfall near the Klip River Valley from 1903 to 1909.

From the last it appears that during the last six years the annual rainfall in this area varied from 21·85 inches (1904-05) to 41·27 inches (1908-09), the mean average being 29·06 inches.

Run-off and Percolation.

We have been asked by the expert witnesses who gave evidence before us to draw a sharp line between the run-off from that portion of the catchment area which is on the dolomite and that on other formations, from which most of the tributaries of the Klip River draw their supplies.

At the outside, therefore, great uncertainty and a considerable difficulty in estimating run-off and percolation arise from the fact that not only the exact extent of the catchment area itself, but also its apportionment between dolomite and non-dolomite areas, is a matter which cannot be definitely arrived at, and is the subject of considerable difference of opinion on the part of the expert witnesses themselves (see Appendix "A"). And again, the proportions of surface water which should be assumed to reach the lower beds of the dolomite by percolation is apparently a matter of much uncertainty. At all events the estimates given by the various experts (Appendix "F") vary to a very remarkable extent.

We believe it to be improbable that any approximate accuracy will ever be obtained on this subject since the solution seems to depend on a large number of factors which make exact calculation impossible. It appears, for instance, that the percentage of run-off absorbed by the soil depends quite as much upon the manner in which the rain falls, as it does upon the quantity. A very heavy downpour falling within a short period may be followed by less percolation than intermittent showers spread over several days of cloudy weather, which may aggregate a far smaller total of rainfall than the former.

Another very important factor is evaporation, which again depends upon circumstances which it is most difficult to gauge, for instance, the effect of the vleis, which are confidently asserted to increase evaporation to a most remarkable extent (see evidence of Messrs. Leitch and Melville, attached under Appendix "G").

The most puzzling feature, however, in connexion with percolation is the divergent nature of the surface of the dolomite. In some instances when the fissures it contains are large and near the surface, it is possible that no run-off whatever takes place, the rainfall being absorbed almost immediately. We had a very striking instance presented to our observation at one of the Rand Water Board pumping stations (Borehole H) where, for the purpose of cleaning the supply from the wells, a large volume of water (500,000 gallons per day) had been discharged on the veld for a considerable period and disappeared below the surface within a hundred yards.

Under all these circumstances it seems very difficult to arrive at any definite results. In other localities it might be possible to work out the solution backwards, in the manner suggested by Mr. Karlson, e.g. to deduct from the total quantity of water deposited by rainfall on the catchment area the amount of the run-off in flood and through springs at ordinary times, and call the balance evaporation, after making allowance for what is consumed for irrigation and other purposes. But such calculation does not seem possible here for a reason that in our opinion make all above estimates and calculations of little practical value. This reason is the existence of the large underground drainage, which appears to find its way down the Klip River Valley in the direction of the Vaal River without ever seeing daylight.

That this drainage exists seems clearly proved from the fact that the boring operations of the Rand Water Board have in all instances led to the discovery of water. In some instances the water so found has not been strong enough to warrant exploitation but in most instances it was capable of being developed by cross driving into a large supply.* Other facts given in evidence, brought together under Appendix "H", support the inference that much of the water percolating into the Klip River catchment area does not see daylight north of the Vaal River; the existence of this stream and its probable course have also been clearly demonstrated in the Addendum of Dr. Jorissen already referred to.

Assuming, as we feel bound to assume, the existence of such important underground drainage, and recognizing its volume as practically inascertainable, even approximately, it seems useless to consider calculations as to the quantity of water deposited annually on the catchment area and the percentage of same percolating into the soil, when it cannot possibly be ascertained what proportion of the rainfall is lost to the catchment area by underground flow.

REPORT.

First Point of Reference.

Position of the Klip River at and subsequent to the time of Reference.

It is a matter of great regret that no reliable continuous records exist as to the volume of the flow of the Klip River. Three gauging weirs have been constructed in its course at different places. The highest of these, at Jackson's Drift, was apparently constructed in 1899, but its use has been discontinued for a number of years. The scanty evidence as to measurements taken by its means and at other places is tabulated in Appendix "J". It appears also that in any event many of these records are not of much use, as a very large quantity of water is taken from the river above it for the purpose of irrigation, and without simultaneous measurements of the volume of water in the furrows, gaugings at the weir are of little importance.

The second weir, or rather its remains, were seen by Your Commissioners near the railway bridge on the farm Zwartkopjes. No records of measurements taken there appear to be obtainable beyond those taken by Mr. Pizzighelli, which will be referred to later.

The last weir is some two miles above the junction of the Klip River with the Vaal River. Continuous and reliable measurements at this weir would be of great value. Unfortunately all that could be obtained are those set out in Appendix "J".

Under these circumstances we had largely to fall back upon the evidence of persons who live in the valley or who have otherwise had opportunities of observing the variations in the volume of water. These are based, not upon accurate measurements, but upon approximate estimates and mental comparisons of the quantity of water from year to year. In its nature such evidence cannot be exact and, however bona fide, is liable to a great deal of miscalculation. To give an instance in point: Evidence was given as to a large decrease in the volume of the Kookfontein spring, ascertained by means of actual measurements, while on the other hand, Mr. MacKay, the tenant of that farm, had constantly used the water from 1887 and assured us that the spring had in no way decreased.

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* See evidence of Mr. Leiteh, Questions Nos. 5604 to 5621; and Mr. Sullivan, Questions Nos. 5989 to 6015.

In Appendix "K", extracts of the evidence as to the volume of the river given by a number of witnesses is set out. It will be noted that considerable difference of opinion exists on the point, but the weight of testimony is overwhelmingly in favour of the contention that there has been a very serious decrease in the volume of the Klip River during the last six or seven years, and this is confirmed by the measurements taken by Mr. Pizzighelli in 1892; a précis of his evidence on this point is added to Appendix "K".

The finding of Your Commission, however, on this issue does not rest solely upon the facts set out above.

As already mentioned we were able to make personal observations of the conditions existing in the valley at three periods, the first during September, 1908, at the end of what was described as a period of drought; the second during June, July, and August, 1909, after the abnormal rains of that year; and the last in December, 1909, when normal conditions had been to some extent restored.

Comparative observations made at these inspections are set out in Appendix "L" to this report.

We wish to draw special attention to one or two features of our 1908 inspection:

(*a*) It was found that all the tributaries of the Klip River had ceased to flow.

(*b*) The vleis in the Klip River on lower Zwartkopjes were absolutely dry, and contained no moisture even in trenches cut across it at a depth of some eight or nine feet.

This applies also to some of the vleis in the higher reaches of Klip River and to the vlei of the Klipspruit above its junction with the Klip River. The only vleis or portions of vleis still containing moisture were those below the springs in or near the river bed already referred to. Between these springs there was no water at all in the river in many places.

(*c*) Much attention, both by way of evidence and observation, was given to the condition of the different springs: as to these

(i) very conflicting evidence was tendered to us as to the condition of the upper springs, Oog van Klip Rivier, a précis of which evidence is attached (Appendix "M").

From this it appears that while it is alleged on the one hand that these eyes have much diminished in strength and that some of them, notably one on the south-west of the Oog, had ceased to flow altogether; the Rand Water Board produced tabulated returns (Appendix "N") to show that there was no noticeable lowering of the vlei in which the springs arise.

A similar assertion was made by the Johannesburg Waterworks Estate, before the Arbitration Commission in 1901-05. The comment, however, by Mr. Leitch, at that time already Chief Engineer of the Rand Water Board, was as follows:—

"(Mr. Ward).—And the levels of the vlei? (Mr. Leitch).—Yes; that was also obtained from the records of the Company. I am sorry the records are rather fragmentary, so that one can't piece the data together so well as one could wish; as far as they go they show distinctly that the pumping has affected the level of the water in the shafts and in the vlei also."

The present assertion of the Board is to some extent supported by the comparative levels of the vlei and Hartzenberg's furrow, taken by Mr. Pizzighelli, from which it would appear that the level of the water in the vlei at this point cannot be much lower now than it was when Hartzenberg constructed his dam about a mile below the Oog, in 1857.

It is difficult to reconcile these conflicting assertions except on the assumption admitted as possible by Mr. Leitch, in evidence, that a diminution in strength need not necessarily lead to a lowering of the water level of the vlei.

(ii) *Bennett's Springs.*—It is admitted on all sides that the volume of these have not diminished in strength.

(iii) *Van Zyl's Spring.*—From the evidence, a précis of which is attached (Appendix "O"), it appears that this spring has suffered a very serious reduction in strength.

(iv) *Minor Springs.*—Between Van Zyl's and Kookfontein. Some of these were also stated to be much weaker.

(v) *Schalkwyk's Spring.*—From incontestible evidence produced this must have been a very strong spring. One-half of the water from it was let to the old Sanitary Committee at £1000 a year for the use of the wash-boys of Johannesburg. When inspected in September, 1908, it had ceased to flow.

A précis of the relevant evidence on this point is attached (Appendix "P").

(vi) *Kookfontein Spring.*—From the evidence of Mr. Laschinger it seems that this spring had diminished in volume, between the years 1899 and 1908, from 800,000 to 150,000 gallons per day. On the other hand, the tenant, Mr. MacKay, maintained that it was as strong as it had ever been.

(vii) *Vaal River.*—The chief spring, on the north bank of the Vaal River, originally estimated at some 10,000 gallons a day, had been opened up, and now yields from 90,000 to 100,000 gallons. It is covered in and used by the town of Vereeniging.

All the above refers to observations made and evidence collected at the time and immediately after the first inspection.

The effect on the springs of the unusually heavy rains in the earlier part of 1909 was, as far as the Oog was concerned, that after a rise apparently due to surface accession the vlei soon receded to its former level.

The spring at Van Zyl's was little affected by the rains, and when last inspected (3rd December, 1909) it was very weak.

Schalkwyk's spring is believed to have been affected by the result of these heavy rains: it is, however, difficult to ascertain this definitely as it rises in a dam, which has other sources of supply. These have since been temporarily cut off, and it is now certain that this spring has practically ceased to flow.

Second Point of Reference.

Re Diminution of the Flow, its Results and Causes.

Present Position.

There was, at the last inspection (December, 1909), a good deal of water in the Klip River, chiefly due to the fact that recent rains had made irrigation unnecessary, but when there had been an interval between the rains, as had recently been the case, the insufficiency of water had at once made itself felt.

Summing up the whole position, it has been established that there has been a very serious decrease in the volume of the Klip River, and we have no doubt that as soon as the conditions which existed previous to the 1909 rains recur, as it may be anticipated they will, the scarcity of water which then existed will be repeated, in all probability, to a more severe extent.

Results of the Diminution of the Flow.

There can be no doubt but that the reduced water supply in the river, its tributaries and its springs, has inflicted great loss and injury on many of the riparian farmers.

Abstracts of the evidence on the question of the reduced flow and losses sustained are attached (Appendices "Q" and "R"). From these it will appear that not all of the farmers have been equally affected. The chief sufferers have been the owners, lessees, etc., of the farms Klipriviersoog No. 47, Rietfontein No. 48, Olifantsvlei No. 60, District Krugersdorp; Kromvlei No. 282, Waterval No. 209, Zwartkopjes No. 262, and Witkop No. 66, District Heidelberg, while others, such as Eikenhof No. 14, District Johannesburg, have not as yet suffered actual injury, but the owners assert that if the causes of diminution continue they will soon find themselves in the same position as their less fortunate neighbours.

It is very difficult to gauge the actual loss which has been incurred or which may be anticipated in individual cases, as this largely depends upon the market valuation of the crops which have been lost. It may be broadly stated, however, that on many of the riparian farms of the Klip River, which have previously had an abundance of water, the owners cannot count with any degree of certainty upon being able to harvest what they sow; that the value of their property as well as the chances of obtaining their living from the soil have been considerably reduced, and that should the position as it existed in 1908 revive, their farms will become practically valueless for agricultural purposes; and it should be noted also

that in some instances tenants have already been forced to abandon the ground occupied by them.

The fact that the Klip River Valley is so near to the Johannesburg market, and its great fertility, have resulted in high prices having been paid for land which now appear not to have been justified, so that in many instances the owners are threatened with ruin.

Causes of Diminished Flow.

A number of causes of the reduction of the volume of the Klip River have been urged before or suggested to Your Commission, viz. :

(*a*) A succession of dry seasons preceding the year 1908.
(*b*) Change in the surface of the watershed and consequent increased run-off and decreased percolation.
(*c*) Interference by the mines by means of
(i) the draining of the formation by pumping from the deep level shafts :
(ii) the erection of a number of dams on the rivulets which form the Klipspruit and on other tributaries of the Klip River.
(*d*) Pumping by the Rand Water Board.
(*e*) Alterations in the water-carrying underground fissures of the dolomite formation.

It has also been urged on behalf of the representatives of the mines and the Rand Water Board that the diminution in the Klip River is more apparent than real, and that the scarcity of water complained of by the farmers is due to the increase in the area of the lands under the plough and to intenser cultivation.

Dealing first with the latter points, Your Commissioners find that the area under cultivation has been considerably added to during the last twelve or fifteen years, although such increase was naturally arrested when the scarcity of water began to make itself felt.

It is admitted also that the crops now grown in the valley (lucerne, vegetables, etc.) absorb much more water for irrigation than the cereals which were raised formerly.

No doubt these causes accentuated the insufficiency of the water supply, but obviously they cannot explain the shortness of water, amounting to practically entire failure on the upper farms below the Oog ; nor do they in any way account for diminution or drying up at some of the springs, at the Oog, at Van Zyl's, Schalkwyk's and on other farms.

The evidence adduced by the farmers tends to show that if the river were brought back to the position of fifteen years ago there would be sufficient water for all the lands now below furrows.

Your Commissioners will now deal with the alleged causes of the diminished flow.

(*a*) A Succession of Dry Seasons Preceding the Year 1908.

In the absence of reliable statistics running back for a number of years, we find it very difficult to arrive at a definite opinion as to what amount of rainfall may be regarded as normal, and to what extent therefore, if any, the rate during the last fifteen years fell below the average.

A number of the complainants admitted in evidence that there had been less rain in the years between the war and 1908 than had been experienced by them previously.

At the same time it was pointed out by them that previous dry years, or successions of years, had never had so serious an effect on the Klip River. Mr. Gideon van Zyl (one of the oldest inhabitants of the valley), for instance, stated that in his experience of forty-seven years, he had never known the Klip River to stop running at Jackson's Drift as it undoubtedly did in recent years. He and others especially refer to the year 1862 as a particularly dry year when, they stated, there had been no scarcity of water.

Another witness, Mr. J. P. Meyer, stated in evidence :—" It is a well-known fact that we are suffering from dry seasons at present, but it is also a fact that we suffered from dry seasons previously and during those dry seasons the Klip River never decreased in volume."

From the rainfall records obtained at Joubert Park, and given by Mr. H. E. Wood in Table 2 (Appendix " E "), it would appear that the mean rainfall there during the years 1888–89 to 1907–08 was 30·71 inches and that while the average

during the first five of these years (29·15 inches) was below this figure, those of the second, third, and fourth periods of five seasons were well above it (31·10, 31·25, 31·36 inches respectively).

The average rainfall throughout the Transvaal, given by Mr. Wood in Table 1, averages 32·12 inches for the period 1895–96 to 1908–09. The years 1900–01, 1903–04, 1906–07, and 1908–09 are well above the average, 1901–02 and 1902–03 are about the average, while 1904–05, 1905–06, and 1907–08 are below it.

Divided into quinquennial periods, 1899–1900 to 1903–04, and 1904–05 to 1908–09 are well above the average.

Taking all the above facts into consideration, we find it difficult to believe that the ten years preceding 1908 have been abnormally dry or that the conditions of the rainfall during that period were such that they may not be anticipated to recur.

Assuming, however, that there has been a decrease in the flow of the Klip River, due to drought, it should be remembered that any additional diminution caused by the artificial interference would be all the more grave in its consequences since it would cause a lesser flow at a period when the water in the river had already been diminished, and when by reason of the drought, the water would be all the more urgently required.

(*b*) Alterations in the Surface of the Soil.

It was suggested to Your Commissioners that the run-off of the rain-water had been much promoted, and in consequence percolation diminished by the fact that much of the surface of the soil of the watershed had been entirely changed in character. It was pointed out that the erection of a large number of buildings, the construction of streets and roads, the grazing down of the veld and the consequent hardening of the top of the soil, which had formerly been kept soft by vegetation, had had the result that a great percentage of water which formerly sank into the soil now ran off without appreciable percolation.

It is impossible to arrive at any definite conclusion as to the effect of these superficial changes; and it is possible also that the result suggested may have been to some extent counterbalanced by the fact that a considerable portion of the watershed area had been broken up in the course of dry-farming, which would undoubtedly tend to assist percolation.

It should further be noted that, as will be pointed out later, a very large percentage of this increased run-off is preserved in dams and in that manner retained in the watershed.

(*c*) Interference by the Mines by means of—

(i) Draining of the formation by pumping from their shafts.
(ii) Erection of a number of dams on the rivulets which form the Klipspruit and on other tributaries of the Klip River.

General Position.

It appears that some sixty gold mines actually at work are on the Klip River catchment area. Their names and sites are set out in Appendix "S", furnished to us by Mr. R. N. Kotze, Government Mining Engineer. From this it also appears that the tons of ore milled by these mines during the year ended 30th June, 1908, amount to 13,884,922 and for the year ended 30th June, 1909, 16,322,197.

We have it in evidence from Mr. Kotze that from 300 to 400 gallons of water are absorbed by evaporation, etc., for every ton of ore crushed.* The total number used in the milling of the above tonnage during the year 1908, calculated at an average of 350 gallons per ton, was, therefore, 4,859,722,700, and in 1909 was 5,712,768,950.

This water is obtained in two ways :—

(*a*) By pumping from mine shafts.
(*b*) From storage by means of dams situated mainly in the watercourses in the vicinity of the mines.

(*a*) *Pumping from Mine Shafts.*

From Appendix "S" it appears that the average amount of water pumped daily by thirty-two mines on the Klipspruit, Doornkop Spruit, and Natal Spruit areas, from their shafts, during the year ended 30th June, 1908, amounted to 8,656,100 gallons, and to the 30th June, 1909, to 10,691,888 gallons.

* Mr. E. H. V. Melville gives the figure at 300 gallons.

This water is encountered at different depths in the different mines. The information relative to this is also shown in Appendix "S".

It is difficult to ascertain even approximately what effect has so far been produced by this pumping from the shafts. In the first instance cones of depression are created which are filled up again by percolation, and to that extent the run-off is undoubtedly diminished. But the area of such cones and the period it would require to again saturate them it is impossible to calculate. Some indirect conclusions may be drawn from Appendix "T", which contains information collected by the Mines Department on the question as to whether the water appearing in the mines is diminishing or not. The evidence on this issue is conflicting, but may be broadly taken to show that in most cases the water has either decreased (in some instances to a considerable extent) or is stationary. In a few cases only has the water increased. From a further question put and answered in the same Appendix, it is clear that in the majority of cases the top levels of the mines are already drier than they were in the earlier days of mining, and ultimately the subtraction of 10½ million gallons a day cannot but affect to an important extent the whole water supply of the catchment area.

(*b*) *Storage of Water by means of Dams.*

The second source of the water required by the mines for milling purposes is from the reservoirs constructed by them in the different watercourses of the Klip River watershed. Appendix "U" gives a list of these dams, with their storage capacity on the 30th June, 1909.

The interference with the flow of the river by these mine dams appears to be of a very grave nature. Its results are most noticeable in the Klipspruit.

A map of the Klipspruit and its tributaries (Appendix "V") is attached showing the position of seventeen dams on the different spruits. The cumulative effect of these dams is that in dry seasons they absorb not only the normal flow of the streams but also capture the entire storm-water collected from that area, so that, with the exception of some seepage from the dam walls and a few unimportant springs between them, the tributaries of the Klipspruit and the latter itself cease to run for the whole year. In years when the rainfall reaches or exceeds the average, a great deal of storm-water finds its way down the spruits and joins the Klip River notwithstanding the existence of these reservoirs. After the heavy rains in the beginning of 1909, for instance, an enormous quantity of water passed the Canada Dam, which is the lowest dam on the Klipspruit; and from a statement put in by the General Manager of the Consolidated Main Reef Deep Gold Mining Company, Limited, which constructed this dam in 1903–04, it appears that there was an overflow in April, 1904, again in February, 1906 (when the bywash had to be enlarged), and again in February or March, 1907. It should be noted moreover, that, owing to the practical stoppage of all mining during the war, the reservoirs were all filled in 1903, so that a comparatively small rainfall would cause an overflow, a condition which is not likely to recur at the commencement of a series of dry years.

The Water Supply of the Klipspruit in 1908.

Your Commissioners inspected the Klipspruit in September, 1908. From the notes of that inspection it appears that the Klipspruit itself and all the tributaries down to the junction had ceased to run, the course between the different dams being either dry or the stream reduced to a mere trickle. The vlei at the lower end of the spruit above the junction of Klip River was dry. A number of farms on the spruit below the proclaimed area were visited, and evidence taken as to loss of water and to damage alleged by their owners and tenants is included in Appendix "W".

It was clearly established in evidence that previous to the discovery and development of the Witwatersrand goldfields, Klipspruit at a point now above the Canada Dam was a perennial stream, the volume of which was divided between a number of lower farms.

The stoppage of the flow of the Klipspruit during dry years appears to have very far reaching consequences on the Klip River itself. As already pointed out, the Klipspruit is the largest tributary of the Klip River, at all events until the latter is joined by Rietspruit some twenty miles lower down.

The Klip River itself and its immediate catchment area being situated on dolomite from which the run-off is comparatively small, the vleis in the Klip River have to rely for replenishment almost exclusively upon the storm-water floods which reach the river from the more impervious portions of the catchment area, i.e. the Witwatersrand.

These vleis appear to form a very important factor in the hydrographic conditions of the Klip River. They act as large storage reservoirs in which water is collected during the wet season and gradually part with the supply when the rains cease. Any interference with them, such as burning of the grass and reeds by which they are covered, appears to have an immediate adverse effect on the volume of the river and on some of the springs (see evidence of Meyer and others, Appendix "X").

On the other hand the vleis promote evaporation to a remarkable extent and unless they are, therefore, waterlogged they are exposed to the risk of drying up: and when once dessicated the volume of water yielded by the springs as well as that of the floods, unless of large dimensions, appear to have practically no effect upon them. It was shown in evidence, for instance, that on several occasions when the Klip River was so much in flood at Jackson's Drift, that the drift was impassable for wagons, the flood-water did not reach farms some twelve or fifteen miles lower down; and the lessee of Waterval, Mr. Allison, stated that if the whole stream used for irrigation at Zwartkopjes in 1908, some four or five hundred thousand gallons, were turned into the vlei (then dry) it would not reach Waterval (which immediately adjoins Zwartkopjes) within six months.

It is obvious, therefore, that obstructions which prevent storm-water, during the drier seasons, from reaching the Klip River, affect the latter to an extent which is repairable only when the rainfall season is above the average.

Position of the Mines in Law.

Pumping.

In our opinion the right of the mines to use the water pumped from the shafts, for their own purposes, cannot be challenged.

Water-Right Dams.

The dams referred to above were constructed under water-rights granted under the different Gold Laws.

We obtained copies of the forms of grant issued by the old Diggers' Committee under Law No. 8 of 1885; of those issued by the Mines Department previous to the war and those granted by the Department subsequently under Law No. 15 of 1898.

In the first of these, the stipulation is made that the grantee should indemnify the Government against any damage which might arise. That by the Diggers' Committee was issued "subject to such rules and regulations with reference to water-rights for these goldfields which now exist or may later become of force". The grants subsequent to 1900 state that they are made under Section 56 and others of Law No. 15 of 1898 and subject to the provisions laid down in that law or any provisions that may be laid down in the future by any other laws or regulations with respect to lapsing or beaconing-off of water-rights.

The earlier grants do not appear to fix the capacity of the reservoirs. Those granted since the annexation give the dimensions of the dam and other particulars of the grant. In none of them is the fact whether they are situated on a public stream, and if so, to what share of the water of such stream they would be entitled, referred to.

Law No. 8 of 1885 provides, in Section 18, that the Diggers' Committee of any proclaimed goldfield shall have the right of making such regulations as to the division of water which may appear to be fair and reasonable, according to the circumstances of such field, *respecting, however, the rights of private owners.* The same section, moreover, expressly declares that no digger under whatever circumstances, shall obtain any right of property in the water running in any river, watercourse or constructed furrow, but shall only have the right to use such water according to law and regulations. Section 47 of the same law enacts that owners and occupiers of ground along a river or other watercourses shall have no right of action against the Government, or any gold mining company, or gold digger, or other companies or persons, who may exploit mines under the protection of the laws of the country, by reason of making turbid or muddying of the water in such rivers or watercourses through the use of the same by the mines.

The stipulations of Section 48 have been taken over, practically verbatim, in all subsequent gold laws, substituting, however, the Mining Engineer (with the approval of the Government) for the Diggers' Committee (see Section 120 of Law No. 15 of 1898).

For the provisions as to the muddying of the streams, the later laws substituted the provision that the State President should have the right to make regulations in respect of the making turbid or muddying of streams by mining operations.

Law No. 35 of 1908, now in force, reiterates that no person upon any public digging shall have any proprietary rights in water running in a river, stream, watercourse or water-furrow by reason of any mining title, licence, or certificate granted to him under this Act or any prior law, and Section 66 enacts: "the Minister may frame such regulations not inconsistent with the provisions of this chapter as he may deem fair and reasonable

(*a*) for preventing the disturbing or fouling of rivers, streams, watercourses, or water-furrows;

(*b*) for the proper distribution and prevention of waste of water on public diggings, among persons prospecting or mining for precious metals and for the grant of temporary rights to the water, *regard being had to the rights of owners, lessees, or other lawful occupiers of land*;

and by such regulations, penalties may be imposed for the breach thereof."

From the foregoing it appears to Your Commissioners that the different gold laws did not intend to, and as a fact do not, in any way affect the rights of lower proprietors on a public stream when the farms above them have been proclaimed as public goldfields, in other words, whatever water-rights may have been granted on a proclaimed farm, the total quantity of water abstracted from such stream by virtue of such grants cannot exceed the quantity to which the owners of such farm were entitled before the proclamation.

As stated, it was established in evidence that Klipspruit, at the point already referred to in this report, was a public stream.

A public stream is defined (see Section 2 of Act No. 27 of 1908) as "a natural stream of water

(*a*) which in ordinary seasons flows for the greater part of the year in a known and defined channel (whether or not such channel is dry during any period of the year); and

(*b*) which is capable of being applied to the common use of riparian proprietors.

A stream of water which fulfils these conditions as to part of its course only shall be deemed to be a public stream, as regards such part".

Now it has been proved that by reason of the cutting off of the tributaries of the Klipspruit by the mine dams, the Klipspruit has ceased to be capable of being applied to the common use of its riparian proprietors and that it, therefore, had lost one of the essentials of a public stream.

The question now arises, has the Klipspruit, under the above circumstances, ceased to be a public stream?

The issue is one of such grave importance and one that entails such far-reaching consequences, that we deemed it expedient to submit the matter for the advice of the Crown Law Officers.

The opinion obtained (after confirming the view of Your Commissioners, as to the effect of the proclamation of a farm in respect to the right to water, as between owners of mining water-rights and lower riparian owners) laid down that when a river loses one of its attributes as a public stream it ceases to be such, and the provisions as to the division of its water between riparian owners do no longer apply.

The Crown Law Officers, however, drew the attention of Your Commissioners to the fact that the common character of a public stream adheres also to the source from which it takes its origin, and that Section 11 of Act No. 27 of 1908 limits the right of any proprietor to use exclusively and without restriction water rising naturally on his land to water which has not reached a public stream or "does not form the source or part of the source of a public stream".

The Crown Law Officers add: "It is, therefore, important to ascertain what is the source of the Klipspruit. It must have some ascertainable source, and as it is a public stream the owner on whose ground the source rises has no right to cut it off."

The inquiry suggested in the last sentence would, in our opinion, lead to the result that, as the Klipspruit does not originate in a spring which is prominent either by reason of the volume or its distance from the junction of the Klip River, the smaller spruits which jointly form it should be looked upon as "its source or part of its source".

If that be so, the advice by the Crown Law Officers would show that the mines were not justified, under cover of their water-rights, in entirely cutting off,

by means of their dams, the flow of these tributaries of the Klipspruit, and that they are bound by law to permit a portion of the water to run for the use of lower proprietors. This would also apply to storm-water conserved by them, which becomes public as soon as it joins a public stream (see Section 12 of Act No. 27 of 1908).*

The contention that the Klipspruit is no longer a public stream would be of no avail if the companies owning the dams acted beyond their rights in cutting off the tributaries; they could not well maintain that the Klipspruit has ceased to be a public stream as it does not in ordinary seasons flow for the greater part of the year, if the stoppage of such flow was due to interference on their part.

(*d*) Pumping by the Rand Water Board.

