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Hydrological Research Institute

Report on:

Surface water quality of drainage region 300

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SURFACE WATER QUALITY OF
DRAINAGE REGION 300

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1. INTRODUCTION

Drainage region 300 contains the Vaal Dam catchment in the east, the Witwatersrand complex in the north, the Bloemhof Dam catchment in the centre, the Harts River catchment in the west and the Riet River catchment in the south. The surface water of drainage region 300 receives a wide spectrum of pollutants of agricultural, general industrial, urban and mining origin. These pollutants encompass major inorganic species such as chloride and sulphate, heavy metals such as manganese, and organic pollutants of both industrial and agricultural origin.

The purpose of this report is to provide an over-view of the water quality of the surface water of drainage region 300, particularly with reference to significant water quality problems existing in the region. The water quality data used were chiefly drawn from the Hydro Data Bank, and represent mean concentrations over the period of observation. The period of observation varies for the different stations from the past year, to the past twelve years (Schoonraad, 1981).

The water quality criteria used to gauge the degree of pollution are the summarized criteria given in TR108 (Kempster, Hattingh, Van Vliet, 1980). For irrigation water the U.S.A. Department of Agriculture C-S conductivity/salinity classification was used (Richards, 1954).

This classification divides irrigation water into 4 conductivity classes viz C1, C2, C3 and C4. Water of class C1 has a low salinity hazard, while water of class C2, C3 and C4 has a progressively higher salinity hazard. Plants sensitive to salt are affected by class C2 water. Class C3 water can only be used for plants with good salt tolerance, while class C4 water (with a conductivity in excess of 225 mS/m) is under ordinary conditions not suitable for irrigation.

In the C-S classification the sodium (alkali) hazard is indicated by the sodium absorption ratio (SAR) class in which the water falls. Water of class S1 has a low sodium content, while class types S2, S3 and S4 indicate progressively higher sodium contents. Water of type S2 is not suitable for fine-textured soils, while water of type S3 presents a high sodium hazard and requires special soil management. Water with a sodium hazard of type S4 is generally unsuitable for irrigation.

Thus good quality irrigation water would be type C1-S1, while very poor quality irrigation water would be type C4-S4.

The water quality of drainage region 300 is discussed below, starting from the source of the Vaal and Wilge rivers in the east, and concluding with Douglas Dam in the west. For the positions of the sample stations, refer to Fig. 1, which gives a summarized TDS map of region 300.

2. QUALITY OF SURFACE WATER OF REGION 300

2.1 Vaal River above Vaal Dam

The mean total dissolved salts (TDS) of the Vaal River at Standerton was 206 mg/ℓ. The sodium absorption ratio (SAR) at this point was 0,61 giving a medium salinity water of type C2-S1. The chloride concentration was 7 mg/ℓ and the sulphate concentration 12 mg/ℓ. The major anion was bicarbonate.

The branch rivers flowing into the Vaal River from the Transvaal side also had C2-S1 medium salinity type water with the exception of station C1MO4 on the Waterval River which had C3-S1 high salinity type water with a SAR of 3,9 and showed evidence of pollutant concentrations of sodium, chloride, sulphate, nitrate and phosphate. (Table 1).

The Vaal River at Villiers showed a mean TDS of 211 mg/ℓ, only slightly greater than the TDS of 206 mg/ℓ at Standerton. The SAR of the Vaal River water at Villiers was 0,61 giving a medium salinity, low sodium content water type C2-S1. The chloride concentration was 7 mg/ℓ and the sulphate concentration 12 mg/ℓ with the major anion being bicarbonate.

Thus, while the Vaal River at Villiers is of relatively good quality, pollution by both nutrients (nitrate and phosphate)

and sodium chloride/sulphate is already apparent, particularly on the Waterval branch-river.

TABLE 1

MEAN WATER QUALITY AT STATION C1M04 (WATERVAL R. AT ROODEBANK)

Electrical conductivity (25°C)	99	mS/m
Total dissolved salts	628	mg/ℓ
Sodium	124	mg/ℓ
Chloride	151	mg/ℓ
Sulphate	105	mg/ℓ
Nitrate nitrogen	4,5	mg/ℓ
Inorganic phosphate (as P)	0,58	mg/ℓ
Sodium absorption ratio	3,9	

Note that Sasol-II lies on the northern boundary of this catchment, and that any accidental-release of effluent at Sasol-II will result in a pollutant impact on the Vaal River above the Vaal Dam.