Historical.

A full statement of the creation of the Rand Water Board, its subsequent history, area, and sources of supply was handed to Your Commissioners by the chairman of the Board, Mr. T. A. R. Purchas.

In Appendix "Y", its first twelve clauses are taken over verbatim, with the exception of Clause 11, which gives details as to the requirements and conservation of water by the mines, as to which the Commission are in possession of later information.

Since the framing of this statement important additions have been made to the rights and scope of the Board by Act No. 22 of 1909, which will be more fully reported on later.

Title.

The Rand Water Board bases its right to pump from the Klip River Valley both upon statute and contracts with the owners.

Ordinance No. 32 of 1903, as amended by Ordinance No. 18 of 1904, empowered the Rand Water Board to supply water within the limits of supply (which were defined in the 1903 Ordinance as the area included within the Witwatersrand District or any extension thereof under that Ordinance), and for that purpose to erect water and other works, and to acquire rights in connexion with its objects, and more especially "certain existing undertakings" which were set out in Schedule E to the 1904 Ordinance, to wit, the "Water undertakings of the Braamfontein Co., Ltd., the whole undertakings of the Johannesburg Waterworks Estates and Exploration Co., Ltd., and of the Vierfontein Syndicate Ltd.", and Section 107 (1) of the 1904 Ordinance imposed the following limitation as to the maximum quantity which could be pumped by the Board:—

> "107. (1) It shall not be lawful for the Board to pump more than ten million gallons of water per day in the aggregate from the properties comprised in the undertakings referred to in Schedule E, and any properties or rights which may be acquired by the Board under Sub-section (*b*) of Section 10 of this Ordinance, nor shall it be lawful for the Board to pump any underground water contained in the dolomite formation from any other property not so comprised as aforesaid which may be acquired by it for the purpose of carrying out its objects."

It may be noted here that all the water at present obtained by the Rand Water Board is pumped from the dolomite.

The powers to supply, granted under Section 10 of the 1904 Ordinance, were extended by Section 3 of Act No. 22 of 1909

These Ordinances do not vest in the Board the right of pumping itself, which must, therefore, be based either upon the right of ownership to the farms where boreholes are sunk and the pumps erected, or upon agreements with the owners of such properties.

In Appendix "Z", a statement is given of the farms held in ownership by the Rand Water Board and of others upon which pumping rights have been secured by them have either been obtained by the acquisition of the "existing undertakings" referred to in the 1904 Ordinance, or subsequently by the Board direct.

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* *Note.*—It should be stated that the manager of the Main Reef East and Deep undertook that he would allow a certain portion of the water from the Canada Dam to run for the use of the lower Klipspruit farms. This arrangement, although of great value to the farmers at the time, was subject to the proviso that the company could at any time cancel it should they require the water for their own purpose. It was, moreover, given verbally only; a promise made to Your Commissioners by the chairman of the company to reduce it to writing not having as yet been carried out.

Operations.

In Appendix "A1", a full statement is given of all boreholes and pumping stations of the Rand Water Board in use on the 1st December, 1909, together with the supplies drawn from each station during the months of October, November, and December, 1909.

It will be noticed that the total amount drawn by the Board from the Klip River catchment area now amounts to 151 million gallons per month, giving a daily average of nearly five million gallons.

A further statement (Appendix "B1") supplied by the Rand Water Board shows the maximum quantity which can be pumped from their present boreholes, together with the depth of the latter and their locality.

From this statement it would appear to us that those boreholes which are nearest the vlei yield the largest volumes of water, and that at the same time they are the shallowest. Or, in other words, the nearer the boreholes are placed to the vlei, the greater the possibility of tapping the water supply flowing underground along the centre of the valley, that is of the underground stream or streams. With the boreholes some distance away from the centre of the valley the case is different. Taking borehole H as an example. This borehole is situated nearly one mile south of the river; at this place the underground flow towards the centre of the valley should, therefore, be to the north. The Commission, during one of their visits to borehole H. found this to be the case. Inspecting the drives or "headings" from the bottom of the shaft, water was seen to flow out through a multitude of cracks and small fissures from *the north only*.

Allegations of Interference with the Klip River Water by the Board.

Before giving our views on the assertion that the operations of the Rand Water Board are largely the cause of the decrease of the flow of the Klip River in general, it would be expedient to examine the complaints as to interference with individual springs made by the farmers.

Following the course of the river we shall first deal with the Oog.

The Oog.—The allegations of interference given in evidence on this issue is set out in Appendix "C1".

In refutation of these statements the Board in the first instance relied upon the statistics as to the levels of the vlei given in Appendix "N", which were quoted to establish that the pumping at Zuurbekom has not adversely affected the level of the vlei, and that in several instances such levels had risen notwithstanding an increase in the amount pumped.

In the next place the Board pointed out that the reduction of the volume of the river, alleged by the farmers, was so much in excess of the quantity of water pumped at Zuurbekom that the latter could not be the cause, or at all events the sole cause, of the former.

It was pointed out also that the difference in hardness between the water at the Oog and that obtained by pumping at Zuurbekom clearly showed that the waters could not have the same origin. Appendix "D1" gives analyses of both waters. On this point, however, it was suggested that the Oog need not necessarily draw its entire supply from the source of the water pumped by the Board at Zuurbekom, but may in addition receive part of its supply from a source which from long contact with the dolomite has attained exceptional hardness.

Under these circumstances we thought it advisable to institute certain tests under the supervision of the Government Analyst, the nature and result of which are given in Dr. McCrae's report (Appendix "E1").

After full consideration of all this evidence and assertions we arrive at the conclusion that the connexion between the pumping at Zuurbekom and the decrease of the water at Klipriversoog has not been proved.

Van Zyl's Spring.—The second spring which was asserted by the riparian owners to have been affected by the pumping operations was that of Van Zyl's. Their statements on this point are contained in Appendix "O".

The Board, whilst denying a connexion between this spring and borehole H, did not urge special reasons in its refutation. The Commission then instituted a test, the details and result of which appear in Appendix "F1".

The result of this test was challenged by the farmers for the following reasons:—

(*a*) Refusal of the Board to allow complainants to go down the shafts during test.

(*b*) Short duration of test.

On the latter point it was confidently asserted by the owners that when pumping had been stopped at borehole H, subsequent to the test (owing to the washing away of some piping), the volume of the spring had considerably increased after an interval of about a week.

We thereupon decided to have a further test, the character and result of which appear in Appendix "G1".

Exception was taken as to the reliability of this test by the Board, but upon inquiry we could not support the objections raised.

From the result of this last test, as well as from other facts elicited in evidence, we have no doubt that the pumping has an adverse effect upon the spring at Van Zyl's.

It is not possible to state whether a direct channel exists between the spring and the borehole, or whether the pumping at the borehole creates a cone of depression which absorbs the water supply of the spring.

Schalkwyk's Spring.—The allegations of the complainants relative to the third spring, Schalkwyk's, are contained in the evidence of the owner of the farm, a précis of which is attached (Appendix "H1").

In view of the distance between the pumping station at Zwartkopjes and the spring in question (7½ miles), and the further fact that both before and after the 1909 rains this spring had either ceased to flow or flowed to a very unappreciable extent, compared with the large quantity of water in Mr. Schalkwyk's dam, which covers it, Dr. McCrae advised that it would be useless to attempt any tests.

As the periods of pumping at Zwartkopjes, as far as the same have been elicited in evidence, do not support the contention that they affected the spring, it must again be held that no connexion has been proved.

Minor Springs.—In several other cases, such as the springs at Rietspruit and elsewhere, allegations of interference were made, which were, however, not sufficiently supported by the evidence to establish the necessity for fuller inquiry.

We are, however, of the opinion that great weight should be attached to the apprehensions fostered by many of the proprietors of Klip River that the Rand Water Board would find no practical difficulty in tapping the springs so far unaffected, for instance, that of Bennett's, should they in the future find it expedient to do so. In cases where springs are due to dykes the latter are usually traceable, and it appears to us that the Board, by means of experimental boring, would sooner or later strike the source of their underground supply.

Boring operations were started some years ago on the farm Misgund, at a spot a mile south of the river and near a dry spruit running into the Klip River from the south. This borehole (E) was found to have struck a dyke and was abandoned. It would appear that underground water is diverted here by the dyke into the valley above Bennett's springs.

The Chairman informed us that it was not the intention of the Board at present to increase their sources of supply by further boring on this farm; no pledge, however, was, or could be, given as to future operations.

Dealing now with the general effect which pumping by the Board has on the volume of the Klip River, we arrive at the conclusion that while, save in the one instance of Van Zyl's spring, direct interference had not been proved, the abstraction of an average of over 552 million gallons annually since 1902 (see Appendix "A1") or 1½ million gallons per day,* must of necessity be one of the contributing causes of the decrease.

To what extent it is so, is now, and will, as already stated, probably always be impossible to calculate, since a larger or smaller proportion of the water pumped is, in all probability, water which would never see daylight in the Klip River Valley at all.

A much more serious consideration, however, is that of the quantity of water which may be drawn by the Rand Water Board in the future. In this connexion an important factor was introduced by Act No. 22 of 1909.

For the purposes of paying for the "existing undertakings", which were taken over at a valuation fixed by arbitration, and for the purpose in connexion with its works, the Board has issued 4 per cent. debentures in terms of Ordinance No. 48 of 1904 to the extent of £3,400,000. Interest, as well as redemption, is met from the proceeds of the water sold, after the payment of ordinary expenditure.

The price of the water is fixed in accordance with the amount anticipated as required for these purposes (see Section 16 of Ordinance No. 18 of 1904).

If the revenues of the Board proved insufficient for the purpose of meeting the above charges, a special rate could be levied under Section 62 of the 1904

* Now increased to nearly five million gallons.

Ordinance, on the local authorities within the limits of supply, such local authorities being defined as "including the Councils of the Municipalities of Johannesburg, Krugersdorp, Germiston and Boksburg; and the Urban District Boards of the Urban Districts of Roodepoort-Maraisburg and Springs".

It will be noted that under this Ordinance no part of the liability for any shortage fell upon the mines.

From the evidence of Mr. Purchas it appears that out of the 12½ millions (now 15½ million gallons) per day, the average consumption of the mines, only 400,000 gallons were taken by them from the Rand Water Board, chiefly for domestic purposes; the balance being obtained from their pumping from the mines and their reservoirs.

Those mines who had no dams of their own found it cheaper to purchase water from their neighbours than from the Rand Water Board. In using the water made and conserved by them, the mines often seriously depleted their storage, but they took that risk for the above economic reasons and regarded the Board as a stand-by upon which they could fall back when their own water failed.

By Act No. 22 of 1909, Sections 5 and 6, it is enacted that in cases of shortfall of revenue of the Rand Water Board a contribution shall be levied, half of which is to fall upon the holders of mining titles within the limits of supply. The mines are, therefore, made potentially responsible for the expenditure of the Board and it is in their interest to take as much water as possible from it.

Under these changed conditions it seems probable that the mines will revert to their original intention of looking to the Rand Water Board for their water supply and keeping their reservoirs as a stand-by (see statement handed in by the Directors of the Vierfontein Syndicate to the Witwatersrand Water Supply Commission, page 156).

Increased demand will result in a large diminution of the rates charged by the Board, and it will therefore be increasingly profitable to many of the mines to purchase their water supply from the Board.

Apart, therefore, from other considerations, such as the expansion of mining operations and consequent increased demand for water, and the decrease in the yield of mine pumping, owing to the drying up of the upper levels of the mines, it seems highly probable that the call upon the water resources of the Rand Water Board will be materially increased within the next decade, and if the anticipations made in some of the former reports as to the growth of Johannesburg and the population of the Rand generally are realized it is well within the bounds of reasonable contemplation that the quantity now supplied by the Rand Water Board may be doubled, or even trebled; so that should a recurrence of dry seasons be experienced, the demand may exceed 10 million gallons a day during the spring months, viz.: the very time when the volume of the river and the springs is at its lowest and the calls upon the water for agricultural purposes are at their greatest height.

Further, there is nothing in the Ordinance to prevent the Rand Water Board from much exceeding these 10 million gallons per day during the dry months, so long as the *aggregate* of the water pumped by them in one year does not exceed the rate of 10 million gallons daily.

Sources of Supply at the Disposal of the Rand Water Board.*

It seems very improbable that the Board will be able to avail itself of the sources of supply other than those in the Klip River Valley owned by it. These consist of

(*a*) half interest in the Wonderfontein Concession, formerly the property of Mr. George Goch;
(*b*) Steenkoppies;
(*c*) Rietvlei; and
(*d*) comparatively unimportant sources on the Witwatersrand.

As to these, the first (*a*) was compulsorily acquired in terms of Section 106 of Ordinance No. 18 of 1901, Sub-section (5) of which reads:—

> "It shall not be lawful for the Lieutenant-Governor or the said Board either separately or jointly to exercise or deal in any way with the rights ceded as aforesaid by the said George Henry Goch or his legal representatives under sub-section (1) of this section unless and until legislation has been passed authorizing them so to do."

The reason for the restrictions of this sub-section seems to be the probability (not amounting to absolute certainty, however) that the water disappearing at Wonderfontein appears on the surface again within the Transvaal.

It therefore seems highly improbable that the legislative sanction required for the exercise of the rights in regard to Wonderfontein will ever be given.

As to the second, (*b*), the Board owns both Steenkoppies and Wolvekrans, but for reasons stated in the evidence of Messrs. Purchas and Leitch (Appendix "J1") the Board is unable to avail itself of the water supply of these farms.

As to (*c*) the Board holds seven claims, and it at one time hoped that permission would be given by the Government to bore for and pump water therefrom. Such permission has been definitely refused by Government.

It should be pointed out, also, that Rooikop No. 151 is situated on the area calculated within the catchment basin of the Klip River Valley.

As to (*d*) some water in quantities of little importance are obtained by the Board at Braamfontein, Oliphants Vlei, Springs, Natal Spruit, New Doornfontein, and Bertrams; these supplies do not appear capable of development.

It is clear, therefore, that for the future, as in the present, the Board will have to rely for its water supply upon the dolomite of the Klip River Valley.

On the other hand it is quite impossible to arrive at any estimate of what quantity of water can safely be taken away from the valley without depleting the underground storage to an extent which may cause injury which, if not permanent, may be irreparable for a large number of years. The officials of the Board decline to pledge themselves to any given quantity which they believe could be safely abstracted, while other experts pointed out the danger of taking water at all under circumstances which make it impossible to calculate how much of the quantity received annually by percolation goes to the replenishment of the underground storage and how much of it escapes by underground channels.

This difficulty of calculation is increased by the impossibility of apportioning the Zuurbekom basin between Gemsbokfontein and the sources of the Klip River. The catchment area of this basin, calculated by Mr. Melville as 162 square miles, is undoubtedly the most important factor in the water storage of the valley. The fact that no visible watercourses emanate from it prove that practically all the rainfall precipated on it, which is not lost by evaporation, sinks into the soil. The strata filling the basin, comprised as they are of sandstone and shale, especially lend themselves to percolation, and it does not seem improbable that the greater quantity of water supplying the upper reaches of the river comes from this basin.

Admittedly it has two outlets, Gemsbokfontein and Klipriviersoog, on the same level, and it is strongly held by several experts that these two are connected.

Evidence was led to show that the damming up of the Oog many years ago (by Hartzenberg in 1857) led to a large increase in the volume of Gemsbokfontein. The evidence on this point, however, is neither direct nor conclusive. On the other hand, it is held by others that the long distance separating the two springs, and the nature of the strata between them, make their connexion highly improbable if not impossible. Accepting the former view, it is obviously quite impossible to apportion this area between the two outlets with a view to estimating the resources of the Klip River Valley. The rough and ready mode adopted by Mr. Melville of equally dividing it between the two cannot be accepted with safety.

We can therefore quite appreciate the apprehensions of the inhabitants of the valley that an increased demand upon its water resources may lead to the loss of all water which is brought to the surface by the springs and upon which, as pointed out, the water in the Klip River in ordinary seasons almost exclusively depends.

Legal Position of the Rand Water Board.

Unless it be proved that a defined channel exists between the boreholes of the Board and any sources of the river (which proof has not been adduced at this inquiry) the position of the Board appears to us to be unassailable.

The Board carries on its operations of searching for and pumping water only where it has acquired legal rights to do so by contract with the owners of property or where it is itself the owner of the farm; and the exceptional position in which it is placed by Section 52 (1) of the Irrigation Act (No. 27) of 1908 exempts it from provisions (2) and (3) of that clause, which read as follows:—

> "52. (2) The proprietor of a farm shall not be entitled without legislative sanction to dispose of subterranean water derived from the dolomite formation, nor to convey it, after it has been abstracted, beyond the limits of his farm; provided that the holder of mining title may take steps for removing to any place any subterranean water from a mine worked by him, if necessary for the efficient working of the mine or the safety of persons employed therein, and may with the consent of the Governor dispose of such water.

"(3) Any superior court may, upon application, interdict any person from abstracting subterranean water if thereby substantial interference with the water supply of a town or any populated area is probable; provided that if the court, on such application, grant a perpetual interdict the operation of such interdict may be suspended pending the payment by the applicant to the person to be interdicted of compensation on the basis of the value to such person of the use of the water of which he is actually deprived and to which he is entitled, the amount of compensation being determined in the absence of agreement by arbitration."

Previous to the passing of this Act the onus of proving connexion by way of a well defined channel rested upon the party who claimed that his spring or well was affected by the boring or pumping operations of his neighbour. Section 51 of the Act under reference relieved such complainant from the burden of such proof provided the water the object of the dispute was in the dolomite formation. The section reads as follows:—

"51. All subterranean water in the dolomite formation shall until the contrary is proved, be presumed in courts of law and other places to flow in defined channels."

And Section 52 (1) already referred to, specially exempts the Board from the operations of Sections 51 and 52 of the Act.

This privilege has been extended to no other owners of water-rights in the Transvaal.

(*e*) Alterations in Water-Carrying Fissures.

It has been submitted that the cause of the decrease in the volume of certain of the springs may be found in the constant changes which it is asserted, take place in underground channels. This point has been fully dealt with by Dr. Jorissen in the Addendum to the report. There are strong indications that changes in the underground stream in the Klip River Valley may have occurred during recent years; for instance, the increase of the water flowing out at the Vereeniging gauge is evidence of underground water now flowing at a lower level, which can only happen at the expense of some of the springs higher up the valley. It appears improbable, however, that important variations in the strength of springs observed in so many different places within the same period, extending over a few years, should be attributable to this cause.

The diversion of underground streams is sometimes assisted by artificial means; it seems to us that the underground discharge of large quantities of explosives, in the shape of so-called torpedoes carrying a very heavy charge, such as are of constant occurrence in the boring and tunneling operations of the Rand Water Board, would tend to accelerate to a very large degree the slower processes of nature in a highly and largely fissured country, and so cause springs to weaken or disappear which might otherwise have remained unaffected for a very long time to come. Additional colour is lent to this assumption by the experience of the farmers in this country, who refrain from opening up the springs existing on their farms by dynamite as they have found that often the result of such blasting is that they lose the water altogether.

SUMMARY.

The conclusions arrived at by Your Commissioners on the first and second points of reference may be briefly summarized as follows:—

(1) There has been a very serious decrease in the flow of the Klip River and the volume of some of the springs in the valley.

(2) This decrease is partly due to dry seasons, the recurrence of which may be anticipated.

(3) Other contributing causes, such as changes in the surface of the watershed and in the natural lowering of the level of underground streams, will probably be accentuated in the future.

(4) The decrease is largely due to artificial interference both by the mines and the Rand Water Board.

(5) It is impossible to apportion the extent to which the action of the mines and the Board have affected the volume of the river.

(6) The decrease due to these artificial causes is likely to be much more serious in the future.

(7) While the Rand Water Board is acting within its rights, doubt has been thrown upon the legality of the action of the mines in entirely cutting off the tributaries of the Klip River.

Third Point of Reference.

We are here asked to suggest remedial measures if such should be found necessary and expedient.

A large number of suggestions has been submitted to us on this point.

The complainant farmers were practically unanimous in stating that the only remedies which would restore the volume of the water which they formerly possessed would be to stop pumping operations in the valley altogether and also either to do away with the water-right dams on the tributaries of the Klip River or to compel the owners to allow a reasonable quantity of water to pass their reservoirs.

Less drastic proposals were suggested by representatives of the Chamber of Mines and the Rand Water Board and also by other witnesses, viz.:—

(i) The construction of a large dam with an estimated storage capacity of 100,000,000 gallons on the Florida Loop which joins the Klipspruit just below the Canada Dam. The object of this dam would be, in the first instance, to serve the farms as far as the junction of the Klipspruit with the Klip River.

A contoured plan of the catchment area supplying this dam, sent in by Mr. Spencer, manager, Main Reef East and Deep, Ltd., was forwarded to the Land and Irrigation Department and found substantially correct.

It was suggested also that this dam might be duplicated and that similar reservoirs might be constructed on Doornkop Loop and other tributaries.

(ii) The opening up of the Klipriver Oog springs and the canalization of all vleis in the course of the Klip River down to a point below Zwartkopjes. The length of these vleis was ascertained to be about twenty-five miles.

It was pointed out that, in addition to conserving the water, the canalization would drain the vleis and so create large areas of valuable land.

(iii) The better distribution of the water now available and the prevention of waste by means of the creation of a river board.

The Commission, after careful consideration of the above suggestions, arrived at the conclusion that it cannot recommend the same, for the following reasons:—

(*a*) The only sites available for the construction of storage dams that have a reasonable prospect of holding water would be those not immediately underlain by the dolomite formation, at the headwaters of the Klip River. On most of the tributaries of the Klip River mine dams have been constructed which absorb almost all the flood-water of these tributaries in a dry year.

The only two streams where dams such as those suggested could well be constructed are the Florida Loop and the Doornkop Spruit.

The combined catchment area of these two streams is not greater than eighty-four square miles and the total amount of storm-water which could be expected, in ordinary seasons, from the entire catchment area, would not exceed 10,928,300 cubic feet (about 681,000,000 gallons) being 2 per cent. run-off of 28 inches.

Even if *all* this storm-water could be conserved (and the figures given are generous) it will be obvious that such an amount of stored water would not permanently relieve the situation.

(*b*) As already pointed out, the vleis appear to act as storage reservoirs and regulators of the river and the springs, and there is, therefore, a serious risk that their canalization and drainage might detrimentally affect the springs to a very large degree.

On the other hand, without canalization the storage of water in the dams suggested would benefit the upper riparian farms only, since, given a recurrence of the conditions of the eight or nine years prior to 1908, the flow of water from the reservoirs, even if several should be constructed, would not be sufficiently strong to force its way through the vleis when these had once been dried up (see evidence already referred to).

(*c*) The expenses connected with these proposals would be very large, especially as to canalization, and out of proportion with the benefits likely to be derived from them.

(*d*) While there can be no doubt that the creation of a river board would result in better distribution and the prevention of waste of the water, its work could not affect the great diminution of the flow of the river itself.

(*e*) Lastly, even if it had been established that the cumulative effect of the remedies set out under (i), (ii), and (iii) would be to cope with the diminution of the river under the present conditions, they would without doubt be totally inadequate if the demand for water should be increased, as Your Commission think it is quite possible it will, to the full amount of 10 million gallons a day, so that these proposals could, at best, not be relied upon to provide more than temporary relief.

Another proposal which was examined by us was that of concentrating the operations of the Board at Zwartkopjes and the prohibition of pumping on all farms above.

This suggestion has several features which strongly recommend its acceptance.

Most of the dykes which cross the river and so raise the water level and create springs appear above Zwartkopjes. Below it there are only two large springs, viz., that of Schalkwyk's and that at Kookfontein, and it seems probable, therefore, that by far the larger quantity of water which could be pumped at Zwartkopjes would not come to the surface in the valley. Its abstraction would not impoverish the general water supply of the Klip River Valley to the extent that pumping in the upper levels of the valley does. We have it in evidence from Mr. Leslie that measurements taken at the time of the construction of the Vaal River weir showed conclusively that at that time at least five million gallons more water passed the weir daily at Vereeniging than the volume of the Vaal below its junction with Klip River, so that that quantity must have entered the Vaal from underground sources within a mile and a half. As already found by us, there is a very strong probability that a large underground stream reaches the Vaal from the Klip River Valley, and there is a strong inducement, therefore, to tap this for the use of the inhabitants of this Colony.

The Board would be quite prepared to concentrate its works at Zwartkopjes if it were sure of a supply of good water sufficient for its requirements; in fact the tendency has already been to do so as much as possible: the largest engines are erected at Zwartkopjes and much less water is being pumped from Zuurbekom than was formerly the case (see Appendix "N"). In addition, the expense of pumping from Zwartkopjes is lower than it is from Zuurbekom.

There are, however, grave objections to this proposal, which may be summed up as follows:—

(*a*) The water at Zuurbekom is of much better quality than that lower down the river, where it gets harder (see evidence of Dr. Porter, Appendix "K1").

The result of this increased hardness is to make the water not only less desirable for domestic use, but also for industrial purposes, for instance, in regard to its use for boilers (see Appendix "L1").

(*b*) In addition to the deterioration in quality on the grounds of hardness, some of the water found at Zwartkopjes contains iron in such quantities as to require treatment to eliminate it.

(*c*) The Board states that it is by no means certain that a sufficient quantity of water would be found at Zwartkopjes.

(*d*) Although, as pointed out, the risk of detrimentally affecting the springs in the Klip River Valley would be considerably reduced by removing the pumping to a lower point, that risk would still exist (and might probably be much accentuated) in regard to the springs below it.

(*e*) The chief objection to this suggestion, however, is that it attempts to deal with only one of the causes of the diminution in the flow of the river and leaves untouched another and probably more serious factor in the problem, viz., the cutting off of the tributaries by means of the mine dams with all its results.

Another suggestion that has been made is that of compensating the farmers by a cash payment. We cannot support this proposal, as, under the circumstances, it would be absolutely impossible to fix any equitable rate of compensation. In years such as 1909 the loss caused to the farmers would be practically nil. In the dry seasons preceding that year, the majority of farmers suffered very material damage which, however, naturally varied in each individual case and in each season, some farms being practically unaffected even then, and it appears to us absolutely impossible to estimate the probable loss that may arise in the future. There would therefore be no finality in this settlement.

Reverting now to the proposals already described as drastic, made by the farmers, the Commission was glad to find that the leading men amongst them

recognized their impracticability. They admitted in evidence that the interests of the mines and of Johannesburg were of so vast an importance that any serious interference with their prosperity, such as would be caused by the failure of the water supply to either of them, could not be seriously contemplated. On the other hand, they asked why the loss incurred for the benefit of the mining industry and the townships upon the Rand should fall upon their shoulders, and although they did not directly ask for legislative interference, they challenged the fairness of the privileged position in which, to their detriment in their opinion, the Rand Water Board had been placed under Act No. 27 of 1908, which exempts the Board from the provisions of Sections 51 and 52.

Your Commissioners cannot but feel the impossibility of ignoring the claims to protection due to the owners of the Klip River Valley in equity if not in strict law.

Our view on this subject is strengthened by the report of the Witwatersrand Water Supply Commission, 1901-02, to the recommendations of which the Rand Water Board owes its existence. Section 45 of this report reads as follows :—

> "45. Evidence has been given before us as to whether the water supply should be taken from one source or from several. It is doubtless true that one source, if an adequate one could be found, could be equipped and maintained at smaller cost than several of the same aggregate capacity. But against this there are three considerations to be taken into account. In the first place, if several sources are taken the effect of accident or damage to one of them is minimized. In the second place, we are not likely to get, within a reasonable period, absolutely convincing data as to the permanence of any one supply under the demands that may be made upon it. Lastly, while we regard the provision of an adequate water supply to the Rand as a paramount necessity, we consider that this should be so arranged as to cause the least possible inconvenience to agriculture. We are somewhat sceptical as to the riparian rights, of which we have heard a good deal, and we think that in many cases they might, under the conditions that have existed up to now, be used as a little more than a kind of blackmail on the undertaking under cover of the existing law. But we believe there is a prosperous future for agriculture in the vicinity of the Rand, and we consider that this should not be impaired by unduly depriving any one locality of its stores of water."

It is to the disregard of the advice of this Commission in obtaining the water supply from the Klip River Valley only that the position of to-day and the much graver apprehensions as to the future are largely due.

RECOMMENDATION.

Having arrived at the conviction that the position cannot be allowed to remain as it is at present, and that the dangers of the future can still less be ignored, and having examined and discarded the various remedial proposals submitted, Your Commissioners are driven to the conclusion that there is but one way of dealing with the problem and that is the purchase of all the riparian farms from Klipriviers Oog to the Vaal River and those on the Klipspruit below the Canada Dam, so as to enable the valley to be exploited exclusively for the water supply of the towns and mines on the Witwatersrand.

Such purchase should be made by voluntary agreement, and failing that by arbitration.

If the owner of any ground should decline to sell his ground by friendly agreement, or to enter into arbitration, we consider that such owner should not be entitled to receive any further consideration from Government in so far as any matters referred to this Commission are concerned.

Should any compensation be due to a lessee or occupier their claims should be dealt with in the same manner.

We do not anticipate that the farmers will be unreasonable in agreeing as to prices. Theirs is, as already pointed out, not an enviable position, as they can never be certain of their crops from year to year, and as their ground has recently much deteriorated in value. And assuming that legal remedies are open to them, they could only enforce their rights by actions which would be very expensive both because of the complex nature of the position and the pecuniary strength of their adversaries. It should be remembered also that, as appears from Appendix "Z", a good many farmers have granted pumping rights to the Board, so that their claims would be subject to material reduction.

This consideration would also have considerable weight should it be necessary to fix the price by arbitration.

We have reason to believe that the total amount required for the purpose of acquiring all the farms in question would probably not exceed £600,000.

A very large portion of this amount could, moreover, at once be recovered by the resale or letting of the farms purchased under conditions which would leave to the purchasers or lessees only such water as might not be required for the purposes of the Board. Such stipulation would no doubt affect the price of the farm dealt with, but it would still remain of considerable value.

The advantages of this recommendation are obvious. In the first instance, it would free the mines of the grave danger of any interference with their water-rights by legal process at the instance of the lower riparian owners referred to in this report.

In the next place, it would forestall an appeal to the legislature requesting that the Rand Water Board should no longer be allowed to occupy the favoured position in which it was placed by Section 52 (4) of the Irrigation Act (No. 27) of 1908, a request which it might be difficult on equitable grounds to refuse, and which could not be opposed on the plea of vested interests, since the obligations of the Board have, we understand, not been increased since Act No. 27 was passed.

In addition, it would tend to eliminate the risk of the pollution of the underground water within the valley itself, which seems at all events possible when, as in the instance already referred to in this report, water appears to sink directly into fissures of the ground.

And lastly, it would enable the Board to carry out, if so advised, the suggestion made by Mr. Karlson in his evidence given before the Witwatersrand Water Supply Commission, in which he recommended that absorption dams should be constructed all down the valley, in connexion with which proposal he stated it might be necessary to break through the dykes. Such works are clearly impossible while the farms are the property of third parties. We were informed, for instance, that the construction of a large dam at Zwartkopjes, which was recently contemplated by the Rand Water Board, was abandoned because of the difficulty of getting the consent of the proprietors of lower riparian farms.

We are of opinion that the amount required for the purchase of the ground should be found by the Rand Water Board, as the acquisition of the area will facilitate the operations of the Board and enable it to exploit to the full the water resources of the Klip River Valley, which are of such paramount importance to the prosperity of the mines and the health and comfort of every inhabitant on the Rand. It is also most desirable that the redisposal of the farms should be in its hands so that it may be able to impose terms when letting or reselling which leave its engineering operations absolutely unfettered and which will eliminate any danger of pollution.

Lastly, the Board, and the Board only, is in the position to distribute the net loss sustained, if any, amongst those in whose interests such loss will primarily have been necessitated.

Should there be a large difference between the expense of the purchase recommended and the proceeds of the properties when subsequently dealt with, the interest on and redemption of the deficiency would necessitate an addition to the water rate charged to consumers, but such increase should not be considerable and would be outweighed by the advantages already indicated.

There should be no difficulty in obtaining the funds for the purchase, as the Board has been placed in a much stronger financial position by Act No. 22 of 1909, under which half of any shortfall of revenue falls, as already pointed out, upon the holders of mining titles within the limits of supply.

We further recommend, in view of the importance of the dolomite in this valley and elsewhere, as the principal water-carrying formation of the Transvaal, that all boring and other water-exploiting operations in it, and their immediate and subsequent results, should be closely watched and recorded departmentally, as the data so obtained will probably be of the greatest value in determining the future policy of the Government and Legislature on this subject.

In conclusion, we beg leave to express our recognition of the frank and ready way in which all requests for information and assistance, in pursuance of this inquiry, were responded to and afforded by the farmers of the valley, the Rand Water Board, the Chamber of Mines, and the witnesses who appeared before the Commission.

We also desire to put on record the valuable services rendered to us by the Secretary of the Commission, Mr. J. C. V. Roos, and subsequently by Mr. C. B. Bunnell, on the retirement of Mr. Roos through illness.

CARL JEPPE, *Chairman.*
E. JORISSEN,
L. GELDENHUYS,
F. A. HURLEY, } *Members.*

CHAS. B. BUNNELL, *Secretary.*

7th March, 1910.

Addendum by Dr. E. Jorissen.

DOLOMITE.

The character of the dolomite both geologically and hydrographically was dealt with in the Interim Report of the Inter-Colonial Irrigation Commission. It is desirable to add a few observations to the evidence then obtained, as the operations of the Rand Water Board in the Klip River dolomite have thrown a new light on the storage of water in this formation.

Summarizing the evidence led, both before the Inter-Colonial Irrigation Commission and this Commission, it may be held as established that the dolomite is the chief water-bearing formation in the Transvaal, in which almost all the large rivers of the Colony have their sources, viz.:—Klip River, Mooi River, Schoonspruit, Harts River, Molopo (both branches Polfontein and eye of Molopo), Notowani (Kalafyn and Tweefontein), Malmani River, Klein Marico (all sources), Great Marico (eye of Marico and all sources), Elands River, Magalies River, Six Mile Spruit, Aapies River.

Dolomite is a sedimentary rock composed chiefly of carbonates of lime and magnesia, with the addition of manganese and iron, either in the shape of carbonates, or of oxides and a little silica and water.

The proportion of calcium-carbonate to magnesium-carbonate is roughly as five to four. The other two carbonates, together with silica and moisture, constitute about 5 per cent. of the rock. The name "dolomite" is, however, not only applied to rocks having as nearly as possible the composition of the mineral dolomite, but also to limestone containing smaller percentages of magnesium-carbonate.

Dolomite is a hard grey to bluish sometimes pink rock, easily distinguished from other rocks.

Structure.

The "rock" dolomite has not the same texture as limestone, because the individual crystals of the minerals "dolomite" and "calcite" differ in shape. Some of the faces of a dolomite crystal are commonly curved; the crystals do therefore not touch each other intimately, but only in places leaving open spaces between them. With limestone, composed as it is of crystals of calcite, this is not the case, although here also microscopic spaces may exist. Similar minute open spaces are found in all rocks: in some to a great extent as in sandstone, in others in negligible quantities. The percentage of a rock occupied by these open spaces constitutes its porosity.

A table of porosities of some Wisconsin building stones, taken from the Irrigation papers of the United States Geological Survey* is inserted here. It gives a comparison between the porosities of different kinds of rocks.

Kind of Stone.	Name of Quarry.	Average porosity of two specimens.
Granite	... Berlin (Wis.) Granite Co.	0·384 per cent.
Granite	... Montello (Wis.) Granite Co.	0·237 ,, ,,
Niagara limestone	... Marble-head (Wis.) Lime and Stone Co.	0·77 ,, ,,
Niagara limestone	... Story Bros., Wauwatosa, Wis.	6.4 ,, ,,
Lower magnesian limestone ...	... Bridgeport, Wis.	*13·19* ,, ,,
Sandstone ...	... Bass Island, Wis., etc.	20·7 ,, ,,
Sandstone ...	... Dunnville, Wis.	28·26 ,, ,,

Origin of the Dolomite (Dolomitization).

The origin of magnesian limestone is not yet well understood. Some dolomite appears to have been formed by the action of magnesium salts, contained in the sea water upon the limey ooze formed by the remains of lime-secreting

* "The Motions of Underground Waters." Slichter, 1902.

organisms, which afterwards consolidated into limestone. Other dolomite has been formed by the action on slightly dolomitic limestones of permeating surface water, which dissolves and removes the lime, leaving rocks with larger percentages of magnesium-carbonate. This explains why samples of dolomite taken from different localities do not show a uniform proportion of calcium-carbonate to magnesium-carbonate as has been stated in evidence.*

Weathering.

The dissolving action of surface waters containing carbonic acid (CO_2) in solution on limestone and dolomite is well known, and has been explained by several witnesses. All the carbonate of calcium is carried away in solution, whilst magnesium-carbonate, iron oxide, silica and the hydrated oxide of manganese (Wad) contained in the dolomite, together with the silica of the chert bands, the clay of the clay shale interbedded in the dolomite and the decomposition product of dykes intersecting it remain behind. A small portion of these products of weathering fill the dry fissures in the dolomite, but the greater portion form a layer of red soil and chert fragments covering the dolomite. In places this layer is only a few inches thick; in other places, especially in the valleys, it attains a thickness of several feet. Sometimes it is altogether absent, leaving the rock bare with its characteristic wrinkled and furrowed surface which made the old inhabitants gave it the name of "Elephant Rock". When devoid of vegetation and exposed to the heat of the sun, this soil is more or less impervious to water. It has often been noticed that water remains standing in pools on this soil for many days after a heavy storm.† Where, however, the soil is covered with grass, rain-water disappears quickly.‡

The Action of Underground Water on Dolomite.

The porosity of dolomite has already been mentioned; it is, however, not sufficient to explain the large quantities of water stored in this rock. On examination dolomite is found to be intersected by a network of minute cracks as well as of large fissures. Both are due to internal changes, viz., to shrinkage the rock has undergone in the process of dolomitization, to want of homogeneity in the composition of the rock, and to folding and resulting movements of the earth's crust. The cracks and fissures decrease in depth, a phenomenon found in all rock masses. Rain-water charged with carbonic acid taken from the atmosphere percolates into them and dissolves the lime from the dolomite, that is to say it forms a highly soluble double carbonate of calcium which is taken away in solution. The other constituents of the dolomitic limestone are removed to a lesser extent. This chemical process goes on indefinitely, as can be ascertained any day by analysing water flowing from dolomite; the so-called hardness of dolomite water consists of calcium-carbonate and magnesium-carbonate.§

For this chemical action to have any appreciable effect on the rock it is clear that the carbonates once they are dissolved must be removed; in other words, water must not be stagnant, but must flow through and out of the dolomite. This fact is of great importance, and must not be lost sight of in discussing the formation of underground reservoirs. Wherever water is stagnant its dissolving action ceases the moment it is saturated with carbonates, and it is the renewed supply of surface water, which has a progressive dissolving effect on the dolomite along the cracks and fissures, which are thus slowly widened.‖

Caves and Reservoirs.

Once the fissures are enlarged surface water can bodily penetrate into them, especially during heavy storms. Its chemical action is then assisted by a mechanical action of the water carrying with it mud, sand, and small stones. Fissures are widened more quickly into galleries, and caverns are formed through the grinding action of the muddy water. The subterranean stream first corrodes and undermines the lower portions of its walls, the higher parts then crumble away along lines of parallel fissuring. Nothing is, however, more irregular than the courses of these underground streams, which can be best described as tortuous channels resulting from the widening of original fissures, where large caverns communicate with each other through narrow passages. An inspection of any series of caves will bear this out. The flow of the stream is often interrupted by cascades and rapids, some caused by dykes, others by rock debris falling from the

* Dr. Pakes. † Kynaston. ‡ Melville. § Dr. Pakes. ‖ Kynaston.

roof or from the sides. A fall of rock may altogether close its channel, and the stream will then find another outlet. In cases where a stream saw daylight within a small distance from the place of diversion, it would no longer flow out at the old spring, which would be said to "have dried up". Several instances of such diversions are known, which prove them to be more than mere theoretical possibilities. Moreover, the galleries and passages found in many caves represent the channels of these subterranean streams which for the most part have now found escape at lower levels.

Evidence of the existence of such caverns was brought by Mr. Melville, viz., in borehole 2 at Zuurbekom, where caverns of 20, 40, and 29 feet were struck at 120, 208, and 251 feet respectively. In Olifantsvlei No. 16, District Johannesburg, a large cavern was struck by the Vierfontein Company. On the farm Misgund a cavern of large dimensions is found close to the foot of the Gatsrand hills.

Swallow-Holes.

It happens sometimes that through the progressive falling in of the roof, galleries hole through to the surface and open caverns known as "swallow-holes" are formed. And as the galleries were formed by subterranean streams it follows that the swallow-holes are surface evidence of the existence of such streams, which may still be flowing at the bottom of the holes or have been diverted into other channels. Swallow-holes give easy access to large volumes of rain and storm water, which bring with them increased activity on a larger scale, and underground conditions are then changed more quickly. As a rule, swallow-holes indicate the existence of extensive underground caverns and galleries cut out of the dolomite by underground streams.

Surface Water and Underground Water.

As already explained, one of the causes of the fissuring of dolomite and other rocks is due to folding of the strata. Whenever folding takes place, the rock thus affected is fissured into, generally speaking, two main directions—one parallel to the axis of the fold, the other more or less at right angles to it. Where, however, the axis is curved, additional fissuring takes place and intricate intersecting systems of fissures are formed.

A surface stream is not only fed from springs in or close to its bed, but also with seepage water along its banks. As a rule, the direction of this seepage is not parallel to that of the river or the valley, but at right angles to it. The same is true of underground flow of water, which can also be divided into two distinct parts, viz., one a subterranean flow below the surface river and in the same direction, the other a seepage from both sides towards the main flow. Applying what has been said here to dolomite, the underground seepage in this rock flows through the interstices of the rock and along its minute cracks and fissures. The more the rock is fissured, as in places of complex folding and bending, the easier and quicker the seepage will find its way through continually enlarging fissures. The seepage flowing from both sides of the valley towards its centre joins the underground stream which flows there. Because the surface and underground streams have different origins their chemical composition will generally differ, and a direct connexion between the two is extremely rare; on the contrary, in many cases the underground flow can be tapped without affecting the surface stream above it, as has, for instance, been proved by the Rand Water Board.

Springs.

Outflows of water in dolomite are not necessarily caused by dykes traversing the rock and damming the water behind. Some springs owe their origin to faults in the rock; others rise naturally to the surface from underground channels. Springs in the bed of a dolomite river rise from the underground stream running in the centre of the valley; those away from the river and its tributaries have, as a rule, a shallow origin and are quickly affected by surface conditions.

The Klip River Valley.

The Klip River takes its source on the farm Klipriviersoog and runs from there more or less due west through the farms Olifantsvlei No. 60, Misgund No. 56, Olifantsvlei No. 16, Rietvlei No. 17, and Petrusvlei No. 8, on to the farm Kromvlei No. 282. It then turns towards the south-east through the farms Kromvlei and Zwartkopjes, and from here southwards until the farm Kookfontein is reached, where it changes its course to the south-west until it joins the Vaal River.

The cause of the change in the direction of the river is due to mountain folding. On Dr. Humphrey's map (Appendix "C") the Potchefstroom system (consisting of the Gatsrand or Pretoria—the chert or dolomite—and the Black Reef series) are seen to curve round in the same manner. The middle series, that is the dolomite series, weather more easily than the other two (which are composed of conglomerate, shale, quartzite, and sandstone). It has, therefore, been denuded more rapidly, and a valley has been formed along the strip of dolomite.

From what has been said above, it is clear that, especially on the farms Allwynspoort and Zwartkopjes, which are situated on the curve of the strata, the dolomite must be one mass of cracks and fissures. Apart, therefore, from the underground stream along the centre of the valley, an abundant supply of water should exist here, away from the stream, in highly fractured dolomite. That is the case has been proved by the boring operations of the Rand Water Board.

APPENDICES

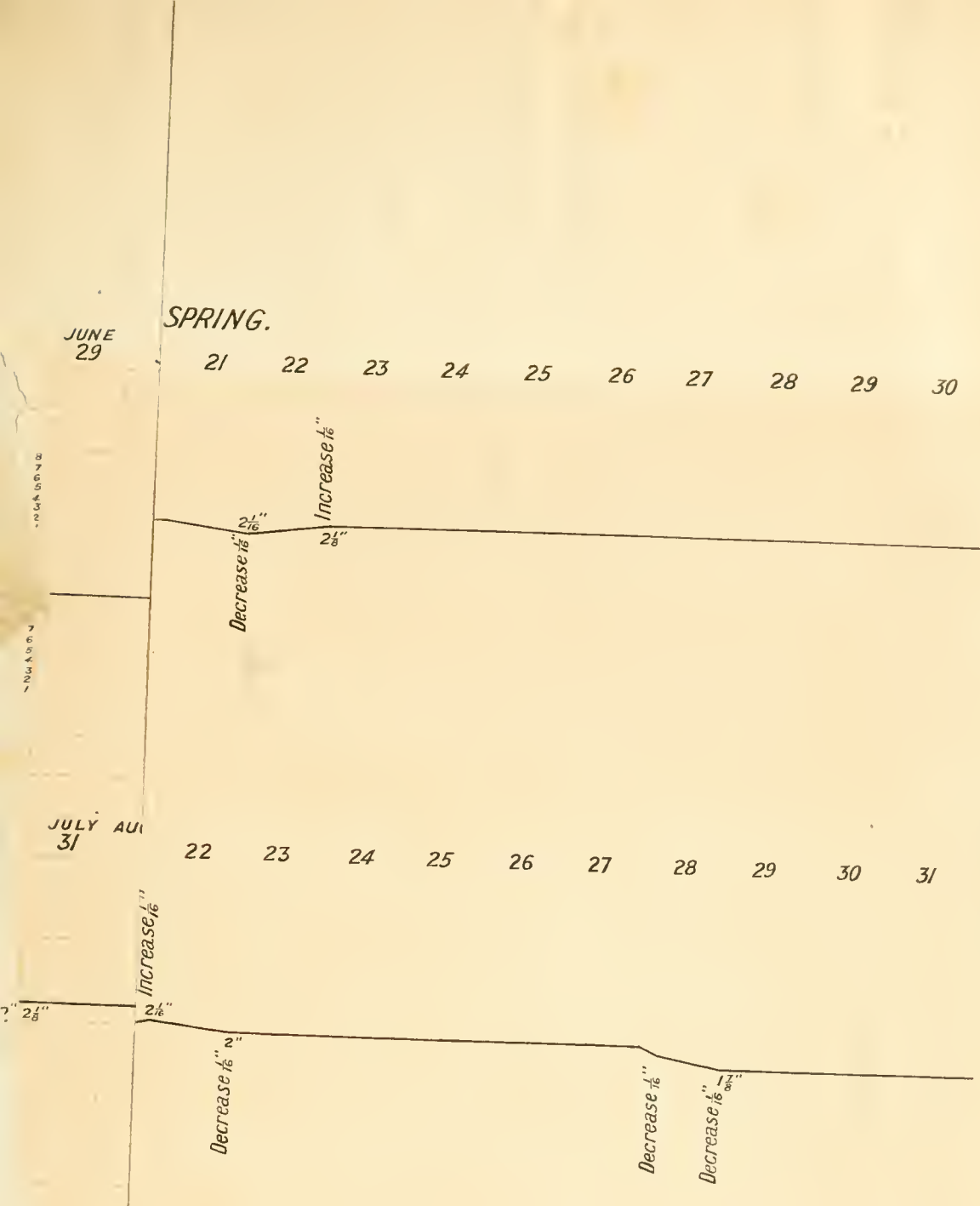
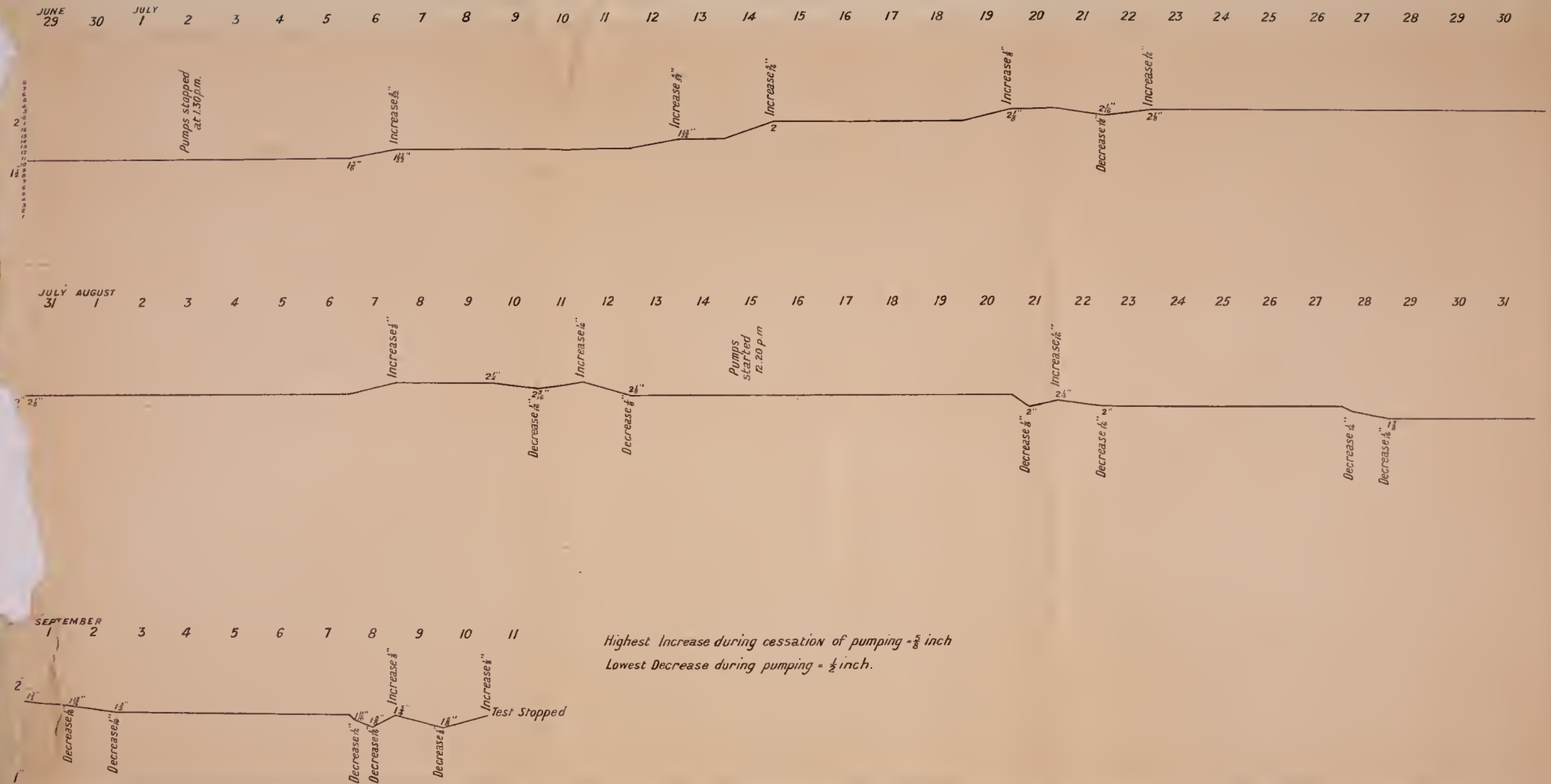

SPRING.
JUNE
29
21
22
23
24
25
26
27
28
29
30
Increase 1/16"
2 1/16"
Decrease 1/16"
2 1/8"
JULY
31
22
23
24
25
26
27
28
29
30
31
Increase 1/16"
2 1/8"
2 1/16"
Decrease 1/16"
2"
Decrease 1/16"
Decrease 1/16"
1 7/8"

CHART. SHOWING RISE AND FALL IN WATER FLOWING OVER GAUGING NOTCH AT Mr VAN ZYL'S SPRING.



Highest Increase during cessation of pumping = 5/8 inch
Lowest Decrease during pumping = 1/2 inch.

APPENDICES.

Appendix " A ".

AREAS OF KLIP RIVER CATCHMENT.

Witness.	All Formations. Sq. miles.	Dolomite. Sq. miles.	Remarks.
Karlson, A.	818	261	Does not give areas of different formations.
Wotherspoon, T. A. ..	880	Not given	—
Laschinger, E. J. ..	861	327	Does not give areas of different formations.
Leitch, D. C.	—	—	Only gives areas above Klip River drift, 308 square miles; above Jackson's Drift, 236 square miles.
Melville, E. H. V. ..	873	309	Classifies different formations as follows :— Witwatersrand .. .. 197·9 Diabase .. .. .. 240·8 Black Reef .. .. .. 17·4 Gatsrand .. .. .. 107·4

Appendix " B ".

STATISTICS OF KLIP RIVER AND KLIPSPRUIT RIPARIAN FARMS.

Name and No. of Farm.	District.	Area.		Land (in Morgen).		Population.
		Morgen.	Sq. roods.	Irrigated.	Irrigable.	
KLIP RIVER.						
Klipriversoog No. 47 ..	Krugersdorp	3,926	215	168·52	18·42	87
Rietfontein No. 48 ..	,,	3,633	95	211·01	9·69	78
Olifantsvlei No. 60 ..	,,	3,420	48	99·74	101·51	156
Misgund No. 56 ..	,,	3,861	92	138·47	31·48	104
Olifantsvlei No. 16 ..	Johannesburg	1,586	358	179·60	3·14	123
Eikenhof No. 7.. ..	,,	2,303	88	Included in	Olifantsvlei	112
Rietvlei No. 17.. ..	,,	4,167	372	101·13	14·75	73
Allwynspoort No. 249	Heidelberg ..	2,900	369	136·87	13·07	75
Kromvlei No. 282 ..	,, ..	3,000	—	24·22	—	62
Zwartkopjes No. 262 ..	,, ..	4,755	541	249·36	55·42	—
Waterval No. 209 ..	,, ..	8,835	478	168·20	109·90	195
Witkop No. 66 ..	,, ..	4,129	529	82·05	339·23	220
Witkoppies No. 116 ..	,, ..	3,269	372		21·26	55
Slangfontein No. 121 ..	,, ..	6,181	114	18·98	8·06	395
Rietfontein No. 315 ..	,, ..	3,363	567	29·58	15·18	205
Kookfontein No. 57 ..	,, ..	5,087	437	33·92	25·05	240
Waldrift No. 92 ..	,, ..	1,344	69	Nil	Nil	0
Klipplaatdrift No. 336	,, ..	2,985	130	Nil	Nil	1
		68,752	74	1,641·65	766·16	2,181
KLIPSPRUIT.						
Klipspruit No. 59 ..	Krugersdorp	2,838	543	Nil	30·10	
Klipspruit No. 8 ..	Johannesburg	2,694	205	51·74	11·33	—
		5,533	148	51·74	41·43	
	GRAND TOTAL	74,285	222	1,693·39	807·59	2,181

Appendix "D".

REPORT ON THE GEOLOGY OF THE KLIP RIVER VALLEY IN ITS RELATION TO WATER SUPPLY.

By Dr. W. A. Humphrey, B.A.

With the exception of a small portion south-east of Meyerton Station, the whole of the course of the Klip River lies in rocks belonging to the dolomite formation.

The dolomite occupies a stretch of country varying in width from some seven miles at Klipriversberg to two and a half miles at Jackson's Drift.

The rocks of the Transvaal System in this district occupy a roughly semicircular area, with a diameter from Klipriversberg to Vereeniging of some twenty-five miles.

Of this semicircle the outmost beds are those of the Black Reef quartzites and shales, which dip under the dolomite towards the centre of the circle. Then follows the dolomite, overlain by the quartzites and shales of the Pretoria Series, which form the bulk of the inside area.

The formations are thus disposed so that the Black Reef is practically a huge basin, in which are laid the dolomite and Pretoria Series.

The Klip River follows a course along the semicircular outcrop of dolomite; the Pretoria Series rocks forming high ground to the south and west, and the Black Reef forming a slight ridge along the rim of the basin. Outside the basin of sedimentary rocks the Ventersdorp igneous rocks form high ground.

Although surface streams find their way through the Black Reef to join the Klip River yet the underground system of drainage in the Transvaal System rocks is independent and probably self-contained within the limits of the Black Reef basin.

Many of the important springs occurring along the course of the river are found in the lower beds of the dolomite and are brought to the surface by the presence of the underlying impervious Black Reef, whose outcrops are never far from the river, and which in some cases bound the vlei directly.

The source of the water in these springs is the elevated area covered by rocks of the Pretoria Series in the centre of the basin, and the underground flow probably coincides in direction with that of the surface tributaries.

A series of igneous dykes exists in the dolomite and Pretoria Series whose outcrops run in lines almost at right angles to the strike of the dolomite, roughly forming radii of the circle. Only a few of these show continuous surface outcrops, but the presence of others is proved in the Misgund borehole of the Rand Water Board, where two considerable igneous dykes are met with showing absolutely no surface outcrop.

These dykes would probably render impossible any considerable underground system of drainage in the direction of the surface flow of the river in the upper portion of its course, where they chiefly occur. They would break up the underground flow in the dolomite drawn from the high ground to the south-west into a series of independent systems confined by these radial dykes. The flow is to the circumference of the circle and the water appears at the surface as the dolomite becomes shallow and the underlying impervious Black Reef makes itself felt. This is roughly along the line taken by the Klip River and occupied largely by vlei land.