The Klip River which joins the Vaal River, west of Standerton and drains the area east of Vrede, is a good quality water of type C2-S1, with a TDS of 199 mg/ℓ, chloride concentration of 6 mg/ℓ, sulphate of 7 mg/ℓ and total alkalinity of 132 mg/ℓ as bicarbonate.

2.2 Wilge River

The Wilge River drains the Harrismith-Bethlehem area. The Wilge River at Harrismith (Station C8M15) is of excellent quality, with a TDS of 72 mg/ℓ and SAR of 0,6 giving an irrigation type C1-S1 water. The alkalinity of this water is 46 mg/ℓ as bicarbonate, the chloride concentration 3 mg/ℓ and the sulphate concentration 3 mg/ℓ.

The quality of the Wilge River water deteriorates slightly to class C2-S1 at Frankfort (Station C8M01) due to the influx of class C2-S1 water containing moderate amounts of sodium and bicarbonate ions from the branch rivers, such as, for instance the Liebenbergsvlei River draining the Bethlehem area. The Liebenbergsvlei River at Bethlehem (Station C8M07) has a TDS of 270 mg/ℓ, a sodium consentration of 20 mg/ℓ and bicarbonate of 185 mg/ℓ and is of irrigation type C2-S1. Further downstream it's quality is much the same. For instance at Station C8M04, the Liebenbergsvlei River has a TDS of 271 mg/ℓ with a sodium concentration of 25 mg/ℓ and bicarbonate concentration of 176 mg/ℓ. The Liebenbergsvlei River must receive a salt input near Bethlehem, as south of Bethlehem the water is of type C1-S1. Thus at Loch Athlone (Station C8R05) the TDS is 174 mg/ℓ with sodium and bicarbonate concentrations of 16 and 111 mg/ℓ respectively.

Table 2 shows a comparison between the water quality of the two main feeder rivers to the Vaal Dam viz the Vaal River and the Wilge River. Note the presence of nitrate in the Wilge River at Frankfort at a concentration of 1,6 mg/ℓ (as N).

TABLE 2

COMPARISON OF QUALITY OF VAAL RIVER AT VILLIERS (C1M11) WITH WILGE RIVER AT FRANKFORT (C8M01).

Determinand	Concentration	
	C1M11	C8M01
TDS	211 mg/ℓ	240 mg/ℓ
Bicarbonate	132 mg/ℓ	140 mg/ℓ
Chloride	10 mg/ℓ	11 mg/ℓ
Sulphate	12 mg/ℓ	17 mg/ℓ
Nitrate (as N)	0,1 mg/ℓ	1,6 mg/ℓ
SAR	0,7	0,6
Irrigation type	C2-S1	C2-S1

2.3 Vaaldam to Barrage

Apart from the major feedrivers i.e., the Vaal and Wilge Rivers, the Vaal Dam receives a few small streams. One such stream, i.e., the Kalkspruit (C1M09) draining the area immediately north-east of Vaal Dam carries a rather heavy salt load. The mean TDS of the water at C1M09 was 498 mg/ℓ, while the sodium concentration was 95 mg/ℓ, the sulphate concentration 75 mg/ℓ and the SAR 3,7 giving a water of type C2-S1.

The Vaal Dam itself exhibited the following mean concentrations at the wall over the past 13 years:
Total dissolved salts 134 mg/ℓ, with calcium as the major cation at 13 mg/ℓ and bicarbonate as the major anion at a concentration of 88 mg/ℓ. The mean sodium concentration was 3,4 mg/ℓ giving a SAR of 0,2 and water of irrigation type C1-S1.

The chloride, sulphate and nitrate concentrations were 7 mg/ℓ, 7 mg/ℓ and 0,14 mg/ℓ respectively.

If the mean Vaal Dam water quality at station C1R0101 over the past 13 years is compared with the mean water quality of released water at C2M03 just below the Vaal Dam for the past 2 years, the deterioration of the water quality can be seen (Table 3).

TABLE 3

MEAN WATER QUALITY OF VAAL DAM AT WALL (C1R0101) OVER THE PAST 13 YEARS, COMPARED TO MEAN WATER QUALITY OF RELEASED WATER AT ENGELBRECHTSDRIFT (C2M03) OVER THE PAST 2 YEARS.

Determinand	Concentration	
	C1R0101*	C2M03**
TDS	134 mg/ℓ	181 mg/ℓ
Sodium	3,4 mg/ℓ	15 mg/ℓ
Bicarbonate	88 mg/ℓ	105 mg/ℓ
Chloride	7 mg/ℓ	10 mg/ℓ
Sulphate	7 mg/ℓ	13 mg/ℓ

* mean concentration of past 13 y.