In the opinion of the writer the whole of this water belongs to the Klip River, and would, if left to its natural course, find its way to the lower reaches of the river. There can be no rigid line drawn between dolomite water and surface water as each in turn supplies the other.

In the dolomite are inter-stratified bands of chert. These strike parallel to that of the dolomite, and their outcrops are very numerous, and have been mistaken for those of igneous dykes. With the exception of one persistent horizon at the top of the dolomite, and one near the bottom, they are all of an intermittent character, thickening and then dying away forming thin lenticular masses. This want of continuity makes their influence upon the underground water practically nil, and renders their detailed mapping a matter of little moment, while consuming a great deal of time.

(Signed) W. A. HUMPHREY,

Geologist.

Geological Survey Office,
Pretoria, 28th June, 1909.

Appendix "E".

VARIATIONS IN THE AMOUNT OF RAINFALL OVER THE TRANSVAAL.

The rainfall records of countries in which the observations of rainfall have been conducted for a long period of years frequently show cyclical variations, i.e. a period of years with rainfalls exceeding the average is followed by a period of drier years and this in turn by a period of wet years. For certain countries the length of this cycle is known to be about thirty-five years.

The rainfall records of the Transvaal are not yet of sufficient length to draw any conclusion as to the nature of any periodicity in the amount of its annual rainfall, but it is probable that such a periodicity may exist. It appears from certain records of the difficulty of travelling in the country owing to swamps, flooded rivers, etc., that the rainfall may have been much heavier about the years 1876–80 than it has been during the last twenty years.

Systematic rainfall records over the Transvaal Colony have only been in existence since the season 1903–04, but for a few places the records are much older than this.

Table I gives the annual rainfall at a few places distributed over the Colony from the season 1895-96. This table shows very roughly (owing to the small number of stations) that the average rainfall over the Transvaal during this period has been approximately 32·14 in. It further shows that of the five rainy seasons ended 1907–08, three have had rainfalls decidedly below the average. These were compensated, however, by good rainfalls in the remaining two seasons.

On dividing this series of fourteen rainy seasons into three groups of five each it appears that the average rainfall for the last five rainy seasons is greater than that of the first five rainy seasons of this period.

The longest record of annual rainfalls in the Transvaal is that obtained at Joubert Park, Johannesburg, and this is given in Table II. Here the average rainfall for the last twenty seasons ended 1907–08 has been 30·71 in. Of the last five seasons, three have had rainfalls below the average, but the other two were well above the average.

Dividing the series into groups of five years it is seen that the average rainfall of such a group has slowly increased throughout this period.

Table III gives the annual rainfall during the last six years at rainfall stations either inside or on the borders of the catchment area of the Klip River. The mean rainfall over this area is estimated to be roughly 29·26 in., and it is shown again that three of these six years had rainfalls decidedly below the average, but that these were compensated by three years with rainfalls well above the average. From the similarity in the variations of rainfall during the last six years, as shown for Joubert Park in Table II and for the Klip River area in Table III, it is concluded that the earlier records of Joubert Park may be accepted as indicating also the variations of rainfall over the Klip River area.

General Conclusions.—From these rather scanty records it may be inferred that the alleged desiccation of the Transvaal cannot be attributed to any continuous decrease in the annual rainfall. In considering the question of the desiccation of the Transvaal it is necessary also to consider the natural percolation through the surface soil and also the evaporation of surface moisture. It is probably true that that amount of the rainfall which percolates through the surface soil and so replenishes underground supplies of water has decreased to some extent during the past twenty years, as a natural consequence of increased activities over the Colony. The making of roads for transport and the numerous paths made by cattle and sheep on the farms would have the effect of decreasing percolation slightly. This, however, is almost unavoidable and would not be a matter of much moment. The effect of the burning of the grass during the dry season is probably much greater than this. After the burning a caked hard surface is obtained, from which the run-off of the early rains is considerable, at the expense of the percolation. The formation of deep dongas over the Colony also reduces percolation very considerably.

The evaporation of surface water over the Transvaal is very considerable, as the figures submitted in Table IV (not printed) will show. Observations of evaporation have only been carried on for the past four years, so that it is not possible to draw any conclusions as to the variation from year to year.

(Signed) H. E. WOOD,

Transvaal Meteorological Department.

Appendix "E"—(Continued).

NOTE ON POSSIBLE CHANGES OF CLIMATE AND THE PROBABILITY OF CYCLES OF RAINFALL.

Considerable attention has been paid by meteorologists to the question of the possibility of secular changes of climate over various parts of the earth, but no definite conclusions have yet been formed on this point. Professor R. de C. Ward, in his book on "Climate", makes the following statement :—

"It is apparent, on examining the evidence thus far at hand, that the fact of permanent, progressive changes in climate during historical times has not yet been definitely established."

There is, however, more evidence in support of the belief that there are periodic changes in the climate and more especially in the rainfall of any place.

In the first place, there is a distinct eleven-year periodicity in the state of activity of the sun, and as the sun is the prime cause of meteorological phenomena over the earth, it would be expected that a similar periodicity would exist in terrestrial meteorology. This is to some extent found in the variations of rainfall over large areas, but is hardly found in the records of individual stations.

Of more importance than the sun-spot cycle is the thirty-five-year cycle established by Brückner. This is based upon the study of such matters as the fluctuations of water level of the Caspian Sea, the dates of opening and closing of the rivers of the Russian Empire, the dates of vintage in various wine-producing countries. Brückner found that in a cycle whose average length is thirty-five years there comes a series of years which are somewhat cooler and also more rainy, and then a series of years which are somewhat warmer and drier.

This interval of thirty-five years between wet periods is not perfectly regular ; it has been as short as twenty years and as long as fifty years, but on the average the interval between two successive wet periods is about thirty-five years.

It may be interesting to remark that the period 1841–55 was a Brückner wet period, from 1856–70 a dry period, 1871–85 a wet period. Continuing this series the period 1886–1900 would be a dry period, and 1901–1915 a wet period.

This is to some extent in agreement with what is known as to the existence of dry and wet periods over the Transvaal.

There are also evidences of the existence of longer climatic cycles of several hundred years' duration, but these are not sufficiently definite to be of practical interest.

Rainfall records taken over the Transvaal are not yet of sufficient antiquity as to show whether these cycles or combinations of them are represented here. But the Brückner cycle has been shown to exist in the records of so many parts of the world that it is very probable that it will apply also to the rainfall over the interior of South Africa. Assuming that this is so then it would follow that we have passed through a dry period between 1886 and 1900 and are at the present time passing through a wet period, which may be expected to last until about 1915. In support of this it may be remarked that the average rainfall at Joubert Park from 1888–89 to 1899–1900 was 29·64 in., while from 1900–01 to 1908–09 it has been 34·28 in.

H. E. WOOD.

APPENDIX TO STATEMENT.

The following further details are given in order to bring up to date the statement made before the Commission on 23rd September, 1908 :—

The appended table gives the rainfall for each month of the year from July, 1908, to June, 1909, at nine stations, either in the Klip River Valley or sufficiently near to be of use in estimating the rainfall over the catchment area.

The rainfall of the season 1908–09 has been very great, and in fact is the largest that has been recorded since the rainfall of the district has been measured. A rain-gauge has been established at Joubert Park since 1888, and the rainfall of the season 1908–09, viz., 50·00 in., is by far the greatest annual rainfall yet recorded. The second heaviest rainfall is that of 43·39 in. in 1890–91.

Since there are only twenty-one years' records of rainfall at Joubert Park up to date, the average rainfall deduced from these records may differ by as much as 5 per cent. from the true average rainfall deduced from a very long period. The most accurate expression which can, so far, be obtained for the average rainfall at Joubert Park is $31{\cdot}54 \pm 1{\cdot}58$ in. The rainfall for the season 1908–09 lies therefore between 51 per cent. and 67 per cent. in excess of the average seasonal rainfall. From European records it is found that the wettest year of a long period has a rainfall exceeding the average by about 52 per cent. Thus the rainfall of 1908–09 is as large as may be expected to occur, and it is not likely that a similar large rainfall will be experienced again for many years.

The amounts of evaporation registered by a Symons' Tank Evaporimeter during the past five seasons have been :—

1904–05	.. ..	92·31 inches.
1905–06	.. ..	84·72 ,,
1906–07	.. ..	70·10 ,,
1907–08	.. ..	76·69 ,,
1908–09	.. ..	66·59 ,,

H. E. WOOD,

Transvaal Observatory.

Appendix "E"—(Continued).

TABLE I.

ROUGH ESTIMATE OF AVERAGE RAINFALL OVER THE TRANSVAAL.

Season.	Joubert Park, Johannesburg.	Government Buildings, Pretoria.	Klerksdorp.	Ermelo.	Kaapsche Hoop.	Mean.
1895–96	22·28	23·91	20·76	22·26	36·51	25·14
1896–97	32·05	20·86	19·20	25·76	46·80	28·93
1897–98	28·89	27·82	20·67	31·27	51·24	31·98
1898–99	25·36	19·23	17·59	18·69	47·12	25·60
1899–00	29·12	25·52	—	25·99	46·40	31·76
1900–01	35·88	26·05	—	36·75	56·94	38·90
1901–02	36·22	28·90	21·95	—	40·43	31·88
1902–03	29·66	24·98	—	—	39·84	31·49
1903–04	34·98	28·42	20·32	—	50·75	33·62
1904–05	26·14	21·55	14·83	30·65	38·41	26·32
1905–06	29·53	19·69	21·95	23·46	36·20	26·17
1906–07	38·63	28·27	35·64	39·15	73·73	43·08
1907–08	27·50	17·41	17·35	26·25	43·45	26·39
1908–09	50·00	45·43	35·80	32·72	79·67	48·72
					MEAN ..	32·14

Average for five seasons—

1895–96 to 1899–00 .. .. 28·68 inches.
1899–00 to 1903–04 .. .. 33·53 ,,
1904–05 to 1908–09 .. .. 34·14 ,,

TABLE II.

RAINFALL RECORDS OBTAINED AT JOUBERT PARK, JOHANNESBURG.

Season.	Annual Rainfall.	Average of Five Seasons.
1888–89	24·56 inches	
1889–90	21·66 ,,	
1890–91	43·39 ,,	29·15 inches
1891–92	28·15 ,,	
1892–93	28·00 ,,	
1893–94	40·16 inches	
1894–95	32·11 ,,	
1895–96	22·28 ,,	31·10 inches
1896–97	32·05 ,,	
1897–98	28·89 ,,	
1898–99	25·36 inches	
1899–00	29·12 ,,	
1900–01	35·88 ,,	31·25 inches
1901–02	36·22 ,,	
1902–03	29·66 ,,	
1903–04	34·98 inches	
1904–05	26·14 ,,	
1905–06	29·53 ,,	31·36 inches
1906–07	38·63 ,,	
1907–08	27·50 ,,	
MEAN ..	30·71 inches	—

Appendix "E"—(Continued).

TABLE III.

ANNUAL RAINFALLS NEAR THE KLIP RIVER CATCHMENT.

Station.	1908–09.		1907–08.		1906–07.		1905–06.		1904–05.		1903–04.		Means.	
	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.
Krugersdorp	42·05	99	22·05	84	32·76	97	24·25	86	20·02	95	26·96	89	28·01	92
Zuurbekom	35·13	109	22·88	86	28·54	100	22·63	76	22·73	80	28·57	79	26·74	88
Florida ..	45·63	115	22·77	89	33·15	91	23·22	80	24·16	79	37·48	94	31·07	91
Maraisburg	39·14	96	23·75	78	26·80	89	24·56	83	19·90	68	—	—	26·83	83
Langlaagte	44·92	102	27·58	77	31·39	93	30·76	82	20·95	86	30·17	74	30·96	86
Vierfontein	39·93	104	22·85	71	28·11	84	23·15	81	19·05	77	—	—	26·62	83
Elkenhof ..	—	—	—	—	26·83	73	—	—	—	—	—	—	26·83	73
Joubert Park	50·00	124	27·50	92	38·63	99	29·53	89	26·14	88	34·98	96	34·46	98
Zwartkopjes	38·69	97	24·36	73	—	—	—	—	—	—	—	—	31·52	85
Hayfields ..	35·93	99	23·87	62	38·09	82	20·19	67	—	—	—	—	29·60	77
MEAN ..	41·27	105	24·18	79	30·70	90	24·82	80	21·85	82	31·63	86	29·26	86

Appendix "F".

RUN-OFF AND PERCOLATION.

Name of Witness.	PERCOLATION.			RUN-OFF.		
	All Areas.	Dolomite.	Klip River Area.	Non-Dolomite.	Dolomite.	Klip River Area.
Draper, D.	—	—	—	—	Nil	—
Karlson, A.	2 per cent.	4 per cent.	4–5 per cent.	—	—	—
Laschinger, E.	—	—	—	—	—	1·44 per cent. average for four seasons.
Leitch, D. C.	—	—	10 per cent. average. $7\frac{3}{4}$ per cent. last four seasons.	—	—	10 per cent. average. 9 per cent. last four years.
Struben, A. M. A. ..	Between 4 and 7 per cent.	—	—	—	—	—
Wotherspoon, T. ..	6 per cent.	18 per cent.	—	14 per cent.	6 per cent.	—
Inter-Colonial Irrigation Commission	—	7–25 p. c.	—	—	—	—

Appendix "G".

INCREASED EVAPORATION FROM VLEIS.

Mr. E. H. V. Melville.

It will be seen that the vleis and lands of Klip River and its tributaries lose a large amount of water by evaporation. The water in vleis rises in the peaty soils and dry vegetation by capillary attraction and exposes a larger surface for evaporation. This is still more increased since the vleis are now largely burnt and the surface is exposed to the fierce rays of the sun, whereas shade tends to decrease evaporation by keeping the water cooler.

Mr. D. C. Leitch.

There is a very considerable volume of water lost by evaporation from the surface of the different vleis and by the reeds and vegetation growing in them.

Appendix "H".

UNDERGROUND DRAINAGE TO VAAL RIVER.

Mr. E. J. Laschinger, M.E., B.A.Sc., etc.

An undetermined and probably indeterminable amount of water, probably belonging to the Klip River basin, may be finding its way by underground channels out of the area and is lost as far as the district is concerned.

Chairman: In your opinion there is a large supply of underground water which can and ought to be tapped, and which would otherwise be lost to the country?—I say that all the evidence points to that.

Chairman: It is your opinion that there is water which can be used and the taking away of which cannot affect anybody?—That is the tendency of the facts which I have collected in former years.

Mr. D. C. Leitch, Chief Engineer, Rand Water Board.

Chairman: You say there is an underground river running down the valley, which comes from Zuurbekom, because you calculated that in the catchment area?—Yes.

Mr. A. M. A. Struben, A.M.I.C.E.

Chairman: From what you know, would it be inconsistent with what you have seen that a large portion of the stream in the valley should remain underground and only see daylight at Vereeniging?—If you ascertain the total flow of the stream at Vereeniging and also ascertain whether there are any dykes affecting that flow, then you have your question answered; it is a matter of accurate gauging.

Chairman: But without that gauging you cannot assume that this is water escaping from the Klip River?—I think it would be very unsafe.

Mr. T. A. Wotherspoon, Rand Water Board.

It is apparent that the bulk of the water finds its way out of the dolomites below Vereeniging weir or to the west of the Klip River valley. Were it possible to intercept the underground flow, the community on and about the Reef and valley would benefit considerably, instead of which most of the water passes out of the Klip River Valley unobserved, probably entering the Vaal to no useful purpose.

In support of this statement, it has been observed that both above and below the railway bridge at Vereeniging there are large quantities of dolomitic waters exuding in the bed of the Vaal River.

Mr. A. Karlson, Hydrographic Surveyor, Transvaal.

Chairman: What you mean to suggest to us is that the water which once passes Zwartkopjes does not come to the surface again until it gets to the Vaal River?—I believe so.

Chairman: Your idea is that the water flows in one channel from the Klipriviers Oog to the Vaal at Vereeniging and only comes out at these other springs on account of the water plane being raised there?—Yes.

Chairman: And if the water plane is lowered it continues below and goes right down to the Vaal River?—Yes; that is the point.

Mr. E. H. V. Melville.

Chairman: There is one matter which is now, and which has not, been touched upon at previous inquiries, and that is the assertion that a large proportion of the percolated water in the dolomite area of the Klip River Valley escapes and finds it way underground. Do you subscribe to that opinion?—I have no doubt about it.

Chairman: Provided the measurements (of the flow of the Klip River) were correct and knowing that the spring at Vereeniging did not run more than 40,000 gallons during the war, it is evident that some underground channel is emptying itself near the bridge (at Vereeniging)?—That is the only explanation I can give.

Chairman: And some may escape lower down?—Yes. If we take the higher figures of percolation of the catchment area there is a tremendous lot of water flowing somewhere which we cannot account for.

Appendix "J".

MEASUREMENTS OF THE FLOW OF THE KLIP RIVER.

Date.	By whom Gauged.	Where Gauged.	Amount in million gallons per day.	Remarks.
1888	E. Laschinger	Jackson's Drift	3·5	Average of five gaugings.
1889	,,	,,	3·2	,, ,,
1893	R. Pizzighelli	Klip River Bridge	4·2	—
Sept., 1896 ..	T. Stewart	Jackson's Drift	4·9	—
Oct. ,, ..	,,	,,	3·0	—
Nov. ,, ..	,,	,,	4·2	—
Dec. ,, ..	,,	,,	6·4	—
Sept. ,, ..	G. W. Herdman	,,	6·5	Over weir.
			3·5	In furrow.
			10·0	Total.
Nov., 1898 ..	E. Laschinger	Van Wyk's Rust	0·15	—
Sept., 1899 ..	,,	Jackson's Drift	0·63	—
,, ,, ..	,,	Klipplaatdrift	2·3	—
Oct., 1900 ..	,,	,,	113·72	For whole month.
Nov. ,, ..	,,	,,	326·98	,, ,,
Dec. ,, ..	,,	,,	383·61	,, ,,
Jan., 1901 ..	,,	,,	357·40	,, ,,
Feb. ,, ..	,,	,,	224·81	,, ,,
March ,, ..	,,	,,	1024·25	,, ,,
April ,, ..	,,	,,	896·97	,, ,,
May ,, ..	,,	,,	363·35	,, ,,
June ,, ..	,,	,,	312·60	,, ,,
July ,, ..	,,	,,	317·21	,, ,,
Aug. ,, ..	,,	,,	218·84	,, ,,
Sept. ,, ..	,,	,,	174·06	,, ,,
			13·18	Average per day.
Oct., 1901 ..	E. Laschinger	Klipplaatdrift	215·11	For whole month.
Nov. ,, ..	,,	,,	630·67	,, ,,
Dec. ,, ..	,,	,,	442·88	,, ,,
Jan., 1902 ..	,,	,,	1373·46	,, ,,
Feb. ,, ..	,,	,,	518·37	,, ,,
March ,, ..	,,	,,	1392·49	,, ,,
April ,, ..	,,	,,	688·76	,, ,,
May ,, ..	,,	,,	441·94	,, ,,
June ,, ..	,,	,,	330·29	,, ,,
July ,, ..	,,	,,	238·08	,, ,,
Aug. ,, ..	,,	,,	108·97	,, ,,
Sept. ,, ..	,,	,,	122·85	,, ,,
			17·82	Average per day.
Oct., 1902 ..	E. Laschinger	Klipplaatdrift	101·38	For whole month.
Nov. ,, ..	,,	,,	82·90	,, ,,
Dec. ,, ..	,,	,,	108·25	,, ,,
Jan., 1903 ..	,,	,,	113·50	,, ,,
Feb. ,, ..	,,	,,	145·39	,, ,,
March ,, ..	,,	,,	91·61	,, ,,
April ,, ..	,,	,,	139·08	,, ,,
May ,, ..	,,	,,	167·48	,, ,,
June ,, ..	,,	,,	126·90	,, ,,
July ,, ..	,,	,,	116·99	,, ,,
Aug. ,, ..	,,	,,	109·97	,, ,,
Sept. ,, ..	,,	,,	79·38	,, ,,
			3·79	Average per day.
Oct., 1903 ..	E. Laschinger	Klipplaatdrift	62·77	For whole month.
Nov. ,, ..	,,	,,	72·23	,, ,,
Dec. ,, ..	,,	,,	128·53	,, ,,
Jan., 1904 ..	,,	,,	96·72	,, ,,
Feb. ,, ..	,,	,,	364·00	,, ,,
March ,, ..	,,	,,	1860·00	,, ,,
April ,, ..	,,	,,	615·30	,, ,,
May ,, ..	,,	,,	419·66	,, ,,

Appendix "J"—(Continued).

MEASUREMENTS OF THE FLOW OF THE KLIP RIVER—(*Continued*).

Date.	By whom Gauged.	Where Gauged.	Amount in million gallons per day.	Remarks.
June, 1904 ..	E. Laschinger	Klipplaatdrift	401·04	For whole month.
July	..	..	269·54	.. ..
Aug.	..	..	230·39	.. ..
Sept.	..	..	137·18	.. ..
			12·72	Average per day.
1903	T. A. Wotherspoon	Klipplaatdrift	1·8	—
1903	..	Jackson's Drift	1·7	—
1903	..	Zwartkopjes, southern boundary	No flow	—
Sept., 1908 ..	E. Laschinger, T. A. Wotherspoon, and E. H. V. Melville	Klipplaatdrift	1·8	Average of six gaugings.
.. .. ..	T. A. Wotherspoon	Jackson's Drift	1·8	—
.. .. ..	..	Zwartkopjes, southern boundary	No flow	—
.. .. ..	E. Laschinger	Van Wyk's Rust	No flow	—
.. .. ..	..	Jackson's Drift	1·5	—

Appendix "K".

DECREASE OF THE FLOW OF THE KLIP RIVER.

Mr. A. B. Allison, Waterval.

Last summer, in 1907, there was not sufficient water in the river to count at all.

Mr. M. E. Frames.

I have known the Klip River from 1890. I cannot remember the amount of water going down but I do remember that the river was a big one in 1890, and up to about 1896 or 1897.

Chairman: You have never known it to stand even in dry seasons?—No; not up to then.

Nor at any point?—No.

Mr. J. M. Berry, Henley-on-Klip.

A strong point about the Klip River formerly was that in the winter time there was always a good current of water, and the extra water you got in the summer was generally overflow.

Mr. T. N. Leslie, Vereeniging.

Chairman: The water is fairly low everywhere now?—Yes; but not nearly so low as it was in 1905.

Do you think the water was lower then than it is now?—Yes: very much lower both in the Klip River and the Vaal River.

Mr. C. MacKay, Kookfontein.

Chairman: I understand you to consider that the river is less strong than it formerly was?—Yes; very much. In the early days when I was here, in the summer we could hardly cross the Klip River.

Mr. R. Pizzighelli.

I was on the farm Witkop during the construction of the railway to Vereeniging, and Mr. Van Elde, who was the engineer in charge, caused a weir to be constructed at Klip River bridge. That was in 1892, and he caused certain measurements to be taken of the flow of the water in the Klip River at that time. During the month of September there never was less than 10 cubic feet per second at the Klip River bridge on the farm Waterval.

Chairman: Is there anything like that quantity of water there now?—No; there is nothing like it. Last time I went down the river did not flow at all, and there was no water in it.

Was the river ever dry?—No; in 1893 it was always running.

Appendix "L".

NOTES OF INSPECTIONS.

Place.	Date of Inspection.	Remarks.
ZWARTKOPJES—		
Borehole G ..	Sept. 1. 1908	Being developed. 2500 gallons running to waste. Second shaft 120 feet away being finished. Yield from two about 600,000 gallons. Level of one does not affect level of other.
,, K ..	,,	Yield about 300,000 gallons. Not working; shaft 90 ft. deep; 30 ft. of water standing.
,, I ..	,,	About one and a half miles from K Weir, between I and K; no water running over for months—not since January. Two boreholes yielding about 100,000 gallons. Pump there—not working.
,, F ..	,,	Yields 400,000 gallons continuous pumping. Only using 300,000. Double shaft being sunk 120 ft. away. Mr. Leitch of opinion that F would produce about 600,000 gallons, if not more.
,, C ..	,,	Yields 1,300,000 gallons. Double pump. Not vlei water, although vlei quite near. Shaft sunk showing there is no connexion. More than 1,300,000 gallons can be got as water level has not been lowered, although pumping continues for over a year.
,, A ..	,,	Yields 1,400,000 at present, but can get 300,000 more. Only pumping during the day: about 700,000 gallons. Water contains iron, which, Mr. Leitch says, proves this is different source. Water cannot come from Oudeklip. Large stream from vlei passes close to borehole. Bacteriological and chemical tests show no connexion exists between vlei water and water pumped.
Water in Vlei ..	,,	About 1,000,000 gallons per day. Used for working farm Zwartkopjes. About 300 acres under plough; let to Mr. Allison, with all buildings, at £400 per annum. Vlei below water-furrow practically dry—no water leaves boundary of Zwartkopjes. Few smaller springs about half-way; only damp ground; no flow.
Pumping Station	,,	Capacity 9,000,000 gallons per diem; at present 2,000,000 pumped. Mr. Leitch stated Zwartkopjes can produce 4,000,000 gallons. Deprecates taking more than 8,000,000 gallons from total area of Klip River basin, as that would not be fair to the supply. In pumping station is borehole yielding 100,000 gallons a day; pumping does not affect level of small pond close outside station.
Borehole B ..	,,	On Allwynspoort. Used to yield 100,000 gallons; not satisfied with supply at present. Driving; can always reasonably count on obtaining further 100,000 gallons by driving 30 ft.
,, D ..	,,	Oliphant's Vlei. Yielding 300,000 to 350,000 gallons. Used to yield 750,000 when Vierfontein Syndicate first had it, and they subsequently obtained 500,000, but the Rand Water Board never got more than 300,000. Usual double shaft, 120 ft. apart. No connexion between two. Lowering one does not affect other. Sunk to depth of 140 ft. and are going to 180 ft.

Appendix "L"—(Continued).

NOTES OF INSPECTIONS—(*Continued*).

Place.	Date of Inspection.	Remarks.
Zwartkopjes—(*contd.*) Borehole H ..	Sept. 2, 1908	500,000 gallons running to waste; water disappears within a very short distance, although it has been running fourteen days. Found small hole into which some of the water was running. Within one mile of fountain (Van Zyl's), which it is alleged to have affected. Usual double shaft, unconnected.
,, E ..	,,	Struck a dyke, driving to avoid it; above is Misgund Cave, a fallen-in swallow hole with water at bottom 200 ft. higher than water level. Mr. Geldenhuys states there are two further dykes crossing the river, of which the E dyke is one. Both dykes produce strong springs, from which Oliphantsvlei (A) and Misgund have water. Both farms have ample water supplies from these springs, and the farmers contend that if the bore had missed the dyke in E the Misgund spring would have been struck and drained in the same way as Van Zyl's spring has been drained by H.
Klipriver Oog ..	,,	Vlei apparently dry.
,, ..	May 28, 1909	Northern eye unchanged; road running near used to be covered with water some years ago; now high and dry. Western eye, standing water only. Swallow hole; no trace of entry of water. Water level of vlei apparently unchanged.
Zuurbekom	Sept. 2, 1908	Large station, used to pump 2,000,000 gallons daily, but dropped 50 per cent. in year 1907–08. Only pumping 1,000,000. Water level 40 ft.; drops down to 60 ft. when pumping.
Robinson Dam ..	Sept. 7, 1908	On spruit, between Fordsburg and Johannesburg and Booysens Spruit. Apparently no overflow.
Crown Deep Dams ..	,,	Two dams: small seepage from larger dam; fair stream of discoloured water running. Good deal of seepage below larger dam; no outlet pipe in embankment.
Crown Dam	,,	Apparently no water running out; some seepage.
.. .. ..	,,	No water running in from mine.
.. .. ..	,,	Has a main pipe below junction of Maraisburg and Langlaagte Spruits on Kruger's Company; from it about 80,000 gallons daily running into vlei below road and thence into Canada Dam.
Canada Dam	,,	Finished in May, 1904. Nearly full. Capacity about 400,000,000 gallons. No seepage. No shaft water runs into it. Mines pump about 3,000,000 monthly, but most of this is returned. Very little water in Klipspruit at its junction with Florida Spruit. Messrs. Le Roux allege this dam kills their supply.
Spencer's	..	Not inspected to-day. It is alleged Mr. Spencer cuts off all water under ordinary conditions.
Dam on Tributary of Klipspruit	—	Not inspected. Tributary comes from Gaol Department ground on Diepkloof; only a trickle of water runs into Klipspruit.
Neumann's Farm (Klipspruit) ..	Sept. 7, 1908	Mr. Spencer pointed out the very small extent of irrigable ground before Canada Dam was completed in proportion to what is now under water.

Appendix "L"—(Continued).

NOTES OF INSPECTIONS—(*Continued*).

Place.	Date of Inspection.	Remarks.
Klipspruit	Sept. 7, 1908	Portion owned by Anglian Mining and Finance Company (F. W. Blood) has its own spring. Mr. Spencer states part of flow used to run into Klipspruit above the Oog, but it is now cut off completely by dam. Spring is not affected by drought.
Le Roux's Furrow ..	,,	Very small quantity of water; a little seepage through railway embankment. Spruit beside old werf dry to end. Le Roux alleges no water flowing since last Christmas, except rain-water. Orchard suffered from drought. Water-holes for drinking-water and watering cattle; quite insignificant but could probably be much enlarged.
Highest Eye of Klip River	Sept. 8, 1908	New road close to it. Old road much higher up formerly impassable. Second eye little lower down. Either of them formerly enough to lead water from.
Hartzenberg's Furrow	,,	North of vlei. Constructed over fifty years ago. Its extent, 300 yards, is quite distinct.
Swallow Hole ..	,,	Formerly stream of water disappeared into it strong enough to drive an overshot wheel. Mr. L. J. van Wyk and others state that after the war water got scarce, and a wall was made round the hole to stop water entering. Water level is now well below that wall.
Hartzenberg's Dam..	,,	Portions of it well raised. Dam did not extend across vlei. Is on Rietfontein.
Southern Eye ..	,,	Filled with reeds. About 100 or 150 yards from vlei. Nine years ago very strong fountain; now quite dry.
Fountain in Vlei ..	,,	Opened up in 1906; about a mile above dam; runs into a dam a mile lower down. Formerly a very strong stream; still flowing water.
Rietfontein Dam ..	,,	Receives water from vlei fountain. Strong dam across vlei; well gravelled 140 yards back. Large furrow from it, which supplies six farmers and fourteen bywoners. Mr. Hurley estimates capacity at about 1,000,000 gallons. Farmers stated water was formerly three times as strong. Dam and furrow made in 1888 by farmers and bywoners on Rietfontein.
Lekwater Sloot ..	,,	Quite dry. Furrow and dam made in 1878. No water. Below 1888 furrow, which did not affect it formerly, ample water for both. This furrow has not run since the war. It used to be sufficient for all lands below it; now receives only little seepage. Lands under furrow were made in 1888–91; all dry now.
Oliphant's Vlei Furrow	,,	Quite dry; no water in vlei.
Junction of 1878 Furrow with 1888	,,	Very little water. Water being led above.
Mrs. Van Wyk's Furrow	,,	Quite dry.
Furrow at Oliphant's Vlei	,,	At least thirty-one years old. No water now, nor has there been since the war, except storm-water. It used to turn a mill winter and summer.

Appendix "L"—(Continued).

NOTES OF INSPECTIONS—(*Continued*).

Place.	Date of Inspection.	Remarks.
Fountain on Oliphant's Vlei on the Van der Merwe Hoskill Boundary	Sept. 8, 1908	Farmers stated spring neither increases or decreases in volume and has not varied for the last thirty years. Known as Bennett's. Mr. Leitch stated there is a dyke higher up. Boring above it is not being considered now as Board have enough water without it.
Mill Site	,,	On dry furrow on Bennett's portion of Oliphant's Vlei.
Second Bennett's Fountain	,,	Very strong and said never to vary. Pumping station there can supply 120,000 gallons. Have pumped consecutively for two months for crops, in the day time, do not exhaust water.
Junction of Two Bennett's Fountains	,,	Mr. Leitch estimated flow at 2,000,000 gallons. Mr. Hurley concurs.
Several Small Fountains in Vicinity	,,	Said not to vary. None of Bennett's fountains are alleged to be affected by Zuurbekom pumping.
Van Zyl's Spring ..	,,	About a mile north-east of borehole H. Oil driven pump, which worked for forty-five minutes when it had overtaken water in eye. Not only stopped water running out of eye but practically drained the eye. Owners allege they used to pump continuously for weeks at a stretch without exhausting spring.
,, ,, ..	Nov. 20, 1908	Mr. Hurley gauged water at 1 in. over weir and 4½ in. in outlet pipe. No change in afternoon after stoppage of pumping at H.
,, ,, ..	Nov. 21, 1908	No change. Mr. Van Zyl, jun., stated water had risen in early morning, but had resumed its former level. Evidence of rise on woodwork.
,, ,, ..	Nov. 26, 1908	Dr. Jorissen measured water as ¾ in. over weir and 4 in. in pipe.
,, ,, ..	July 28, 1909	Water measured, over weir, east side, 1¾ in.; middle, 2⅛ in; west, 2⅜ in. Level of pool formed by spring risen 1 in. Furrow had overflowed. Certain pools (small) of water in spring basin.
,, ,, ..	August 7, 1909	Mr. Hurley measured water; same as on 28th July. Levels constant from 22nd July, with exception of slight decrease on 21st of 1-16th. Furrow very full. Level increased 1-16th in. while Mr. Hurley was there.
,, ,, ..	Dec. 3, 1909 ..	Large stream of water turned from furrow into pool caused by the spring. Same quantity of water running as at last inspection. Spring apparently dead; no movement traceable.
Government Convict Station	Sept. 21, 1908	Passed this place; large extent of dry cultivation; water obtained from wells.
Municipal Dam ..	,,	Capacity 180,000,000 gallons; completed May, 1906. Has never been filled. Contained 30,000,000 to 40,000,000 gallons: six months' ago contained 50,000,000 gallons; difference lost by evaporation and small seepage stream, about 10,000 gallons per day. None of this water has or is now being used. Municipality water obtained from Klipspruit.
Municipal Lands on Klipspruit	,,	About fifty odd acres under cultivation; good deal of lucerne. Half of water supply obtained from Canada, Dam under an old servitude.

Appendix "L"—(Continued).

NOTES OF INSPECTIONS—(*Continued*).

Place.	Date of Inspection.	Remarks.
Intake from Vlei ..	Sept. 24, 1908	Municipal pumping station. Capacity of furrow, 4500 gallons per hour. Pumps for twelve to eighteen hours a day; average less. No pumping while Commission were there.
Overflow at Intake	,,	Half a million gallons allowed to pass under arrangement entered into on 20th September, 1908.
Springs and Dam at Blood's	,,	Good springs. Very little leakage from dam.
Doornkop Spruit ..	Sept. 25, 1908	Crossed at drift. No water has apparently run in old course for some time. Course overgrown with long grass. Mr. Melville had never seen water at this point in winter; he pointed out dyke running north and south to the north of drift and passing below higher eyes of Klip River. Noticed boring operations at new "aanleg" just above this dyke.
,, ,, ..	May 28, 1909	Flow estimated by Dr. Jorrissen at 3,500,000 gallons per day.
Zuurbekom Basin ..	Sept. 25, 1908	Proceeded round rim of basin. Fairly closed all round as far as surface is concerned; has no valley running off in any direction. Apparently dolomite all the way; saw nothing of coal formation which is inside the basin.
Gemsbokfontein ..	,,	Eyes in vlei. Higher eyes all dry. Watercourse where eyes used to feed vlei, still quite discernible. Vlei practically dry; formerly quite impassable. Several eyes lower down. Saw furrow above eyes said to have been taken out by Sellers.
Gemsbokfontein Water Furrow	,,	Quantity in furrow estimated by Mr. Hurley as from 1,000,000 to 1,250,000 gallons. Vlei below now quite dry and partly being ploughed; formerly impassable.
Convoy Hole ..	,,	About a mile south-west of Gemsbokfontein homestead. Diameter from 200 to 250 yards; greatest depth about 60 ft. Has apparently been much deeper. Contains dwyka conglomerate standing on edge; apparently fallen from roof. Also some cave breccia.
Le Roux's Two Furrows	,,	Dry on either side of valley on his farm Venterspost. Water taken out of Gemsbokfontein 800 to 1000 yards higher. Le Roux states that furrow last contained water in 1904, with exception of rainy season.
,, ,,	June 4, 1909	Water flowing in furrow about 400,000 gallons a day.
Venterspost Fountains	Sept. 25, 1908	Two large ones; water lukewarm ("algae"). Mr. Le Roux says no perceptible decrease. Also saw smaller springs. Dyke north-west of fountains apparently took direction through valley below Venterspost springs. Mr. Le Roux says dyke is red granite, but Dr. Jorrissen describes it as diabase. Outcrop apparently runs north and south. Direction would bring it below fountains.
Eyes of Doornkop Spruit	,,	Fair quantity of water. Young Labuschagne says eyes formerly much stronger; pointed out furrow from one eye twelve yards away. This spring is only separated by a narrow ridge from the springs on Blood's farm; distance, roughly, two miles.

Appendix "L"—(Continued).

NOTES OF INSPECTIONS—(*Continued*).

Place.	Date of Inspection.	Remarks.
Eyes of Doornkop Spruit—(*contd.*)	June 4, 1909	Spring flowing about 500,000 gallons a day. About a quarter to a third more water than at last inspection. Mr. S. du Plessis stated spring was neglected and not so strong as it used to be. Lower course, Vlakfontein, as strong as ever it had been before drought. All reservoirs full. Vlakfontein course quite dry for two years.
Rietvlei No. 126 ..	Sept. 28, 1908	Pointed out by Mr. Jan Meyer. Furrow sixteen years old taken out in Petrusvlei. About 25 morgen of Mr. Meyer's ground under water.
Allwynspoort ..	,,	Furrow in existence about thirty years. About 20 morgen of Mr. Meyer's ground under water. Mr. Meyer alleges that furrow now carries half of former quantity. Present volume estimated by Mr. Hurley as 750,000 gallons. Crossed vlei and river; road made through vlei, which was dry. Formerly said to be a perpetual swamp. River contained estimated supply of 1,250,000 to 1,330,000 gallons. Smaller stream of about 100,000 gallons from springs not far from drift. Followed course of river into vlei; good deal of seepage from vlei into course of river from both sides.
Kromvlei	,,	Inspected dry lands, which are said to have yielded 15,000 oat sheaves last year. Rietvlei furrow quite dry.
Vaal River Springs, Vereeniging	Sept. 29, 1908	About 80,000 gallons per day.
,, ,,	May 29, 1909	Mr. Holt, Irrigation Department, stated spring was yielding about 100,000 gallons.
,, ..	Dec. 4, 1909 ..	About 100,000 gallons; appeared stronger than at last inspection.
Kookfontein	Sept. 29, 1908	Mr. Mackay's son farming there, has ample water; no complaints.
,, ...	Dec. 3, 1909	Springs apparently unchanged.
Klipplaatdrift Gauge	Sept. 29, 1908	Built by Vierfontein Syndicate about eight years ago.
,, ,,	Dec. 4, 1909 ..	Stream very strong and somewhat discoloured owing to rains.
Meyerton	Sept. 29, 1908	Noticed small spring on banks of river.
Henley-on-Klip ..	,,	Dam commenced January, 1904; completed in March. Backed water up four and a half miles. Greatest depth 50 ft. Near end of dam average 32 ft. Several springs in banks of river discharge into reservoir; also some seepage from upstream dams. Furrow with constant flow of about 1,000,000 gallons. Left to run for benefit of lower riparian owners. Seepage from dams and springs below increase volume of river.
Rietfontein Spring	,,	Fair amount of water, at a high level, about 800 or 1000 yards from river.
Van Schalkwyk ..	,,	Springs in dam; very graphic illustration of state of river. Water in dam has sunk many feet at different times, as is shown by the height of old furrows from it.
.. .. ..	Dec. 3, 1909 ..	Small stream running from dam, apparently due to water running in from Rietvlei. Mr. Van Schalkwyk assured Commission that overflow from dam is in no way due to springs which are dead.
Witkop..	Sept. 29, 1908	Mr. Bruwer's portion. Saw dry lands and four of the eight or nine springs. Mr. Hurley estimated flow of river here at from 1,250,000 to 1,500,000 gallons.
Waterval	,,	Mr. Allison's farm. Saw old furrow common to him and Mr. Diedrichs. Said to have been dry since 1904. Dam filled by rain-water only; was nearly empty.
Florida Loop ..	June 4, 1909	Flowing about 1,000,000 gallons a day.
West Roodepoort Loop	,,	Flowing about 400,000 gallons per day from a spring.

Appendix "M".

UPPER SPRINGS—OOG-VAN-KLIPRIVIER.

Mr. J. M. van Wyk (owner of portion of Rietfontein No. 48).

It is my opinion that we do not get from the eyes of the river one-fifth of the quantity of water that used to flow from them in 1897.

Mr. Hudson: If you compare the quantity of water that you used to get in 1897 from the eyes of the river with the quantity of water that you find below the junction of the two Bennett springs, is the comparison in favour of the water coming from the eye?—It was much stronger then, and we used to get more water from Kliprivers Oog than is yielded by the Bennett springs.

Mr. H. J. van der Westhuijzen.

Chairman: Do I understand that you also confirm the statements which have been made that the water used to be five times the present quantity?—Yes.

Mr. J. G. van Deventer (owner of portion of Olifantsvlei).

Chairman: From where do you get your water?—From the furrow which comes from Klipriviers Oog through Rietfontein and Olifantsvlei. I have known this furrow since 1897: it is in the same position. The furrow, however, is now dry and has been dry since 1903.

Mr. D. Draper.

Chairman: We have evidence from farmers that the pumping on Zuurbekom affects their springs. The moment they start pumping any large quantity of water at Zuurbekom their water supply decreases?—It is possible.

If your theory is correct no pumping at Zuurbekom could affect the eye of the Klip River at all?—Oh, yes. It must if you go on pumping for a long time. I have already stated that the diminution of the supply of the vlei at the Oog may be caused by a new subterranean channel having been formed. I do not say it is all the handiwork of man or the treading of cattle. Some obstruction may have been removed, and it would not surprise me to find the Klip River eye disappear altogether. I say that from my general knowledge of the dolomite.

And that would not prove that it would not flow from the coal-measures into the dolomite all the way?—I have not said that. It must go somewhere, and the surplus from Zuurbekom undoubtedly goes there, but that there is no direct connexion is proved by the lowering of the river at Zuurbekom by 22 ft. without draining the eye of the Klip River. If there had been any direct connexion that eye would have been dried up.

Mr. Du Plessis: There were a couple of springs near the Oog, and I know to-day they are merely marshes?—I do not think that really affects the position at all. A little lower down, by the removal of some obstruction in the underground channels, those two springs would stop running and the water would come out lower down. The fountains were at a slightly higher level than the eye of the Klip River itself, so that the water flowed towards the Klip River eye at the time. It does not now. They have simply found some other way out.

Mr. C. W. Duploog (has lived on Gemsbokfontein for twenty years).

Chairman: Do you know the eye that comes out of the hill?—Yes.

Is that as strong as it was formerly?—No; it is altogether dry.

When did you first notice it was becoming dry?—About fifteen years ago. It gradually diminished year by year until it got quite dry.

Twenty years ago was there enough water for all your lands?—Yes.

Mr. A. J. Kock (owner of portion of Venterspost).

Chairman: Where do you get your water?—In the fountain that comes out on Venterspost.

Is the water less than it formerly was?—In previous times the water was stronger than it is now.

When did the fountains first begin to get weaker?—It was before the war, about 1895 or 1896. Zuurbekom was working before the war.

Do you know the fountain on Gemsbokfontein well?—Yes.

Is that as strong as it used to be?—No.

Do you know the fountains on Gemsbokfontein that are now dry?—Yes; I know them.

When did you last see them?—A few years ago.

You know the fountain has become weaker?—Yes; it is less on Gemsbokfontein. I have noticed that in passing.

Mr. E. J. Laschinger.

Chairman: Klipriviers Oog eyes in June, 1899, were 3,000,000 gallons per day, and in September, 1908, 1,500,000 gallons?—Yes; that is so.

Appendix "N".

ZUURBEKOM—WATER PUMPED BY THE RAND WATER BOARD, WITH LEVELS OF VLEI.

Year.	Amount Pumped. Million gallons.	Average Level of Vlei.
1902	336	5135·92
1903	556	5135·84
1904	604	5135·89
1905	766	5135·93
1906	865	5136·01
1907	536	5136·22
1908	353	5136·27
1909	105	5136·48
AVERAGE ..	552	

Average amount pumped per annum for years 1902 to 1909 inclusive is 552,000,000 gallons.

Appendix "O".

ALLEGED INTERFERENCE WITH MR. VAN ZYL'S SPRING.

Mr. J. A. van Zyl.

I am not interested in the land below the fountain, and my share of my father's farm is under the furrow. I am nearly thirty years of age, and as far back as I can remember the fountain was always strong and it drove a mill by itself, but in that case we could only grind about one bag an hour

Chairman: Do you know the borehole put down by the Rand Water Board on Eikenhof?—Yes.

How far is it from the fountain?—It is a little more than a mile; it is west of the fountain. I cannot tell you exactly when the Rand Water Board began pumping, but it was about the end of March or the beginning of April of this year (1908). I do not know that it had any effect on the river. In the beginning of April my brother came and told me that the fountain had stopped running, and I went there myself to look after it and saw that it had absolutely stopped. I have known the fountain for a long time and I know the place where it used to boil up in the white sand, and when I went to look at it I could not see any water bubbling up at all. This happened while they were pumping. The fountain is not nearly as strong as it used to be, and when we pump now it becomes dry. It takes about three-quarters of an hour to empty the fountain.

What do you put down as the cause of the stopping of that fountain?—In my opinion it is due to the borehole H on the ground of Mr. Neethling.

Mr. G. van Zyl, jun.

I farm a piece of ground below the fountain.

On the 7th of April I started pumping early in the morning and the water just ran as far as my land, about 260 yards. I sent down to the fountain to inspect it and I found there was no water in the fountain to pump. I did not know if there was anything wrong and I wanted to dam up the fountain. I started again after an hour's stoppage, and again within an hour there was no more water to pump. It now pumps about forty-five minutes and then I am obliged to stop. There is a little water left, but not enough for the pump. I attribute the cause of this to the boring at H borehole.

Do you know when this borehole began to work?—I think about the end of March or at the beginning of April, but I am not certain. It has been working ever since. I was called once to the fountain by a native about the end of April, and he told me that the water was bubbling up again in the fountain. Formerly there used to be water bubbling up through the sands, but that bubbling has disappeared in April last. When the kaffir called me in the end of April I saw the water bubbling up again as it had done previously.

How long did that continue?—It went on like that until the evening, but next morning it had stopped again.

Did you inquire whether the pump at H borehole had stopped working?—No; I did not go up to see it. I know they used dynamite at H borehole, and it was a very strong charge, sending up rocks hundreds of feet. The man in charge told me there was 100 to 150 pounds of dynamite exploded, and with this tremendous discharge the ground below might have been disturbed.

Mr. Hudson: About when was it that you heard this dynamite report?—I am not certain of it.

How long was it before the stoppage of the fountain; that is all I want to know?—It might be a month or two, but I could not say for certain.

Mr. J. T. Kemp.

I am one of those who have ground on Olifantsvlei, and I have about fifteen to twenty morgen under water. I confirm the evidence of the previous witnesses as to the pumping and the decrease in the water and its alleged cause. I have nothing to add to it. My opinion is that it has been caused by borehole H.

Mr. J. J. Pienaar.

I am also one of those interested in the lands below the fountain on Olifantsfontein, and I confirm the evidence of the previous witnesses.

Until about a month before last April when the borehole H began I tested the pump beyond its ordinary capacity and there was always enough water.

Mr. F. E. Prins.

I have about 500 morgen on Olifantsvlei.

I know the pumping station belonging to Van Zyl, and I know that fountain has decreased in strength. It became weaker after borehole H started. I have been informed that there is a vein of water underground, but I have not seen it. I sank a well for drinking-water between borehole H and the fountain on Van Zyl's ground, but not exactly on the same line. We did not put it exactly on the line, because we did not want to show the direction, and we were afraid the Rand Water Board would go and cut off our water. It seems to me, however, that they got the line after all. I have no interest in Van Zyl's fountain. It is my opinion that the borehole H has cut off the supply of water from Van Zyl's fountain.

Mr. J. A. Buhrmann.

Chairman: Do you know the pumping station at Van Zyl's?—Yes; but I have nothing to do with it.

I do not know exactly the reason for the diminution of the supply, but I consider it is due to all the pumping that is taking place round here at Zuurbekom and so on.

Mr. D. D. Torrein.

I know the Klip River and I was owner of Zwartkopjes, and I have lived on different portions of farms along the river.

My view is that whereas Zwartkopjes affects Klipriversoog and Olifantsvlei No. 60, and the pumping station on Eikenhof affects Mr. Gideon van Zyl's fountain.

Chairman: How is it do you think that borehole H has affected Gideon van Zyl's fountain?—It is my opinion that there are water veins or fissures below the ground, which take the water to the river, and if you tap them higher up the fountains at the river will dry up.

Mr. W. G. F. Neethling.

I have about 50 morgen, of which the greater portion is on Misgund, and 4 morgen on Eikenhof.

The second cause is the borehole H which has affected the fountain on Mr. Van Zyl's ground. I have not personally inspected the pumping, but I have known that the spring on Mr. Van Zyl's ground is a splendid one and has always been good.

Appendix "P".

EXTRACTS OF EVIDENCE RELATIVE TO THE DIMINUTION OF THE WATER SUPPLY.

C. J. Schalkwyk, 29th September, 1908.

It (the spring) always had a distinct and marked course to the river, as pointed out to the Commission this morning. I had six bywoners who used the water from the furrows on either side. There was abundance of water for them. There were 4 in. of water running out of the lower dam which had been made to catch the spring. I noticed the water becoming weaker when the pumping began at Allwynspoort. After a year's time the water sank below my top furrow, and then I had to work the lower furrow. It sank again below the second furrow when the waterworks started pumping at Zwartkopjes. I still had some water left, and when the third small pumping station was put in working order, about three miles from here, the remainder of my water disappeared. In consequence of this I did not get any water at all from the spring. I have not got a drop since the third small pumping station was erected.

If my spring was to regain its former strength I should irrigate the whole of the 100 morgen under lucerne.

21st June, 1909.

I gave evidence previously and stated that the magnificent spring on my farm had dried up entirely, and I ascribed that to the pumping at Zwartkopjes. The rains of this year have had no influence on my spring. At the beginning of the year I turned some of the water I have from the Nooitgedacht loop into the dam. I could therefore not see whether the springs in the dam were running again, but about the 23rd May (1909) the water from the dam stopped running, and I could then see that the springs could not have been yielding any water. I have since made another test by stopping the water from Nooitgedacht, and the old springs from the dam did yield something, but not a quarter or a fifth of what they previously yielded. It is more seepage than anything else.

Appendix "Q".

EXTRACTS OF EVIDENCE RELATIVE TO THE DIMINUTION OF THE WATER SUPPLY.

E. P. du Plessis, 9th September, 1908.

I live at Rietfontein No. 38, and have lived there since 1878, about thirty years now. I own about 700 morgen, 40 morgen of which is agricultural land. When I came to the farm there was one furrow lower down, and I made two more furrows myself, the second furrow in 1880 and the third in 1887. That furrow was always full, the other two furrows were also full of water; there was too much for all the lands of myself and the owners of Rietfontein. This continued until 1897. No new lands were made after 1897.

We had dry seasons before the year 1897, but it did not affect our water. I know the new road which passes close to the highest eye. Formerly there was no such road and all that ground was covered by water. Even in dry seasons the eye on the other side of the vlei which is now dry used to be a strong spring, and the space between it and the vlei was covered with water. The waterworks at Zuurbekom were used in 1897 and 1898; you could well notice that the water began to get weaker. In the end of 1897 there was a protest made by all the owners of the Klip River Valley to the Government. In 1903 the water began to get so weak that the people on Olifantsvlei who used to get their water out of the Rietfontein furrow got no water at all.

The water ceased to reach Olifantsvlei, with the exception perhaps of a little night water which we used to allow to pass. In the end of 1905 the two other furrows became so dry that we were obliged to dig wells in the vlei in order to provide ourselves with water. From 1903 to 1905 it was so short that I had to give up one portion of my lands which could not be irrigated.

There is no water below the dams where we have our furrow to-day.

I have cultivated Rietvlei and Kromvlei now for the past thirteen or fourteen years, and Allwynspoort a little longer. I had about 50 or 60 morgen altogether under water. Formerly there was enough water for the 50 or 60 morgen which I cultivated, but now there is nothing. Above the sluit from which I used to get the water in the vlei the vlei is so dry now that you can cross it on horseback, whereas formerly you did not dare to send in a native to put up a surveyor's flag.

Places which were a tremendous swamp are now being ploughed by me and sown with mealies.

J. M. van Wyk, 9th September, 1908.

I am the owner of a portion of Rietfontein No. 48 (942 morgen). I have about 42 morgen that I can irrigate. I can now only put under water about half of the land that I had under water in 1897. I added 4 morgen of land in 1897, but these 4 morgen never got water, because there was none for me to give them. From 1890 to 1897 I had 38 morgen under water, and we had abundance of water. Since the year 1898 the water supply has been steadily decreasing. The lowest I have had was in 1906. From November, 1906, to February, 1907, there was not even drinking-water in the furrows, and we had to make wells in the vlei just to get drinking-water for ourselves and for our cattle.

It became very strong between August and September of last year; at that time I could irrigate about two-thirds of my land. It decreased again a little until May. I can at once notice the water increasing or decreasing according to the amount of pumping which I can see is going on, and which is shown by the smoke from the stack. It takes about a week after pumping ceases until the water again begins to increase. I remember very dry seasons, such as that of 1878, when there was no rain until the 1st of November, and our springs here were not at all affected.

C. P. du Plessis, 9th September, 1908.

I live at Olifantsvlei No. 60, part of which I own, and I am also part owner of Rietfontein.

I now own 18 morgen as heir, and since 1903 these 18 morgen have not had a drop of water, and I had to make a well 45 ft. deep for my own drinking water. In the joint furrow with Rietfontein no water has run since 1903, except in times of rain, and then the moment the rain ceases the water also stops running at once. I cannot use this land now for anything except mealies, and I have to rely on the rains.

On Rietfontein in 1903 there was a full stream of water, but since then it has become less and less.

L. D. C. van Wyk, 9th September, 1908.

I am the son of the late Jacob van Wyk, and owner now of a portion of the farm Rietfontein. I was born here, and am twenty-five years old. About 14 morgen is arable land, and in former times these lands always had sufficient water, so much so that we never even used the night water. I also farm 12 morgen belonging to my brother, and out of these 26 morgen I have only sufficient water at the present time for about 6 morgen, and it is hardly enough for that. It became bad since 1903.

It began to decrease in 1903. The lowest furrow has not been running since 1903, and then the middle furrow began to stop. A year ago in August and September we had a very fair amount of water, but nothing like what we had before 1903. It decreased the most in February and March of this year, and in May month it became a little stronger, and kept on increasing until about the 20th of last month. Our water furrow was dirty then and we have cleaned it since, but we have now less water than we had on the 20th August.

H. J. van der Westhuyzen, 9th September, 1908.

I live on Olifantsvlei No. 60. I am an owner of Olifantsvlei. I own 14 morgen of agricultural land since 1881. I used to cultivate and sow the whole of these 14 morgen up to 1903, but now it is dry ground, and I have not had any water on it since 1903.

I used to sow grain, oats, and potatoes. *Chairman*: Do I understand that you also confirm the statements which have been made that the water used to be five times the present quantity?—Yes.

J. P. Furter, 9th September, 1908.

I live on Olifantsvlei No. 60. I have known it for eleven years. *Chairman*: You know there is a list given of dry ground on Olifantsvlei that used to be under water?—Yes. *Chairman*: In that list it is stated that you have 6 morgen that are now dry?—Yes. I would like to say that it was a little more, but I put it at 6 morgen so as to be on the safe side. *Chairman*: The others are C. J. Marc, 10 morgen; G. van Staden, 7 morgen; C. H. van der Merwe, 20 morgen; G. C. van Vuuren, 3 morgen; F. A. Middleton, 12 morgen; H. H. Dell, 12 morgen; J. G. van Deventer, 10 morgen; P. J. Marc, 3 morgen; W. J. de Lange, 12 morgen; and H. P. van der Westhuyzen, 14 morgen?—Yes; that list is correct, and the acreage has rather been understated than overstated. All that ground is now entirely without water since 1903. The only thing we can do now with this land is to plant mealies. *Chairman*: Where do you get your water now?—Some people get drinking-water from wells, a few of which are right in the vlei, and others have a small stream of water from the small fountain that other witnesses have spoken of. *Chairman*: Before 1903, was there plenty of water for all the people?—I cannot say there was sufficient water, but still there was enough to enable the people to sow and plant in a way.

The last time we really had sufficient water was before the war. At that time there was enough and to spare for everybody.

C. J. Marc, 9th September, 1908.

I live on Olifantsvlei No. 60 for fifteen years. My portion of ground is 10½ morgen. I bought it with the right to water out of the furrow as the previous witnesses described. This is the furrow on which the farm was originally founded. There has been no water at all since 1903, and all I can do is to plant mealies on this ground. *Chairman*: Was there plenty of water in 1903?—Even in 1903 the water was becoming weak, but we could still irrigate a portion of our land.

J. G. van Deventer, 9th September, 1908.

I live on Olifantsvlei No. 60, since 1879.

All I want to say is that formerly we did have any amount of water, and now we have none.

Gideon van Zyl, 10th September, 1908.

I live at Olifantsfontein No. 132. I own 588 morgen there. I have been on the farm forty-seven years. About 50 morgen is arable. I get my water from the Klip River. The furrow is taken out on the farm Olifantsvlei on the portion now known as Eikenhof. It is a joint furrow, and there has always been only one furrow.

Formerly it was a good strong stream, and there was always a current above the fountain belonging to Bennett, although in case of drought that current sometimes got weak. Now the current has stopped.

J. A. van Zyl, 10th September, 1908.

I am nearly thirty years of age, and as far back as I can remember the fountain was always strong, and it drove a mill by itself, but in that case we could only grind about one bag an hour.

In the beginning of April my brother came and told me that the fountain had stopped running, and I went there myself to look after it, and saw that it had absolutely stopped. The fountain is not nearly as strong as it used to be, and when we pump now it becomes dry.

D. J. Strydom, 10th September, 1908.

The farm Klipriviersoog belonged to my father, where I have stayed when I came here first in 1852. The eyes of the river were very strong there, and the eye which is now dry on the west side of the vlei was then a permanent stream. It was never dry until recently.

In the year 1862, which was a very dry year, Rietfontein still had ample water, but Olifantsvlei water became very weak, not so that it stopped, but they had great difficulty in keeping their lands irrigated. The vlei was full even in those dry years.

It is not the whole of Olifantsvlei which had a scarcity of water during the dry seasons formerly, but it was only the lower portion.

F. E. Prins, 10th September, 1908.

I am an owner on Olifantsvlei. I have about 500 morgen. I think I have about 50 morgen under water. We have not enough water for the ground now, but we used to have enough in former times.

J. A. Buhrmann, 10th September, 1908.

I am not appearing for myself alone here, but for my brother and seven others. We have 20 morgen of irrigable land below the furrow. So far I have not lost any crops, but it is a hard job to keep them alive. We have to work day and night. There is very much less water now than we used to have.

J. J. van der Merwe, 10th September, 1908.

I am the owner of ground adjoining the Klip River. We have about 20 morgen. Formerly the water was much stronger, and there was more than sufficient for the 20 morgen. It has been weaker since 1898. The supply of water greatly decreased, and we lost part of our crops in the years 1901 to 1906. The Klip River was always a strong stream until the Zuurbekom pump started and took away the water.

A. B. Allison, 16th September, 1908.

I am living on Waterval, of which I am lessee, since 1897.

I had 150 acres under irrigation in 1897. *Chairman*: Did you have sufficient water for the 150 acres? At that time more than sufficient. *Chairman*: There has been a decrease of the water since?—Yes; a regular decrease from that time to the present day.

There was enough water for me until the war broke out, but there was less water. When I came back after the war there was not sufficient water for me. That was in 1902. I was then only able to irrigate 100 acres. In 1904 I found that the water had decreased to such an extent that I put a dam right across the Klip River, lower down, a catchment dam, a reservoir to conserve the water from which I then pumped. In 1905 the dam was almost not enough. The water which I caught, the rainfall and so on, was not enough for my needs. *Chairman*: You mean for the 100 acres?—Yes. In the beginning of 1906 we had a good rainy season which brought the river down, and that is practically the last flood we have had down the river. That was in March, 1906. Last summer, in 1907, there was not sufficient water in the river to count at all.

My farm adjoins the Zwartkopjes boundary, and on the Zwartkopje portion of the river is an immense vlei, and that is dry at present. Therefore I got no water during last summer through that vlei into my dam. No water ran out of it. *Chairman*: Whatever water you have got now is entirely catchment water?—Yes; it is absolutely rain-water.

I am also lessee of Zwartkopjes. I have 300 morgen of ground under cultivation. There is not sufficient water for them. At the present time to do the land thoroughly there is water for about 60 acres.

J. P. Meyer, 28th September, 1908.

There is only about one-third now of what there was formerly at this season of the year. I have another furrow on the north side by which I attempt to take water out of the river for Rietvlei. This furrow through Rietvlei is now dry. *Chairman*: When did it last run?—On the 18th July last in consequence of some rains which we had in the river. Before that it had been standing since January, 1908. All the arable lands on the north side are absolutely dry.

C. Mackay, 29th September, 1908.

I have been living at Kookfontein for twenty-one years. My father is owner of the farm. *Chairman*: Do you get your water from the springs known as Kookfontein?—Yes. The river is less strong than it formerly was. A year before the war the river started to get lower and lower. *Chairman*: Just deal with the dry seasons first. We are taking the dry seasons of the different years?—Last year it was very low. It just ran and that was all. *Chairman*: And before that, had it also been very low? It had been running very fair, and in the early days when I was here in the summer time we could hardly cross the Klip River. *Chairman*: Is it your opinion that the river is getting less and less every winter?—Yes. *Chairman*: And is it any better this year, do you think?—No; not at all. In fact, I think it is worse. *Chairman*: In your opinion the river is getting decidedly less every year, and that has been going on since before the war; every winter?—Yes. *Chairman*: And in summer you would say there have been less floods than there used to be?—Yes; very much less. *Chairman*: When did the river last come down in flood?—About two years ago, when the dam broke. *Chairman*: But I am referring to storm-water floods. Before that, did you use to have floods every year?—The river was impassable very often.

Chairman: And now I understand it has not been impassable for two years?—No. You can cross it. You could not cross it in the early days.

Chairman: Why do you think there is less storm-water?—On account of the fact that in former times no one conserved it, and there were no dams except one small one at Henley-on-Klip. Now there are four dams between this and Allison's farm. We only get the overflow from those dams.

I should say that there was not one-third of the water in the river now that there was fifteen years ago.

J. M. Berry, 29th September, 1908.

I live at Henley-on-Klip and have known the Klip River for the last twenty-two years.

Chairman: Is the Klip River as large as it used to be?—No; it is not. *Chairman*: Do you think there is much less water in it?—Yes; considerably less. *Chairman*: Since what time did you notice it begin to decrease?—Within the last five or six years. *Chairman*: Was it a gradual decrease?—Yes; it has always become less and less, and it is still getting less. *Chairman*: It is a river that used to keep its water, more especially in the winter?—Yes. In making this dam I explained that in the winter the dam would soon fill up because the water gets stronger. *Chairman*: Was the water getting less when you built the dam?—Yes; naturally.

Mr. Hudson: Has the rainfall decreased during the past five years?—Yes; very considerably. There were places which ten or twelve years ago were almost impassable for a wagon, and to-day you can go through them without any difficulty. The Klip River always used to have a decent stream of water in the dry seasons. I do not like to say to what I would ascribe the reduction of the flow of the Klip River. It may be due to the boring operations and the pumping operations of the Rand Water Board, or it may be to the mines.

T. A. R. Purchas, 1st October, 1908.

I am chairman of the Rand Water Board, since 22nd September, 1907.

I do not deny for one single moment that the water is much less than it used to be. That, of course, is without question.

W. Carlis, 2nd October, 1908.

I still retain a certain interest in the farm Witkop. I have been owner of that farm for the last five years. I got water from the Klip River. My dam was completed about four years ago.

I had a certain amount of water but not sufficient, and then I had to raise the bank of the river to get the water over the lands. *Chairman*: Was that the reason why you had to build this dam?—Yes. We thought we should have sufficient water on this side for 120 morgen, and on the other side for anything between 150 and 300 morgen. These calculations were based on the flow of the river. The results were obtained for a year or two in the first instance. All at once it fell off considerably. The water all at once commenced to drop to such a large extent that the people on it said it was no good staying there, and they would have to leave the place; I had several tenants there.

They all wanted to leave because they had not sufficient water. I could not even sell the stands. I sold a lot of water-erven, and the people left these erven as well. Some of that ground has been practically abandoned.

I cannot say exactly what the reason is. It is hard to say.

R. Pizzighelli, 2nd October, 1908.

I am a civil engineer and Government land surveyor, residing in Johannesburg. I was on the farm Witkop during the construction of the railway to Vereeniging in 1892. During the month of September there never was less than 10 cubic feet per second of water in the Klip River. It means about 5,000,000 gallons in the twenty-four hours. It was a fairly constant flow. The drift where the main road crosses the river was always running about knee deep or perhaps a little less. I was down there from July to November, and the month of September was the lowest month. Ten cubic feet was the lowest reading then.

Now there is nothing like it. Last time I went down, the river did not flow at all, and there was no water in it. I remember the rivers and springs running stronger twenty years ago than they do to-day. *Chairman*: Do you know of any other places where there has been such a large discrepancy as there has apparently been at Klip River Drift?—No; I cannot say, because there I have taken measurements and paid more attention to it. *Chairman*: Do you know any other instances where 5,000,000 gallons have disappeared?—No; I cannot say.

Appendix "R".

LOSSES SUSTAINED OWING TO THE DIMINUTION OF THE WATER SUPPLY.

E. P. du Plessis, Rietfontein No. 48, 9th September, 1908.

If I lose my water I am absolutely ruined, and will have to throw myself on the mercy of the Government for food along with the other poor whites.

J. M. van Wyk, Rietfontein No. 48, 9th September, 1908.

Chairman: What kind of crops do you plant now and what damage have you suffered?—I have suffered damage on account of the scarcity of water on account of the fact that I cannot sow my usual crop, such as grain and potatoes. It does not pay us well to sow mealies on the dry land, as it is a very unreliable crop; it does not pay as well as potatoes and wheat. Already some of the crops are drying up. It is impossible to exist on a farm like this where there is such an uncertainty of water, because the risk is too great. I do not consider that it is too much to say that a farmer can make £10 per morgen when he has good water. To give you an instance, I sowed a muid of wheat on a morgen of ground last year, and I obtained from that thirty bags of 200 lb. each in weight, and I sold them here at 29s. per 200 lb. bag. When I had finished getting in my corn I can plant potatoes on the same ground during the same year.

C. P. du Plessis, Olifantsvlei No. 60, 9th September, 1908.

Dr. Jorissen: Did you pay a big price for the ground?—I bought it in 1903, and I paid £11 per morgen. *Dr. Jorissen*: Is the ground still of the same value?—The ground is still of the same value, but if there is to be no water then it would not be worth half of that or even less; in fact no one would buy it from me.

L. D. C. van Wyk, Rietfontein, 9th September, 1908.

Chairman: You have heard it said that land under water can produce about £40 per morgen per year?—Yes; and I have worked it out from my books that the yield per morgen under water can be fairly put at £40.

D. D. Toerien, Eikenhof, 10th September, 1908.

I was owner of Zwartkopjes. I am now farming on Eikenhof. I have lost the ground I previously held because I lost the water, and I could not exist on it. It is due to the fact that I have lost my water that I am now working for others instead of working for myself.

A. B. Allison, Waterval, 16th September, 1908.

I have lost crops which I should have had, although I have not actually lost any crops. I have lost what I could have made.

J. P. Meyer, Rietvlei, Allwynspoort, Kromvlei, and Petrusvlei, 28th September, 1908.

Some of the arable lands on Kromvlei I was unable to plough. Part I ploughed after the rain, but it came up very badly, and some did not come up at all. If we get rains now I shall get about one-third of the crop which I ought to have had, but if we get no rains I shall get nothing. On the south side things are not quite so bad, and I have not lost any crops yet, but there is a danger that I will as the water is getting weaker daily.

W. Carlis, 2nd October, 1908.

I still retain a certain interest in the farm Witkop. I was owner of that farm for the last five years. I constructed a dam four years ago. We thought we should have sufficient water on this side for 120 morgen, and on the other side for anything between 150 and 300 morgen.

The farm has decreased in value enormously. I bought it for the purpose of a settlement, and the moment the water decreased it was finished. I would not have sold it for £100,000 if it had retained the water, and I have sold it for £10,000. It cost me over £30,000.

Appendix "S".

TONS OF ORE CRUSHED AND WATER PUMPED FROM SHAFTS BY MINES DRAINING INTO KLIP SPRUIT, DOORNKOP SPRUIT, AND NATAL SPRUIT.

Name of Mine.	Total Tons Crushed during year ended 30th June.		Water pumped from shafts, daily average—gallons.		Depths at which water was drawn.
	1908.	1909.	1908.	1909.	Feet.
Draining into Natal Spruit.					
Carvers Proprietary	Nil	9,548	Nil	16,800	—
Cinderella Deep	Nil	105,007	66,000	16,931	100 and 1,300.
City and Suburban	307,300	293,282	750,000	400,000	300.
East Rand Proprietary ..	1,404,714	1,750,580	850,000	765,657	800 and 2,800.
Geldenhuis Deep	385,185	355,605	175,000	177,600	140.
Ginsberg	131,244	153,396	60,000	175,000	480.
Glencairn Main Reef	240,255	248,080	65,800	120,000	690.
Glen Deep	241,220	260,855	71,000	15,066	200.
Jubilee	58,770	64,242	—	2,000	—
Jumpers G. M. Co.	118,563	92,320	35,000	134,000	292.
,, Deep	233,152	249,677	84,300	Nil	1,000 & 1,300.
Jupiter	Nil	172,863	28,000	53,000	3,350.
Knight Central	Nil	84,774	85,000	150,000	500 and 2,500.
Knights Deep	496,090	588,180	1,087,000	1,431,564	1,300 to 1,700.
May Consolidated	179,355	180,645	10,000	46,400	Seepage.
Meyer and Charlton	153,215	158,026	130,000	157,800	539.
New Goch	259,882	284,632	100,000	220,000	400 and 800.
New Heriot	112,120	120,840	135,000	126,949	All levels.
New Minerva	5,795	17,318	—	120,548	—
New Primrose	230,376	229,560	250,000	150,000	150 and 300.
Nourse Mines	308,898	439,195	218,000	307,037	100 to 2,500.
Orion	27,600	18,200	—	10,000	—
Rose Deep	392,250	455,250	139,000	152,565	From 20 down.
Salisbury	61,951	91,330	10,000	6,240	538 and 565.
Simmer Deep	—	380,125	121,000	146,743	All levels.
Simmer & Jack East	407,250	384,380	192,000	192,594	1,600.
,, ,, Proprietary ..	785,310	831,040	337,000	464,611	Most levels.
Spes Bona Tribute	52,626	66,942	5,000	7,500	354.
Treasury	108,933	110,220	84,400	102,000	560 and 680.
Witwatersrand G. M. Co. ..	105,620	355,590	100,000	197,000	Near surface.
,, Deep	416,350	463,940	100,000	340,505	,, ,,
Wolhuter	214,940	273,020	150,000	99,000	136 and 648.
Phoenix	1,727	—	—	—	—
Draining into Doornkop Spruit.					
Champ d'Or	72,348	66,248	90,000	114,000	260.
Durban Roodepoort	145,923	158,166	30,000	55,874	380.
,, ,, Deep .	145,950	211,110	200,000	256,652	All levels.
French Rand	242,330	145,857	90,000	60,288	263 and 1,134.
Princess Estate	104,711	107,258	52,600	119,885	All levels.
Roodepoort Central Deep ..	104,954	105,983	110,000	128,365	300 down.
,, United Main Reef	191,982	211,245	80,000	232,500	300.

Appendix "S".-(Continued).

TONS OF ORE CRUSHED AND WATER PUMPED FROM SHAFTS BY MINES DRAINING INTO KLIP SPRUIT, DOORNKOP SPRUIT, AND NATAL SPRUIT—(*Continued*).

Name of Mine.	Total Tons Crushed during year ended 30th June.		Water pumped from shafts, daily average—gallons.		Depths at which water was drawn.
	1908.	1909.	1908.	1909.	Feet.
DRAINING INTO KLIP SPRUIT.					
Aurora West	Nil	112,166	120,000	227,701	293.
Consolidated Langlaagte ..	278,135	288,372	120,000	345,000	200.
,, Main Reef ..	203,869	197,083	100,000	400,000	Follows workings.
Crown Deep	432,285	495,940	388,000	419,198	1,066.
,, Reef	280,342	298,738	—	—	—
Ferreira G. M. Co.	277,650	312,060	50,000	70,885	1,300 to 1,500.
,, Deep	330,775	412,957	94,000	173,108	300 and 1,200.
Langlaagte Deep	395,671	492,579	190,000	215,120	150.
,, Estate	478,074	587,464	330,000	150,000	200.
Marie Louise (Ben Nevis) ..	—	—		60,851	—
Main Reef West	23,448	100,003	—	30,926	—
New Unified	118,128	125,431	140,000	169,000	All levels.
Robinson G. M. Co.	467,335	534,739	250,000	346,664	350 to 1,000.
,, Central Deep ..	289,537	368,096	104,000	112,456	200 to 800.
,, Deep	566,838	655,152	66,000	77,500	—
Vesta	—	—	—	85,435	—
Village Deep	319,550	407,200	126,000	213,130	2,000.
,, Main Reef	483,500	509,000	67,000	138,000	262.
Vogelstruis Estates	102,581	127,688	90,000	154,240	200.
	13,884,922	16,322,197	8,656,100	10,691,888	—

Appendix "T".

Name of Mine.	Has the supply of water diminished in individual shafts?	Are the top levels of mine drier now than they were in early days of mine?
Aurora West United ..	Yes. East incline shaft. Drinking-water for mine was formerly supplied from third level. It is now exhausted.	Yes. Since we have resumed pumping we have also drained New Unified Co.'s supply of drinking-water from their upper levels.
Consolidated Main Reef	Water pumped from shafts *considerably* less, notwithstanding mine is now double the size.	Water previously caught in upper levels is now dealt with at lower levels, otherwise quantity remains about the same.
Bantjes Consolidated ..	Have no data.	Have no data.
Champ d'Or (French) ..	No.	No.
Durban Roodepoort ..	Yes.	Yes.
,, ,, Deep	No.	Yes.
French Rand	No. Water has *increased* about 6 per cent.	About the same.
Ferguson Randfontein ..	No.	No.
Johnstone Randfontein	No.	No.
Lancaster G. M. Co. ..	No. Water in Botha No. 1 has *increased*.	About the same. Each new level has tendency to diminish water in level above.
Lancaster West	On Battery Reef No. On Botha Deep Level water is somewhat lower than formerly.	About the same.
Luipaa dsvlei Estates ..	No.	Yes. Attributable to drainage through faults exposed in development of lower levels.

Appendix "T"—(Continued).

Name of Mine.	Has the supply of water diminished in individual shafts?	Are the top levels of mine drier now than they were in early days of mine.
Main Reef West ..	No answer.	At 240 feet level water has diminished to such an extent that there is none for boiler feed water, and barely enough for drinking.
North Randfontein ..	No.	Yes; very much, because we have tapped the water feeders by the lower levels.
New Unified Main Reef	Water diminished about 30 per cent. during last few months.	Top levels great deal drier than formerly.
Porges Randfontein ..	Supply of water has not diminished in any individual shafts of the mine.	Top levels are drier now than they were in the early days of the mine.
Princess Estate	Quantity now practically the same.	Cannot answer as many top levels have caved in.
Randfontein Central ..	Water has not diminished in any of our shafts. (Mynpacht shaft shows an increase.)	In Block A top levels are dry, and water now making in fourth and fifth levels. No alteration mynpacht section, and in West Randfontein all levels are dry.
Robinson Randfontein ..	Yes.	Yes. First, second, third, and fourth levels make very little water at present. Just now we get most at seventh level.
Roodepoort Central Deep	No.	Yes.
,, United Main Reef	Nothing appreciable.	Nothing appreciable.
South Randfontein ..	No.	Yes. Upper levels drained by faults and dykes intersected lower down.
Stubbs' Randfontein ..	No.	Top levels *no* drier.
Vogelstruis Estates ..	No apparent difference.	No apparent difference.
,, Cons. Deep	Cannot say. Now unwatering shafts.	Cannot say. Now unwatering shafts.
Van Hulsteyn Randfontein	No.	No.
Windsor G. M. Co. ..	No noticeable difference.	No noticeable difference.
West Rand Consolidated	Has no data.	Has no data.
West Rand Central ..	Supply in main shaft (which is only one we pump from) *has diminished considerably.*	Top levels are *much drier* than they were four or five years ago.
York G. M. Syndicate ..	Supply of water has not diminished since reopening mine fifteen months ago.	Upper levels are *no* drier than they were in early days of mine.

Appendix "U".

STATISTICS *RE* MINES DRAINING INTO KLIP SPRUIT, DOORN SPRUIT, AND NATAL (RIET) SPRUIT—TRIBUTARIES OF KLIP RIVER.

Name of Company.	No. of Dams.	Maximum Capacity. Gallons.	Estimated contents at 30th June, 1909, in Dams and Reservoirs.	Situation of Dams.
DRAINING INTO KLIP SPRUIT.				
Aurora West	—		—	(Water obtained from New Unified.)
Bantjes Consolidated Mines	1	60,000,000	—	On spruit flowing from Florida to Klip Spruit.
Cons. Langlaagte Mine ..	2	12,000,000	27,000,000	On spruit from Langlaagte to Klip Spruit.
Consolidated Main Reef ..	1	9,000,000	110,115,000	On spruit flowing to Klip Spruit.
Crown Deep..	—	—	550,000	(Water obtained from Rand Mines and Rand Water Board.)
,, Reef	1	38,000,000	45,000,000	On spruit from Fordsburg to Klip Spruit.
Ferreira G. M. Co... ..	—	—	2,650,000	(Joint dam with Robinson G. M. Co.)
,, Deep	—	—	24,250	,, ,, ,,

Appendix "U"—(Continued).

STATISTICS *RE* MINES DRAINING INTO KLIP SPRUIT, DOORN SPRUIT, AND NATAL (RIET) SPRUIT—TRIBUTARIES OF KLIP RIVER—(*Continued*).

Name of Company.	No. of Dams.	Maximum Capacity. Gallons.	Estimated contents at 30th June, 1909, in Dams and Reservoirs.	Situation of Dams.
DRAINING INTO KLIP SPRUIT—(*Continued*).				
Langlaagte Estate	5	115,000,000	102,692,500	On spruit flowing from Langlaagte Estate to Klip Spruit.
,, Deep	—	—	2,600,000	—
,, Proprietary ..	1	5,000,000	—	On spruit flowing from Fordsburg to Klip Spruit.
Main Reef Deep, east and west	1	—	400,000,000	On spruit from Consolidated Main Reef to Klip Spruit.
New Unified	1	30,000,000	900,000	(Jointly with Aurora West.)
Rand Mines	2	251,500,000	—	On spruit from Fordsburg to Klip Spruit. Estimate of capacity—no definite information obtainable.
Robinson G. M. Co. ..	2	130,000,000	83,000,000	On spruit from Fordsburg to Klip Spruit.
,, Central Deep ..	—	—	1,250,000	—
,, Deep	—	—	1,400,000	—
Village Deep..	—	—	2,960,000	—
,, Main Reef	1	750,000	53,050,000	North-east corner of property just south of Heidelberg Road.
Vogelstruis Deep	—	—	—	—
,, Estate	1	24,000,000	22,540,000	On spruit from Hamburg to Klip Spruit.
DRAINING INTO NATAL SPRUIT.				
Carvers Proprietary	—	—	70,000	—
Cinderella Deep	—	—	346,000	—
City and Suburban ..	1	42,340,800	40,690,000	On Natal Spruit.
East Rand Prop. Mines ..	1	40,000,000	22,900,000	On spruit on Driefontein to Natal Spruit.
Geldenhuis Deep	1	3,000,000	8,797,000	On spruit flowing through Elandsfontein to Natal Spruit.
Ginsberg	2	34,200,000	36,190,000	,, ,, ,,
Glencairn Main Reef ..	1	30,000,000	31,270,000	,, ,, ,,
Glen Deep	1	Nil	310,000	,, ,, ,,
Jubilee	3	4,000,000	7,649,536	—
Jumpers G. M. Co... ..	3	40,000,000	26,262,511	Spruit flowing into Natal Spruit.
,, Deep	—	—	1,455,400	—
Jupiter	—	—	876,000	—
Knight Central	—	—	15,100,000	—
Knights Deep	—	—	2,000,000	—
May Consolidated	1	25,000,000	900,000	On spruit flowing through Elandsfontein to Natal Spruit.
Meyer and Charlton ..	—	—	242,000	—
New Goch	1	2,700,000	1,100,000	—
,, Heriot	3	14,672,400	18,199,000	On spruit flowing into Natal Spruit.
,, Minerva	3	10,000,000	9,000,000	—
,, Primrose	2	59,000,000	35,710,000	On spruit flowing through Rose Deep.
Nourse Mines	1	32,291,000	27,142,523	On spruit flowing through George Goch.
New Orion	—	—	—	Returns incomplete.
,, ,, Mynpacht ..	—	—	—	,, ,,
Orion	1	500,000	50,000	—
Rose Deep	—	—	2,000,000	—
Salisbury	—	—	—	Included in Jubilee.
Simmer Deep	—	—	100,000	—
Simmer and Jack East ..	—	—	200,000	—
,, ,, Prop. ..	1	5,258,000	879,600,000	On spruit flowing through Jupiter.
Spes Bona Tribute.. ..	1	15,000,000	11,130,000	On Natal Spruit.
Treasury	—	—	200,000	—
Witwatersrand G. M. Co...	1	199,000,000	85,990,000	On spruit flowing through Driefontein.
,, Deep ..	1	1,000,000	5,000,000	—
Wolhuter	1	20,000,000	12,200,000	On Natal Spruit.
Rand Mines	1	960,000,000	—	(Rosherville Lake.) On Natal Spruit.
Phoenix	—	—	—	—

Appendix "U"—(Continued).

STATISTICS *RE* MINES DRAINING INTO KLIP SPRUIT, DOORN SPRUIT, AND NATAL (RIET) SPRUIT—TRIBUTARIES OF KLIP RIVER—(*Continued*).

Name of Company.	No. of Dams.	Maximum Capacity. Gallons.	Estimated contents at 30th June, 1909, in Dams and Reservoirs.	Situation of Dams.
DRAINING INTO DOORN SPRUIT.				
Champ d'Or..	1	5,000,000	9,445,000	On spruit flowing through Grey's Mynpacht to Doornkop.
Durban Roodepoort ..	3	30,750,000	32,258,000	On spruit flowing to Doornkop.
,, ,, Deep ..	1	3,000,000	2,500,000	On ground about spruit to Doornkop.
French Rand	2	33,500,000	33,800,000	On spruit from Grey's Mynpacht.
Princess Estate	3	64,011,000	60,367,000	On spruit flowing from North Roodepoort.
Roodepoort Central Deep..	—	—	1,075,900	—
,, United Main Reef	4	46,500,000	29,689,000	On spruit flowing from Roodepoort.
Saxon G. M. Co.	1	65,400,000	—	,, ,, ,,
	68	2,494,373,200	2,611,446,620	

Appendix "W".

LOSSES OF WATER AND DAMAGE SUSTAINED AT KLIPSPRUIT.

Mr. M. J. le Roux.

I have lived on the farm Klipriversoog since 1866, and I stayed there until 1898.

I planted on the farm potatoes, wheat, oats, and tobacco, and I had always sufficient water as ong as I lived there.

The first time the water became scarce was after the war.

The first complaint I had about the scarcity of water was during the summer of 1903. There was still a supply, but the water was gradually getting less and less, and the people I put on the farm complained about it. I told them they had better clean the furrows out, because I thought that was the reason there was no water, but in spite of that the water began to decrease gradually; I personally noticed this. The first time it actually stopped running was about three years ago.

I left for British East Africa in 1905 and returned after nine months and found there was not sufficient water to keep my orchards alive, and on investigation I discovered that the dams of the mines took away all the water. Since that time it has become worse and worse, and it has become so that we are unable to exist on the farm.

We get no potatoes and no corn crops at all. All that we get is the harvest from the dry mealie lands, and no oats, vegetables, or potatoes.

I get some mealies, but am able to give them no water. I have no drinking-water at all on the farm, neither have I got any drinking place for my cattle except the vlei.

Before the war we had plenty of water, so much so that we did not use it during the night, but it was allowed to run down to the next farm.

Mr. F. J. le Roux.

We came to the farm Klipriversoog in 1866, and we still live there. I entirely confirm the evidence given by my brother, but I would like to add that even before the war it was noticeable that the stream began to get somewhat weaker, although not so much as to damage the inhabitants.

The decrease in the flow began after the war, but knowing the farm as I do I am able to notice it is not so much from the furrow as from the vlei, and I can see the decrease of the water there.

Mr. J. M. le Roux.

I am part owner of the farm Klipriversoog, where I have lived all my life (thirty-three years).

There was always some water on the farm, more than we required. The night water ran to waste, and we also gave away water to other owners.

I have suffered damage in my orchards, and I do not get the flow of water that I had before the war. I used to sow before the war about thirty bags of oats, but I have not sown any oats since the war as I have had no water to irrigate it.

I sowed a lot, but harvested nothing because everything was dried up. I do say that the supply has become worse and worse.

Mr. S. J. G. le Roux.

I am owner of a portion of the farm Klipriversoog. I have been living there for the past eleven years.

The water began to get weaker about two years before the war. There was, however, still enough water then for all our lands, but it took us all our time to irrigate them. The first year after the war it ran early in May or June, and we had sufficient water then. I sowed a lot and irrigated all my lands, but since then we have had absolutely no crops on the farm, except last year when I got 3000 bundles of oats. I tried to sow this year, but the crops have proved a failure, as there is no water to irrigate with.

Mr. M. J. Terblanche.

I have known the farm Klipriversoog since before the war. For seven years I was foreman to old Mr. Le Roux. I lived with Mr. Le Roux from 1890 to 1897. I had then also the lands belonging to John and Fanie le Roux under my charge, and I sowed about thirty bags of grain, oats, barley, and wheat. I had good harvests, and we were never short of water. The third owner was Thuys le Roux, and he also had as much water as he wanted, and he had good harvests. He owned as much ground as John or Fanie le Roux. We never used night water or Sunday water. I do not know of my own knowledge how things are here since the war. The water did get a little weaker if the rainfall was low, but we always had sufficient for our purposes. I know this whole district very well, and during the seven years I speak of the vlei was never empty. Even when we turned out of the vlei all the water we could the vlei was never dry. We irrigated a lot of potatoes. About twenty bags were sown and 20,000 tobacco plants, and we used to get from 200 to 300 bags of potatoes, corn, forage, and vegetables. We sometimes in the spring allowed our day water to run to some of the other Le Rouxs who got their water from Klipriversoog and had no right to the water from our farm. I tell you this to show that we had more than sufficient for our own needs.

Mr. J. P. Meyer.

Chairman: You know the farm Klipriversoog?—Yes.

At the time you first knew it in what state was the Klipspruit; was it a strong stream or merely a small flow of water?—It was a very strong stream at times, and although it used to get weak in some seasons it never quite stopped running.

Mr. J. G. van Deventer.

I have lived at Olifantsvlei No. 60 since 1879. I have known the farm well since that date.

I know the Canada Dam. Before that dam was built there was a fair amount of water in the Klipspruit, but there has been none since that dam has been built.

Mr. Hudson: When did you notice that the water in the Klipspruit that went to Le Rouxs had weakened? Since the dams had been made.

Mr. E. P. du Plessis.

I live at Rietfontein No. 48.

Chairman: When did you first notice that the water began to dry up?—The waterworks at Zuurbekom were used in 1897, and in 1898 you could well notice that the water began to get weaker.

In 1903 the water began to get so weak that the people on Olifantsvlei who used to get their water out of the Reitfontein furrow had no water at all.

In 1907 it seemed to me that the Water Board worked less. At all events I could only see the smoke of the stacks from time to time at certain periods, and during that time our water became strong again.

Appendix "X".

WATER SUPPLY AFFECTED BY BURNING OF VLEIS.

Mr. J. P. Meyer.

I have always to watch very carefully that my vlei does not burn, because if it does burn down in the month of August I have considerable scarcity of water. As far back as fourteen years ago I experienced that if my vlei burnt my water would very considerably decrease in strength, and I have taken very great care since then to prevent the vlei being burnt, otherwise I would not notice that in the last six or eight years the water on my farm was less in volume than it formerly was.

Mr. S. J. du Plessis.

Doornkop Spruit used to get weak even in previous years, but only if the vlei had been burnt down in July or August. When the vlei was burnt down it used to run strongly, even in times of drought, so that the mill on it near our farm would be used both in winter and summer.

Mr. J. C. P. L. Labuschagne.

I also admit that the burning of the vlei very much reduced the volume of the river, but it is many years ago since Mr. Meyer and ourselves agreed to prevent any burning of the vlei from Olifantsvlei downwards. It is possible also that the burning of the vleis higher up may have had something to do with the diminution of the river water.

Appendix "Y".

EXTRACTED FROM THE STATEMENT OF MR. T. A. R. PURCHAS, CHAIRMAN OF THE RAND WATER BOARD.

First steps towards creation of Rand Water Board.

1. The first definite step towards the creation of the Rand Water Board was taken on the 4th November, 1901, when the "Witwatersrand Water Supply Commission" was issued under the hand of Lord Milner, then Administrator of the Transvaal.

The terms of reference were as follows:—

"(*a*) To examine the available sources of water supply;

"(*b*) to prepare a scheme for the creation of an unfailing water supply for the Rand and the mines, taking into consideration future requirements; and

"(*c*) to consider the constitution of a public body for carrying out and controlling the said scheme."

This Commission made its recommendations in the form of a report, dated 26th February, 1902

Incorporation of Rand Water Board.

2. The Rand Water Board was established under Ordinance 32 of 1903, known as "The Rand Water Board Incorporation Ordinance, 1903".

Area of supply.

3. The area of supply within which the Rand Water Board was designed by Ordinance to exercise its functions is always referred to as "limits of supply", and is described in the Incorporation Ordinance as "the area included within the Witwatersrand District, or any extension thereof under the provisions of Section 26 of this Ordinance".

Populations within area of supply.

4. The present population resident within the "limits of supply", and dependent ultimately on the Rand Water Board sources for domestic water requirements, is so far as it is possible to ascertain, about 350,000, including natives and Asiatics.

Sources of supply.

5. The sources of supply of the Rand Water Board which are at present in service, and on which all consumers of water are dependent, are situated in the Klip River Valley, being served by two main pumping stations: one at Zuurbekom at the head of the valley, and one at Zwartkopjes, about five miles below Jackson's Drift. The Board has a small source of supply known as the Braamfontein Station—which is not in service, being at present leased to the Braamfontein Company, Limited. There are also two boreholes in Doornfontein not in service which yield a small quantity of water. One of them is leased to the Johannesburg Municipality.

How sources of supply were acquired.

6. The whole of the Board's sources of supply were acquired by expropriation from the Johannesburg Waterworks Estate and Exploration Company, Limited, the Vierfontein Syndicate, Limited, and the Braamfontein Company, Limited. This expropriation was provided for in the Rand Water Board Extended Powers Ordinance (No. 48 of 1904), and was made compulsory on the Board. See Part III, "Transfer of existing undertakings", Sections 22 to 27, Ordinance 48 of 1904, and Schedule "E" of same Ordinance.

Cost of expropriations of "Existing undertakings".

7. The Court of Arbitration constituted by Ordinance to fix the amount payable to the interested parties for the "existing undertakings", sat during December, 1904, and January, 1905, and made its awards on the 14th and 18th days of January, 1905. The total amounts paid to and on behalf of the various interested parties, in terms of the awards, were as follows:—

Johannesburg Waterworks Estate and Exploration Company, Ltd. ..	£1,602,191	9	9
Vierfontein Syndicate	505,811	5	7
Braamfontein Company, Ltd.	51,498	10	7
	£2,159,501	5	1

In addition to the foregoing, the Rand Water Board was compelled to pay all the expenses of the arbitration; these amounted to £16,649. 5s. 7d., bringing up the total amount involved in the expropriation of the above undertakings to £2,176,150. 11s. 6d.

It was also decided by Section 106 of Ordinance 48 of 1904 that the Wonderfontein Concession held by Mr. George Goch should be expropriated and vested in the Lieutenant-Governor of the Transvaal in trust for the Government of the Transvaal and the Rand Water Board, jointly. The amount paid by the Rand Water Board as its half-share of this expropriation, and for the compounding of various annual rentals which were part of the original liability of Mr. George Goch, represents the sum of £52,463. 11s.

Section 106 (5) of Ordinance 48 of 1904 provides that "it shall not be lawful for the Lieutenant-Governor or the said Board, either separately or jointly, to exercise or deal in any way with the rights ceded as aforesaid by the said George Henry Goch or his legal representatives . . . unless and until legislation has been passed authorizing them so to do".

If the amount of £52,463. 11s. mentioned above be added to those sums already detailed a grand total of £2,226,614. 2s. 6d. is reached, as representing the sum paid by the Rand Water Board under statutory compulsion for the various "existing undertakings" which were expropriated.

Amount expended in developing sources of supply and providing necessary plant, equipment, etc.

8. The amount expended by the Board from the date of its establishment to 31st July, 1908, upon developing the sources of supply acquired, equipping them with adequate pumping plant, etc., laying collecting, rising, and distributing mains, constructing reservoirs, etc., is £673,387. 3s. 11d. This is exclusive of interest on cost during construction, which amounted to £68,183. 6s. 8d., bringing the total to £741,570. 10s. 7d.

Water Board loan and security therefor.

9. The Rand Water Board loan of £3,400,000 4 per cent. Inscribed Stock was raised in March, 1905, under provisions of Ordinance No. 48 of 1904. The interest is payable half-yearly on the 1st January and 1st July in each year, and the whole loan is redeemable at par on 31st March, 1935. The loan was issued at £97. 11s. and realized £3,316,700. The stock is secured on Water Fund (being the fund to which all receipts of the Board are to be carried); the Reserve Fund (which the Board has power to set aside out of the profits of the undertaking for certain specified purposes); the whole of the revenues and rents and all the property belonging to the Board, and all the rates levied by the Board or by the Court in accordance with the provisions contained in Ordinance No. 48 of 1904.

Quantities of water sold and proportions taken by municipalities and mines.

10. The Board took over the management of the different undertakings acquired on 1st April, 1905, and the total quantity of water sold from that date to 31st March, 1908, is shown hereunder:—

1905–06	.. ..	851,129,292 gallons.
1906–07	.. ..	1,020,907,999 ,,
1907–08	.. ..	985,450,490 ,,

The average daily quantity sold during the same periods was:—

1905–06	.. ..	2·332 million gallons.
1906–07	.. ..	2·797 ,, ,,
1907–08	.. ..	2·692 ,, ,,

The proportions taken by mines and municipalities respectively during the said period were, approximately:—

MINES.	MUNICIPALITIES.	C.S.A.R., ETC.
15 per cent.	82 per cent.	3 per cent.

Freehold and water-rights held by the Board and amounts paid in respect of same.

12. The water-rights at present held by the Board are detailed in schedule annexed, marked "A" (see Appendix "Z"), which also shows rights formerly held but since abandoned. All the rights set out in the said schedule (with the exception of Zuurbekom) were acquired by expropriation from the Vierfontein Syndicate, Limited. The amount paid by the Board's predecessors in title in respect of rights in the Klip River Valley, exclusive of Zuurbekom, was £2,373 for annual rentals alone. Since transfer to the Board (1st April, 1905) a sum of £2873 for rentals, and a further sum of £1650 for compounding of rentals, have been paid to grantors. The sum paid for the twenty-one contracts of lower riparian owners, to which reference has been made in the schedule, was £525, so that the total sum received by grantors of rights below Klipriversoog up to the present amounts to nearly £7500, and the rentals for which the Board still remains liable represent £400 per annum.

The Board owns the freehold farm "Zwartkopjes", in extent 4745 morgen and 494 square roods. This was acquired from the Vierfontein Syndicate, Limited, and represented in the costs of expropriation about £60,000.

The area represented by the Board's freehold and other rights in the Klip River Valley is equal to about one-seventh of the whole extent from Klipriversoog to Zwartkopjes, and would, therefore, under any circumstances, entitle the Board to an appreciable proportion of the available water in that portion of the valley. When considering the position of the Rand Water Board in connexion with the present investigation this point is not without importance.

Appendix "Z".

STATEMENT OF FARMS AND PUMPING RIGHTS HELD BY THE RAND WATER BOARD.

Farm.	Title.	Details and Comments.
1. Portion of Zwartkopjes No. 262, Heidelberg.	Ownership, under deeds of transfer Nos. 10220–10221/1904, 234 and 1577 to 1592/1905, and 2233/1908.	—
2. Portion of Rietvlei No. 17, Johannesburg.	Ownership, under deeds of transfer Nos. 924 and 926/1903.	Divided portion.
3. Do. do.	Ownership, under deed of transfer No. 927/1903.	Undivided one-tenth share.
4. Portion of Ormonde No. 18, Johannesburg.	Ownership, under deed of transfer No. 3837/1905.	Divided portion.
5. Zuurbekom No. 9, Krugersdorp.	Notarial contract, dated 27th July, 1896, between F. G. C. le Roux and Barnato Bros.	Perpetual and exclusive right to bore and to dig for water on the farm Zuurbekom, and to pump all water so obtained, and to use and pass the water by means of pipes or otherwise outside the boundaries of the said farm.
6. Misgund No. 96, Johannesburg.	Contract, dated 11th February, 1899, between G. J. van Zyl and Consolidated Gold Fields of South Africa. Renewed by deed of 16th February, 1907, between G. J. van Zyl and Rand Water Board for definite period ending 18th February, 1998.	Sole and exclusive right during a period of ninety-nine years to pump and take away all underground water on a certain portion of the farm Misgund No. 96, Johannesburg District.
7. Misgund No. 96, Johannesburg.	Contract, dated 3rd March, 1899, between D. J. Strydom and Consolidated Gold Fields of South Africa.	Right for a period of ninety-nine years to pump and take away all the underground water on his portion of the farm Misgund No. 96, Johannesburg District.
8. Olifantsvlei No. 86 and Misgund No. 96, known as Eikenhof No. 14, Johannesburg.	Contract, dated 11th January, 1889, between C. L. Neethling, sen., and Consolidated Gold Fields of South Africa.	Sole and exclusive right to pump and take away the underground water and otherwise in and to that part or portion lying to the south of the Klip River of his portions of the farms Olifantsvlei No. 16 and Misgund No. 96 during a period of ninety-nine years.
9. Do. do.	—	The said portions of Olifantsvlei were subsequently joined in one title, now known as Eikenhof No. 14. Deed, dated 25th February, 1907, stipulated that the rights acquired by the Board under the contract shall, in so far as it affects the western portion of Eikenhof, be cancelled, but shall remain of full force and effect on the eastern portion of Eikenhof situate to the south of the Klip River.
10. Rietvlei No. 17 (portion), Johannesburg.	Contract, dated 8th July, 1897, between G. P. Marais and J. A. Vermeulen and E. H. V. Melville.	Rights to lay and maintain pipelines and to do certain other acts . . . for a period of ninety-nine years.

Appendix "Z"—(Continued).

STATEMENT OF FARMS AND PUMPING RIGHTS HELD BY THE RAND WATER BOARD—*(Continued)*.

Farm.	Title.	Details and Comments.
11. Portion of Allwynspoort No. 219, Heidelberg.	Contract, dated 8th June, 1898, between J. J. van der Merwe and Consolidated Gold Fields of South Africa.	Sole and exclusive right during a period of ninety-nine years to pump and take away all the underground water in his portion of the farm Allwynspoort.
12. Slangfontein No. 121, Heidelberg.	Notarial deed, dated 28th February, 1890, executed by M. W. Pretorius, as the owner with others of the farm Slangfontein, grants to the Klip River and Johannesburg Waterworks Co., Ltd.	Right to pump water from the Klip River, namely, on the farm Olifantsvlei, Gideon van Zyl, and declares that neither he, his heirs, or successors shall have any right to bring any action for compensation against the said company on account of the pumping away or use of the water in the Klip River as aforesaid; and further declares the rights so granted to be a real servitude which shall be perpetual against him, his successors, as owners of portion of the farm Slangfontein.
13. Rietfontein No. 315, Heidelberg.	Notarial deed, dated 28th February, 1890, executed by M. W. Pretorius, as the owner with others of the farm Rietfontein, grants to the Klip River and Johannesburg Waterworks Co., Ltd.	Right to pump water from the Klip River, and declare neither they, their heirs, or successors shall have any right to bring any action for compensation against the said company on account of the pumping away or use of the water in the Klip River as aforesaid; and further declare the rights so granted to be a real servitude which shall be perpetual against them and their successors as owners of portion of the farm Rietfontein as aforesaid.
14. Slangfontein No. 121, Heidelberg.	Notarial deed, dated 28th February, 1890, executed by J. H. and M. H. Pretorius, as owners of the farm Slangfontein, grant to the Klip River and Johannesburg Waterworks Co., Ltd.	Right to pump water from the Klip River, and declare that neither they, their heirs, or successors shall have any right to bring any action for compensation against the said company on account of the pumping away or use of the water in the Klip River as aforesaid; and further declare the rights so granted to be a real servitude which shall be perpetual against them and their successors as owners of portion of the farm Slangfontein aforesaid.
15. Rietfontein No. 315, Heidelberg.	Notarial deed, dated 28th February, 1890, executed by J. J. and M. W. Pretorius, grant to the Klip River and Johannesburg Waterworks Co., Ltd.	Right to pump water from the Klip River, and declare that neither they, their heirs, or successors shall have any right to bring any action for compensation against the said company on account of the pumping away or use of the water in the Klip River as aforesaid; and further declare the rights so granted to be a real servitude which shall be perpetual against them and their successors as owners of the said farm.

Appendix "Z"—(Continued).

STATEMENT OF FARMS AND PUMPING RIGHTS HELD BY THE RAND WATER BOARD—*(Continued)*.

Farm.	Title.	Details and Comments.
16. Waterval No. 209, Heidelberg.	Contract, dated 28th February, 1890, executed by J. S. Dietrichsen and M. W. Pretorius, grant to the Klip River and Johannesburg Waterworks Co., Ltd.	Right to pump water from the Klip River, and declare that neither they, their heirs, or successors shall have any right to bring any action for compensation against the said company on account of the pumping away or use of the water in the Klip River as aforesaid; and further declare the rights so granted to be a real servitude which shall be perpetual against them and their successors as owners of the said farm.
17. Rietfontein No. 315, Heidelberg.	Notarial deed, dated 28th February, 1890, executed by W. L. and M. W. Pretorius, grant to the Klip River and Johannesburg Waterworks Co., Ltd.	Do. do. do.
18. Witkop No. 66, Heidelberg.	Notarial deed, dated 28th February, 1890, executed by J. Depsel, grants to the Klip River and Johannesburg Waterworks Co., Ltd.	Do. do. do.
19. Slangfontein No. 121, Heidelberg.	Notarial deed, dated 28th February, 1890, executed by C. J. Pretorius, grants to the Klip River and Johannesburg Waterworks Co., Ltd.	Do. do. do.
20. Do. do.	Notarial contract, dated 28th February, 1890, executed by J. H. Pretorius, grants to the Klip River and Johannesburg Waterworks Co., Ltd.	Do. do. do.
21. Witbank, Waterval and Witkop, Heidelberg.	Notarial contract, dated 28th February, 1890, executed by C. J. Schalkwijk, grants to the Klip River and Johannesburg Waterworks Co., Ltd.	Do. do. do.
22. Rietfontein No. 315, Heidelberg.	Notarial contract, dated 28th February, 1890, executed by P. J. Mulder, grants to the Klip River and Johannesburg Waterworks Co., Ltd.	Do. do. do.
23. Witbank (Witkop No. 66).	Notarial contract, dated 28th February, 1890, executed by P. J. and J. J. Dietrichsen, grants to the Klip River and Johannesburg Waterworks Co., Ltd.	Do. do. do.
24. Rietfontein No. 315, Heidelberg.	Notarial contract, dated 28th February, 1890, executed by G. M. Pretorius, grants to the Klip River and Johannesburg Waterworks Co., Ltd.	Do. do. do.
25. Slangfontein No. 121, Heidelberg.	Notarial contract, dated 28th February, 1890, executed by C. F. Pretorius, grants to the Klip River and Johannesburg Waterworks Co., Ltd.	Do. do. do.
26. Rietfontein No. 315, Heidelberg.	Notarial contract, dated 28th February, 1890, executed by D. J. Pretorius, grants to the Klip River and Johannesburg Waterworks Co., Ltd.	Do. do. do.

Appendix "Z"—(Continued).

STATEMENT OF FARMS AND PUMPING RIGHTS HELD BY THE RAND WATER BOARD—(*Continued*).

Farm.	Title.	Details and Comments.
27. Slangfontein No. 121, Heidelberg.	Notarial contract, dated 28th February, 1890, executed by J. L. Pretorius, grants to the Klip River and Johannesburg Waterworks Co., Ltd.	Right to pump water from the Klip River, and declare that neither they, their heirs, or successors shall have any right to bring any action for compensation against the said company on account of the pumping away or use of the water in the Klip River as aforesaid; and further declare the rights so granted to be a real servitude which shall be perpetual against them and their successors as owners of the said farm.
28. Waterval No. 209, Heidelberg.	Notarial contract, dated 28th February, 1890, executed by F.P.Smit, grants to the Klip River and Johannesburg Waterworks Co., Ltd.	Do. do. do.
29. Slangfontein No. 121, Heidelberg.	Notarial contract, dated 13th March, 1890, executed by M. W. Pretorius, grants to the Klip River and Johannesburg Waterworks Co., Ltd.	Do. do. do.
30. Do. do.	Notarial contract, dated 13th March, 1890, executed by W. Stols, as father and natural guardian of G. P. Stols, grants to the Klip River and Johannesburg Waterworks Co., Ltd.	Do. do. do.
31. Witbank, Waterval, and Witkop, Heidelberg.	Notarial contract, dated 13th March, 1890, executed by C. J. Schalkwijk, grants to the Klip River and Johannesburg Waterworks Co., Ltd.	Do. do. do.
32. Slangfontein No. 121, Heidelberg.	Notarial contract, dated 13th March, 1890, executed by W. Stols, grants to the Klip River and Johannesburg Waterworks Co., Ltd.	Do. do. do.
33. Olifantsvlei No. 60, Krugersdorp.	Contract between G. van Zyl, dated 26th May, 1898, and Consolidated Gold Fields of South Africa.	Sole and exclusive right during a period of ninety-nine years to pump and take away the underground water on his portion of the farm Olifantsvlei No. 16. The Board's rights under this contract were abandoned on the 26th May, 1907.
34. Olifantsvlei No. 16, Johannesburg.	Contract, dated 11th June, 1889, between G. van Zyl and F. E. Prins, and Edward Lippert and others, trading as the Klip River and Johannesburg Waterworks Co., Ltd.	Full, free, and exclusive right to all water belonging to them from the fountains on their ground on Olifantsvlei whereto they are entitled to as owners of the said farm. The Board's rights thereunder were abandoned on the 11th June, 1906.
35. Allwynspoort No. 249, Heidelberg.	Contract, dated 8th June, 1898, between J. A. van Jaarsveld and Consolidated Gold Fields of South Africa.	Sole and exclusive right for an indefinite period to pump and take away all the underground water in his portion of the farm Allwynspoort. The Board's rights thereunder were abandoned on the 8th June, 1907.

Appendix "A1".

RAND WATER BOARD.

SOURCES OF SUPPLY AND QUANTITY OF WATER PUMPED, KLIP RIVER VALLEY, FOR THE PERIOD OCTOBER TO DECEMBER, 1909.

Source.	October.	November.	December.
	In million gallons.	In million gallons.	In million gallons.
ZWARTKOPJES—			
Borehole A	33·58	28·94	30·65
,, B	—	0·70	0·78
,, C	39·66	39·27	39·69
,, D	—	0·90	3·11
,, E	—	—	—
,, F	13·43	9·19	4·22
,, G	15·28	17·08	17·73
,, H	18·30	16·88	17·37
,, I	—	0·05	0·12
,, K	6·87	4·01	5·27
,, P	1·65	1·90	1·46
	128·77	118·92	120·40
ZUURBEKOM	34·61	32·89	30·87
Total from valley ..	163·38	151·81	151·27
Average daily	5·27	5·06	4·88

Appendix "B1".

RAND WATER BOARD.

14TH FEBRUARY, 1910.

Borehole.	Depth of Shafts from Surface.		Length of Headings.	Yield in gallons per 24 hours.	Locality.
	Feet.	Depth of Borehole in feet.	Feet.		
C 1 ..	45	**198**	—	750,000	At edge of vlei.
C 2 ..	63	**74**	—	750,000	Do.
A 1 ..	15	**168**	—	800,000	Near edge of vlei.
A 2 ..	15	**153**	—	800,000	Do.
G 1 ..	84	**81**	64	1,050,000	Do.
G 2 ..	87	**78**	576	* 300,000	Do.
F 1 ..	67	**233**	—	600,000	Less than half a mile away from river.
F 2 ..	89	**81**	37	* 150,000	Do. do.
K 1 ..	96	**34**	—	* 200,000	Do. do.
K 2 ..	82	**101**	—	* 300,000	Do. do.
H 1 ..	82	**128**	—	* 300,000	More than half a mile away from river.
H 2 ..	127	**78**	164	* 500,000	Do. do.
D 1 ..	120	**90**	—	* 600,000	Do. do.
D 2 ..	155	**165**	195		Do. do.
B 1 ..	125	**85**	608	* 70,000	Do. do.
B 2 ..	125	—	437		Do. do.
I 1 ..	60	**175**	56	* 5,000	Do. do.
I 2 ..	100	**135**	—		Do. do.
E 1 ..	103	**77**	780	* 105,000	Do. do.
E 2 ..	103	**77**	670		Do. do.
P	19	**222**	—	72,000	Less than half a mile away from river.

* The figures to which an asterisk is attached indicate the maximum yield of shafts or boreholes. In other cases the capacity of the pumps can only be given; how far this falls short of the maximum yield is not known.

Black figures show depth of borehole below bottom of shaft.

Appendix "C1".

ALLEGED INTERFERENCE AT KLIPRIVERSOOG.

Mr. E. P. du Plessis.

I live at Rietfontein No. 48. I own about 700 morgen. I have lived there since 1878. I get my water from the Klip River.

There was not only enough water for the lands, but there was too much for all the lands of myself and the owners of Rietfontein.

Chairman: When did you first notice that the water began to dry up?—The waterworks at Zuurbekom were used in 1897, and in 1898 you could well notice that the water began to get weaker. In the end of 1897 there was a protest made by all the owners of the Klip River Valley to the Government. I believe they began pumping in 1898. They pumped during the war and then immediately after the war their pumping installations were increased so as to enable them to pump more water. In 1903 the water began to get so weak that the people on Olifantsvlei who used to get their water out of the Rietfontein furrow got no water at all. In 1907 it seemed to me that the Water Board worked less. At all events I could only see the smoke of the stacks from time to time at certain periods, and during that time our water became strong again.

For how many months was it stronger?—The water got stronger again, as they only seemed to work periodically.

Do you consider that the pumping at Zuurbekom is the sole cause of this diminution in the water supply?—I can give you no other reason for it, and I have no other opinion but that it is caused by the pumping in Zuurbekom. I will not only be content, but I shall be very grateful if the pumping at Zuurbekom is stopped.

Do you think if the pumping is stopped that you will get all your water back?—I certainly think that if they stop pumping I will get all the water back, and I would like to add that the value of my ground has been decreased by two-thirds through the failure of the water supply.

My solution, however, of the whole trouble is that the Zuurbekom pumping works should either stop pumping altogether or should agree to give us some water from their pipes.

Mr. J. M. van Wyk.

I am the owner of a portion (942 morgen) of Rietfontein No. 48, and I have been the owner of that since 1875.

Since the year 1898 the water supply has been steadily decreasing.

Chairman: What do you think is the cause of this diminution?—I ascribe the cause of the scarcity of water to the pumping which is going on at Zuurbekom. I can see the stack and the smoke coming out of it from my house. I can at once notice the water increasing or decreasing according to the amount of pumping which I see is going on, and which is shown by the smoke from the stack. It takes about a week after pumping ceases until the water again begins to increase. I constantly notice the correspondence between the pumping and the increase and decrease in the supply of water. It does not of course change immediately, but is a gradual decrease and increase. It becomes noticeable usually about a week after pumping commences or stops.

Mr. Geldenhuys: Are you certain that the pumping at Zuurbekom is the cause of this diminution of water?—I am positive that the pumping carried on at the Zuurbekom waterworks is the only cause of the decrease of water in the Klipriversoog.

In your opinion Zuurbekom is solely responsible for the shortage, and if they are stopped from pumping then you will have a sufficient supply of water?—Yes; absolutely.

Mr. H. J. van der Westhuyzen.

I live on Olifantsvlei No. 60. I have owned 14 morgen on Olifantsvlei since 1884.

I wish to confirm the evidence given by the previous witnesses to the effect that in my opinion the decrease in our supply of water is due to the waterworks.

Mr. J. P. Furter.

I live on Olifantsvlei No. 60. I have known it for eleven years.

The only reasons to which I can ascribe the drying up of the water is the pumping that has taken place at Zuurbekom.

Chairman: Do you think that if pumping had stopped you would get more water?—I am quite certain that if the pumping stopped we would all get sufficient water.

Mr. L. Lowenthal.

I at present occupy Syferfontein. I have the same water as Zuurbekom in this dolomite, and I certainly found that when pumping was heavy at Zuurbekom the water on Syferfontein lowered. I had to lower the pump down, or rather put in a pipe five feet longer, to get down again.

Some thirteen years ago I bought the property from Mr. Van Tonder, he assured me the springs had never been dry, and that was the reason it had the name of Syferfontein. Since the Zuurbekom pumping has taken place these springs are absolutely dry.

Mr. C. F. du Plessis.

I represent the farmers of the Klip River Valley, being duly elected for this purpose.

I am of opinion that the decrease of the flow of the river is not in any way caused by any mining operations. It may be that these eyes were increased a little by the surface water from the rains, but they used to be always constant. Of course the fact that all the tributaries of the Klip River have now been dammed up would very much affect the flow of the river lower down, but it has nothing to do with the springs in the river and at the eye of the river. I can only ascribe it to the action of the Rand Water Board.

Appendix "D1".

THE GOVERNMENT LABORATORIES,

HOSPITAL STREET,

JOHANNESBURG, 7th December, 1908.

THE CHAIRMAN,

KLIP RIVER INVESTIGATION COMMISSION,

PRETORIA.

SIR,

I have the honour to present the following notes on the composition of samples of water which I collected from Van Zyl's spring and from the eye of the Klip River on 30th November :—

	VAN ZYL'S SPRING.	KLIP RIVER EYE.
Total solids	18·1	16·35
Chlorine	0·36	0·28
Total hardness (Hehner)	17·0	14·0
Permanent hardness (Clarke)	3·6	0·8
Iron	0·009	0·0165
Lime	4·85	3·87
Magnesia	3·05	2·40
Sulphate	Heavy trace	Faint trace.

(The results are in parts per 100,000.)

Various analyses have been made of the water from H wells of the Rand Water Board, and the following are average figures :—

Total solids	21·8
Chlorine	0·26
Total hardness (Hehner)	20·0
Permanent hardness (Clarke)	3·5

The range of variation in these figures is small, and in no case has the total solids or the hardness been found to be so low as in the sample of water collected from Van Zyl's spring.

Presumably you are in possession of figures giving the results of analyses of the Zuurbekom water as pumped by the Rand Water Board, but I offer the following as the average :—

Total solids	12·0
Chlorine	0·4
Total hardness	10·0
Permanent hardness	1·0
Lime	2·78
Magnesia	2·31
Sulphate	Trace

I shall be glad to know if you desire to have an opinion as to deductions to be drawn from these various figures concerning the connexion between H wells and Van Zyl's spring, and between Zuurbekom wells and the eye of the Klip River.

I have the honour to be,
Sir,
Your obedient Servant,

(Signed) J. McCRAE,
Government Analyst.

Appendix "E1".

No. 223/A10/09.

The Government Laboratories,
Hospital Street,
Johannesburg, 8th January, 1909.

The Chairman,
Klip River Investigation Commission,
Pretoria.

Sir,

I have the honour to present the following report on the experiments which have been made on behalf of your Commission in order to ascertain if material dissolved in the water of the H wells of the Rand Water Board finds its way to Van Zyl's spring.

The opportunity was also taken to test if the water which has recently been pumped from H2 well and allowed to flow over the ground finds its way to Van Zyl's spring.

On Wednesday, 23rd December, 1908, at about 9.15 a.m. a quantity of fluorescein in alkaline solution was poured into a swallow-hole in the ground immediately to the north of the H wells. A quantity of fluorescein in alkaline solution was also poured into the main stream of the overflow from H2 well which was then running. From main stream the fluorescein distributed well.

The pumps at the wells were stopped at 10.10 a.m., and a solution containing about 900 grams of lithium citrate was poured into well H2, and a solution containing 500 grams of lithium citrate was poured into well H1.

At this time the weir at Van Zyl's spring was dammed, and water (in quantity) was being pumped from the spring pool to the furrow above. There appeared to me to be plenty of water available.

Samples of water were collected from Van Zyl's spring at the following times:—

No. 1. Wednesday, 23rd December, 6 p.m.
„ 2. Thursday, 24th December, 12.30 p.m.
„ 3. Friday, 25th December, 8 a.m.
„ 4. Saturday, 26th December, 10 a.m.
„ 5. Sunday, 27th December, 11.30 a.m.
„ 6. Monday, 28th December, 10 a.m.
„ 7. Tuesday, 29th December, 8 a.m.
„ 8. Wednesday, 30th December, 7.30 a.m.

It is regretted that measurements of the water at the spring could not be made, but the following notes may be of value:—

On the morning of 25th December the level of the water was about 4 inches higher than on the 23rd December, the water was dammed, and there appeared to be little leakage through the dam wall, and water was not being pumped.

On 26th December (possibly on 25th December) water was being pumped from the pool, and at 10 a.m. the water-level was distinctly low.

Pumping was then stopped, and no more water was pumped from the spring before the conclusion of the experiment.

At midday on 27th December the water-level had risen to about where it stood on 23rd December, and there was a progressive rise, but of no great magnitude until the morning of the 30th December.

Rain fell on the evening of 27th, on the afternoon of 28th, and on the evening of 29th December.

The samples collected from Van Zyl's spring were examined for the presence of lithium and of fluorescein.

The results of the examination show that no lithium had passed from the water in the wells to the spring, and no fluorescein was found in any of the samples.

Each sample consisted of 2½ litres of the water from the spring: in each case the sample was concentrated to between 1 and 2 cubic centimetres. Finally, in order to obtain as large an enrichment as possible the concentrates from all the samples were mixed, and this mixture was further concentrated, but again only negative results were obtained.

I may point out that the eight samples amount to 20 litres (about $4^2/_5$ gallons), and this quantity was ultimately concentrated to 1 cubic centimetre (20,000 : 1).

In order to eliminate the possibility that the whole of the solution of lithium salt had passed from the wells and had possibly escaped through the spring at a time between the collecting of samples (an almost impossible contingency), samples were drawn from the H wells on 31st December, and lithium was readily found in them.

The results of these experiments lead me to the conclusion that no specific water-channel exists along which water would flow from the wells to the spring.

Further, I am of opinion that there is no specific water-channel along which water would flow unhindered from the ground immediately to the north of the site of the H wells to the spring.

I have the honour to be,
Sir,
Your obedient Servant,

(Signed) J. McCRAE,
Government Analyst.

Appendix "F1".

CHEMICAL TEST CONDUCTED BETWEEN BOREHOLE "H" AND MR. VAN ZYL'S SPRING.

The Government Laboratories,
Hospital Street,
Johannesburg, 23rd June, 1909.

The Chairman,
Klip River Investigation Commission,
Pretoria.

Sir,

I have the honour to present to you a report on experiments which have recently been made on behalf of your Commission with the object of ascertaining if a connexion exists between the wells of the Rand Water Board at Zuurbekom and that part of the Klip River known as Klipriversoog, or any portion of the bed of the Klip River in that vicinity.

Pumping at Zuurbekom was stopped at 6 p.m. on the 15th May to allow the water in the wells to reach an approximately constant level before commencing the test.

On 20th May, between 12 noon and 1 p.m., a solution of lithium citrate in dilute hydrochloric acid was poured into wells Nos. 1, 4, and 5. (It was not considered necessary to dose well No. 6 on account of its proximity to and demonstrable connexion with well No. 5.) The amounts of lithium salt for these wells was 670,670 and 1350 grams respectively.

On the same day at 6 p.m. a sample was taken at Klipriversoog, and daily thereafter till the termination of the test on 2nd June at or about noon each day; and from 22nd May till 2nd June daily samples were taken from the Klip River below the bridge at Van Wyk's Rust about 2 p.m. each day.

The samples were each of 2½ litres capacity.

At the conclusion of the test *in loco*, they were individually evaporated to dryness, and the residue moistened with pure hydrochloric acid and tested spectroscopically for the presence of lithium. with the result tabulated below :—

		KLIPRIVERSOOG.	VAN WYK'S RUST.
May	20	—	—
,,	21	—	—
,,	22	—	—
,,	23	—	—
,,	24	—	—
,,	25	—	—
,,	26	—	—
,,	27	—	—
,,	28	—	—
,,	29	?	?
,,	30	—	—
,,	31	—	?
June	1	—	—
,,	2	—	—

On 5th June samples of water were taken from the three wells, and lithium was demonstrated to be present in all three.

The occurrence of lithium in two samples on 29th May and in one on 31st May has been traced to bottles which had contained lithia solution having been, by mistake, included in a batch of sample bottles sent from the laboratory to Zuurbekom on the 28th May after it had been decided to continue the test for fourteen days. Had the cause of the contamination not been discovered, the presence of lithium in these three samples could only have been regarded as accidental, and would not have invalidated the findings of the investigation.

From the results of these experiments, I am of the opinion that no gross connexion exists between the wells at Zuurbekom and the bed of the Klip River above the bridge at Van Wyk's Rust.

I have the honour to be,
Sir,
Your obedient Servant,

(Signed) J. C. MITCHELL,
Acting Government Analyst.

Appendix "G1".

DETAILS AND RESULT OF TEST CONDUCTED TO ASCERTAIN IF A CONNEXION EXISTS BETWEEN BOREHOLE "H" AND VAN ZYL'S SPRING.

Part I.

The procedure adopted in this test was as follows :—

(*a*) No pumping to be allowed from Van Zyl's spring, and the pump there to be securely sealed by means of a wire wound round a movable part thereof and fastened by means of a seal to a fixed part, in such a manner as to render it impossible for the pump to be put into action without breaking the seal.

(*b*) That an impartial person, appointed by the Commission, be in attendance at borehole H at the resumption of pumping, and during such period thereafter as is found necessary for the purposes of the test to observe that the pump is actually in motion.

(*c*) That the farmers will not under any circumstances be allowed to descend the shafts.

(*d*) That observations of the flow over the notch and of the level of the water in the furrow be continued as heretofore by Messrs. Sullivan and Van Zyl.

Mr. Geldenhuis, member of the Commission, sealed the pump on the 13th August, 1909, and explained the procedure to the farmers.

For the purpose of commencing the test Mr. Hurley, member of the Commission, proceeded to the spring and thereafter reported as follows:—

"I visited Mr. Van Zyl's spring on the 2nd July, 1909, for the purpose of commencing a test ordered by the Commission.

I cleared away the earthen dam and iron pipe, just upstream of the small wooden gauging weir, and packed earth tightly into all hollow places upstream of the weir so as to ensure all water going over the weir. The measurements of depths of water over the crest of the weir are as follows:—At the east side, or right bank, looking downstream, the depth of water on the sill $1\frac{1}{4}$ in., at the centre $1\frac{3}{8}$ in., and at the west side $1\frac{7}{8}$ in.

After these measurements Messrs. Pienaar and Kemp went down the south shaft at H and satisfied themselves that the rock below was in a natural condition, e.g. the channels had not been blocked with concrete. They afterwards went down the northern shaft to the top of the borehole in that shaft, which is, I believe, at a depth of 82 ft., and expressed themselves entirely satisfied at what they had seen. All pumping was stopped at 1.30 p.m. Continuous measurements are to be taken of the water flowing over the gauging weir by Messrs. Sullivan and G. van Zyl, jun., together."

Part II.

Hereafter we appointed Mr. P. A. W. Saunders as the "impartial person": a statement on oath, at the conclusion of his observation, reads as follows.

Percy Alfred William Saunders, duly sworn, states:—

"I am in the employ of the Irrigation Department, and was deputed by the Chief Engineer, Irrigation, to proceed to Jackson's Drift to take certain observations of the flow from Mr. Van Zyl's spring at Klipriver, where I arrived on the 14th August last, and found the pumps at borehole H stopped. They started working on Sunday, 14th August, at 12.20 p.m.

"On proceeding to the spring, I found Mr. Van Zyl's pump was sealed, and it remained in this condition during the time I was on duty there.

"My duties were to take daily observations of the flow over the small weir at Van Zyl's spring. I did this every day until 13th September at 11.30 a.m. I took five and sometimes six observations daily, at 7.30, 9.30, 11.30, 1, 3, and 5 o'clock. I also took observations at odd hours to see if there was any difference. One slight mistake in one record, of no importance, has been corrected and noted by the secretary of the Commission.

"There has been no sudden drop in the flow, only a gradual decrease. The largest drop between observations has been $\frac{1}{8}$ in., and has kept at that.

"About 6 in. of snow fell about 16th August, but there was no increase in the flow.

"I found a hole in the earthen dam on one side of weir on 21st August, about 1 in. diameter and 9 in. vertical depth. I first noticed this hole at 2 p.m.; it was not there when I left for lunch. I did not touch it. I could not see through to the other side of the hole. It was there at 5 p.m., but was closed when I visited spring at 7.30 next morning. The hole was there between 1 p.m. and 7.30 next morning.

"There were two changes in the flow that day of $\frac{1}{8}$ in., it came up $\frac{1}{16}$ in. again at 3.30 while the hole was still there. Next morning at 7.30 the flow rose. I do not think the hole could have influenced the observations for more than eighteen hours.

"This was the only hole I noticed on the spring side. I reported the presence of the hole to the Commission.

"Farm boys were in the habit of bathing in the spring. They were bathing there on the 26th, 27th, and 29th August. The apparent reason they bathed there is that the water is warmer than in the river. I stopped the boys bathing, which caused a certain amount of friction with their parents. I noticed that one of the eyes was weaker than it had been before the bathing, and attributed this to a boy having evidently stepped on the eye. This was the reason for stopping the bathing. The water was muddy after the bathing, evidently caused by mud under the sand. I was not on good terms with the boys. I did not report the bathing in writing, as I did not attach much importance to it, but had the boys not stopped I would have reported it to the Commission.

"Mr. Sullivan made a certain test by placing a board in front of the weir, and thus damming the water back into the spring; he had the board in for ten minutes, and the water dammed back took twenty-eight minutes to come back and thus bring the flow down to normal again. While the board was in position I noticed the water was coming out at two places through the bank, and thus it would appear that all the water from the spring does not flow over the gauging weir. I had never seen water stopped before on the weir. I noticed several crabs in the spring."

A chart showing the rise and fall of the spring flow during the test forms Part III of this annexure.

Appendix "H1".

MR. SCHALKWYK'S SPRING.

Mr. C. J. Schalkwyk (owner of portion of farm Witkop No. 66, District Heidelberg, in extent about 2000 morgen).

I know two ways out of the trouble in which we now are. The first is that we can get back the heavy rains that we used to have, and the second is that the waters of the Klip River should again have their free course. All the pumping would have to be stopped, and also the pumping from the deep level mines, and the dams must be taken away.

I am of opinion that the weakening of my water has nothing to do with the vlei, and that there is direct connexion underground between the pumping station at Prins on Olifantsvlei and my fountain here.

Mr. Wessels Greef.

I am one of the upper proprietors on Nooitgedacht Loop. The two springs which are the sources of Nooitgedacht Spruit began to get weak from the time when the boring commenced. It is a good six miles from the springs to the pump station. I cannot tell you when pumping is going on. This pumping is on the farm Zwartkopjes and another place of which I do not know the name. There is one borehole between Klip River Station and Zwartkopjes in the Rooipoort and the other is further up Zwartkopjes. The spring became weaker and weaker gradually, and last year it was so bad that I had to dig for drinking-water. Formerly, before the pumping commenced, I could never see any difference in the volume of the springs, whether in dry years or wet ones.

Mr. J. J. Greef.

Chairman: You live on Witpoortje?—Yes. You are a brother of the previous witness (Mr. W. Greef)?—Yes. You have heard what he said and you confirm his evidence?—Yes. Formerly we never had any scarcity of water. The water became weaker about three years ago. I do not know positively what the cause of it is, but I should say portions of it are due to the drought and a portion to the boring and pumping that has been going on at Olifantsvlei and Zwartkopjes.

Mr. C. J. Jacobs.

I have lived on Witpoortje for about thirty years. I know the fountain well. Formerly we never had any scarcity of water. The water now is not strong enough. I used to ascribe it to the drought, but I now think it is also because the waterworks have pumped away some of our water.

Appendix "J1".

STEENKOPJES SOURCE OF SUPPLY.

Mr. T. A. R. Purchas, Chairman, Rand Water Board.

The Rand Water Board own Steenkopjes and Wolvekrans. It is not using these sources of supply. At one time I believe Steenkopjes was regarded as an important source of supply, that is as far as the quantity of water flowing out was concerned.

Mr. Hurley.

Steenkopjes Spring is the source of the Magalies River.

Mr. D. C. Leitch, Chief Engineer, Rand Water Board.

Chairman: You did not look upon Steenkopjes as a possible additional supply?—No. I reported on Steenkopjes. The trouble there is this. There is a site to make a reservoir down below, but the fall of the valley is steep and it would be a very expensive matter to store water there enough to enable us to take 7,000,000 to 8,000,000 gallons a day. The Waterworks Company abandoned it altogether as a water scheme, and Steenkopjes was passed on to use by them solely as an agricultural proposition. They put forward no figures to show it was a suitable water scheme.

It may be good as a standby?—No; I do not think so. There are other catchment schemes which would be better. Another trouble with Steenkopjes is that it is so remote from the Rand, and from the portion of the Rand which the Board supplies. Evidence will be led to show that the yield (at Steenkopjes) has fallen off very considerably of late years, and it would be a serious matter to put down works calculated to take 10,000,000 gallons and find your supply has decreased to 5,000,000 gallons. Steenkopjes is one of the most striking cases of a stream falling off without any ostensible reason, because it is beyond the influence of the Rand.

Appendix "K1".

HARDNESS OF WATER FROM ZWARTKOPJES.

Dr. C. Porter, Medical Officer of Health.

The Zuurbekom water is of exceptional purity, its quality is well proved and the conditions of supply are more settled, and at present it is better.

The Zwartkopjes water is very much harder, contains more solids, and the trace of iron from the mixed yield of the different boreholes colours it slightly. The conditions of the Zwartkopjes supply cannot yet be regarded as normal, but the yield from the boreholes is settled, and principal use has for some months been of exceptional chemical and bacterial purity.

I am bound to say I think that of importance, and I consider the degree of hardness at present is a real hardship to householders, and I have a good deal of evidence in my possession that owing to the choking up of hot-water pipes the expense people are put to has been very heavy in some instances. If means were adopted to reduce this hardness and to reduce the iron which favours the growth of a crenothrix in the pipes and reservoirs, there would be absolutely nothing to choose between the two waters provided the recent excellent chemical and bacterial quality of Zwartkopjes is maintained.

There is no doubt hard water is not suitable for domestic purposes from the point of view of convenience and also of economy and washing (soap consumption). You do not get the best results from the food and materials you cook in hard water.

I have no hesitation in saying that I think it ought to be softened.

Appendix "L1".

EFFECT OF USING DOLOMITE WATER IN BOILERS.

(Extract from the report of the Witwatersrand Water Supply Commission, 1901-02.)

Mr. G. B. Poore, examined.

What has been the experience of mines using water from the dolomite in their boilers as compared with water from the Vaal River?—The dolomite waters have been used to such a small extent that whether the water gave a good result or a bad result I cannot tell.

You have not used dolomite water by itself in your boilers?—Not to my knowledge.

It has always been mixed with surface water so that the result escaped your notice?—Yes, sir. All the water that I know of as coming from the dolomite has a permanent hardness of about ten degrees, and in such cases a water softening aparatus should be used.

So that you are in a position to say that the mines have not used water from the dolomite?—Not to any extent.

Have you any idea what will happen if they do use it? Are you apprehensive of these results to boilers which have been suggested?—I do not think it would do much harm. It might be necessary, if the water is hard in future, to get a softening apparatus in connexion with all boiler plant in which dolomite water is used.

Which is not a very expensive business when used on a large scale?—It would depend on the degree of hardness of the water what the expense would be.

That is a question that some one on behalf of the Chamber of Mines ought to be able to speak on definitely. Do you say you cannot employ the water from the dolomite on account of the hardness?—I should say you can employ it.

And the expense of the softening would not be so great as to lead you to say that you ought to go to the Vaal for your water? I should say it would add 10 to 15 per cent. to the cost of boiler plants to add softening apparatus. Dolomite water would be beneficial in milling operations. We have to add lime to the water in several of the reduction processes.

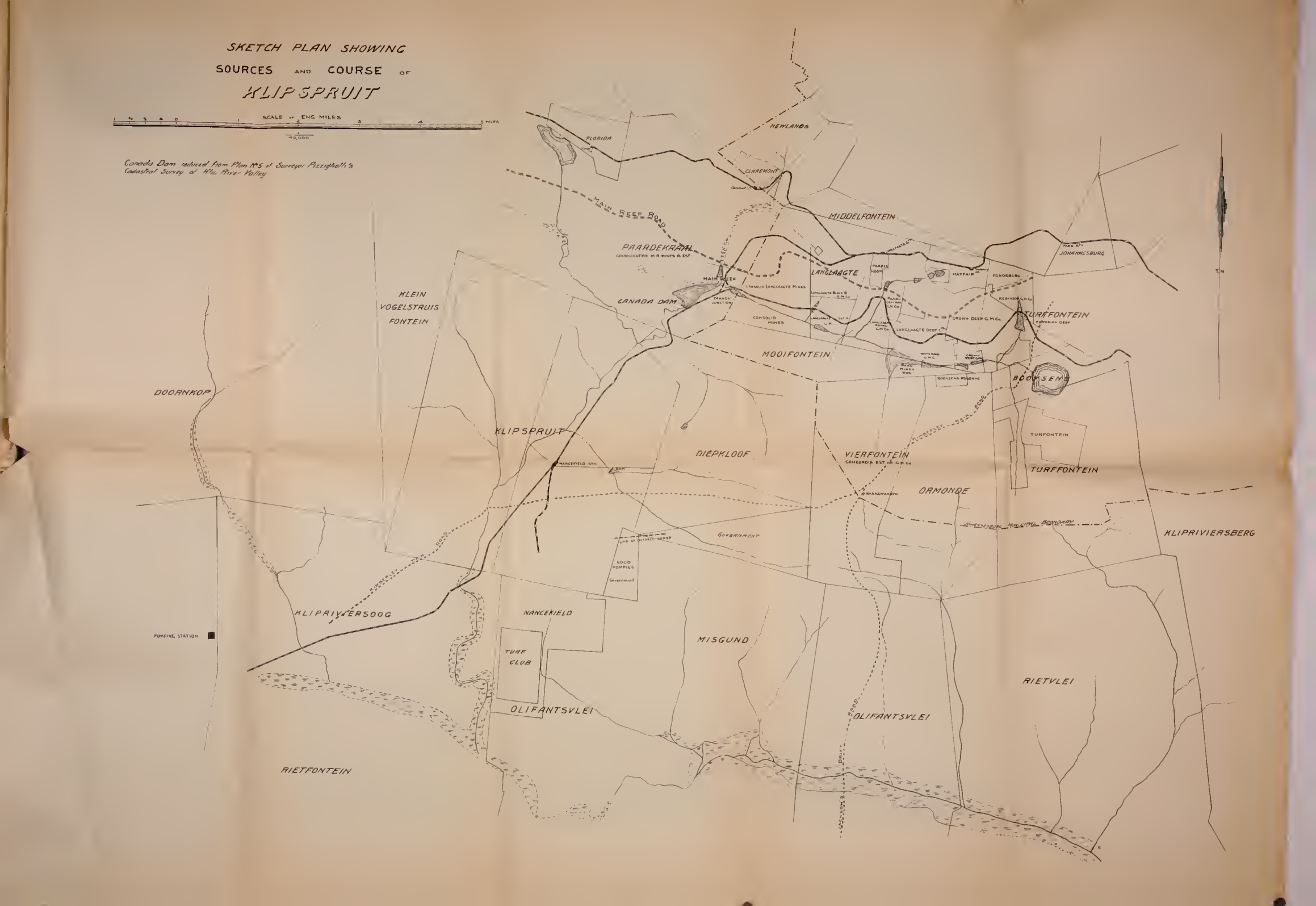
There you have a counter-balancing advantage?—No. I do not think the advantage you would have in using hard water would be worth mentioning. It would certainly not be a disadvantage.

You are sufficiently clear in your own mind to make it unnecessary for me to ask the Chamber of Mines to give us a statement on the subject?—There is no objection to your doing so. I think I have given a correct answer.

Your answer in effect is that it would increase the cost of a boiler plant 10 or 15 per cent., which I suppose would be a pretty large item?—Yes; I think it is an item.

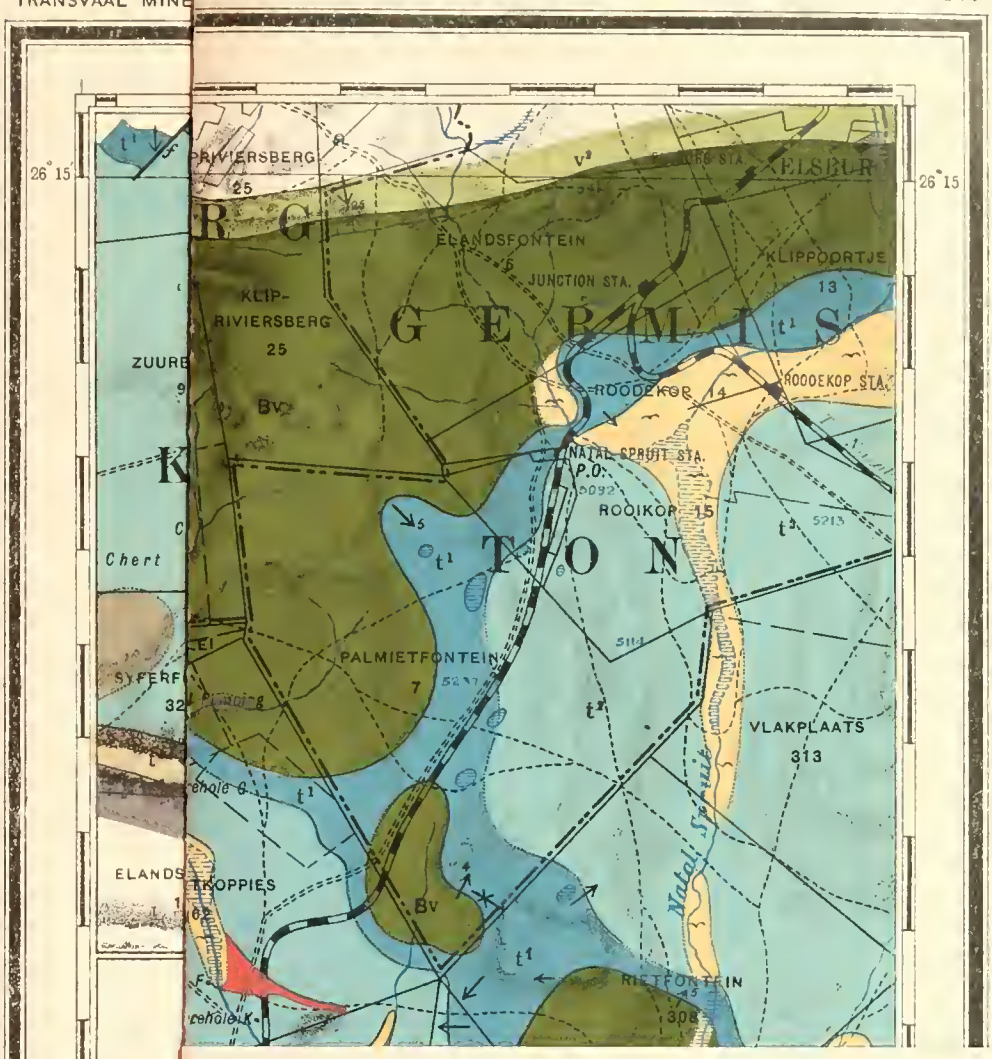
But spread over 20,000,000 gallons it would not amount to very much?—Only a small portion of the water is used in the boilers.

It would not average very much per thousand gallons? You do not think it an important point?—No.


SKETCH PLAN SHOWING
SOURCES AND COURSE OF
KLIPSPRUIT
SCALE OF ENG MILES
1/40,000
Canada Dam reduced from Plan No 5 of Surveyor Pazzighelli's Cadastral Survey of Klip River Valley
FLORIDA
NEWLANDS
CLAREMONT
MAIN REEF ROAD
MIDDELFONTEIN
PAARDEKRAAL
CONSOLIDATED M R MINES & EST
MAIN REEF
CANADA DAM
CANADA JUNCTION
LANGLAAGTE
KLEIN VOGELSTRUIS FONTEIN
CONSOLID MINES
MOOIFONTEIN
TURFFONTEIN
BOOYSENS
DOORNKOP
KLIPSPRUIT
DIEPKLOOF
VIERFONTEIN
TURFONTEIN
TURFFONTEIN
ORMONDE
KLIPRIVIERSBERG
GOVERNMENT
KLIPRIVIERSOOG
NANCEFIELD
PUMPING STATION
TURF CLUB
MISGUND
RIETVLEI
OLIFANTSVLEI
OLIFANTSVLEI
RIETFONTEIN

TRANSVAAL MINE

MAP OF THE KLIP RIVER VALLEY.



MAP OF THE KLIP RIVER VALLEY.

Geologically Surveyed in 1909 by W. A. Humphrey, B.A., Ph.D.
H. Kynaston, B.A., F.G.S., Director

Drawn in the Geological Survey Office
Photolithographed in the Government Printing Works, Pretoria