** mean concentration of past 2 y.

The Suikerbosrand River and Klip River which drain the Springs and Southern Johannesburg area are highly polluted. Both of these rivers are of type C3-S1, i.e., high-salinity water unsuitable for irrigating salt-sensitive crops. The Suikerbosrand River had a mean TDS of 830 mg/ℓ with sodium, chloride and sulphate concentrations of 152 mg/ℓ, 173 mg/ℓ and 252 mg/ℓ respectively. The Klip River (Station C2M21) had a mean TDS of 907 mg/ℓ with sodium, chloride and sulphate concentrations of 90 mg/ℓ, 85 mg/ℓ and 407 mg/ℓ respectively. In addition the algal nutrients nitrate and phosphate were present at concentrations of 2,2 mg/ℓ (as N) and 1,6 mg/ℓ (as P) respectively.

The inflow of the highly polluted water of the Suikerbosrand and Klip Rivers to the Vaal River at Vereeniging leads to a greater than ten-fold increase in the sulphate concentration in the Vaal River between Engelbrecht'sdrift (C2M03) and the Barrage (V17) and to a deterioration of the water quality from irrigation type C1-S1 to the medium-salinity type C2-S1 (Table 4).

The analyses of the Rand Water Board (1976, 1977, 1978) also show that the Suikerbos and Klip Rivers receive a considerable quantity of heavy metals such as manganese and lead from the Witwatersrand complex in addition to the inorganic salt load. Apart from the more common heavy metals, the Vaal River at Vereeniging is also polluted by uranium, and contains 0,011 mg/ℓ uranium which is more than ten times higher than the uranium concentration in Vaal Dam of 0,0008 mg/ℓ (Vogel and Kronfeld, 1981).

TABLE 4

COMPARISON OF WATER QUALITY OF VAAL RIVER AT ENGELBRECHTS DRIFT (C2MO3) WITH QUALITY AT BARRAGE (V17), SHOWING DETERIORATION ARISING FROM POLLUTION FROM THE WITWATERSRAND COMPLEX.

Determinand	Concentration	
	C2MO3	V17*
TDS	181 mg/ℓ	330 mg/ℓ
Sodium	15 mg/ℓ	38 mg/ℓ
Chloride	10 mg/ℓ	38 mg/ℓ
Sulphate	13 mg/ℓ	142 mg/ℓ
Nitrate (as N)	0,2 mg/ℓ	0,7 mg/ℓ
Phosphate (as P)	0,01mg/ℓ	0,29mg/ℓ
SAR	0,7	1,1
Irrigation type	C1-S1	C2-S1

*Rand Water Board, 1976, 1977 and 1978.

2.4 Barrage to Parys

Immediately below the Barrage, the Vaal River receives effluent from Sasol-I and from Vanderbijlpark. The Sasol-I effluent has a TDS of around 900 mg/ℓ, with a sulphate concentration of 423 mg/ℓ, fluoride concentration of 3,2 mg/ℓ and boron concentration of 2 mg/ℓ (Verhoef 1979). In addition, the Sasol-I effluent contains 14 phenolic compounds in excess of 1 µg/ℓ (Van Rensburg, 1979). The median world criterion for phenols in drinking water is 1 µg/ℓ (Kempster *et al*, 1980).

The Vanderbijlpark effluent in September 1979 had a TDS of around 660 mg/ℓ, with a nitrate concentration of 26 mg/ℓ (as N) and a phosphate concentration of 6,6 mg/ℓ (as P).

The maximum allowable nitrate concentration in drinking water in the world criteria is 23 mg/ℓ (as N), while for phosphate (as P) a maximum criterion for drinking water of 0,2 mg/ℓ is given (Kempster et al, 1980).

The high TDS of the Sasol-I and Vanderbijlpark effluents has a marked effect on the Vaal River downstream of the Barrage, particularly during periods of low-flow, when little water is released from the Barrage. In September 1979, for instance, the Vaal River at Parys had a sulphate concentration of 355 mg/ℓ and a phenol pollution index of 5, indicating 5 phenolic compounds present in excess of the 1 µg/ℓ criterion (Van Rensburg, 1979). In addition mutagenic compounds have been found more often in Parys water than in Rand Water Board Water (Grabow, Denkhaus, Van Rossum, 1979).

2.5 Vaal River from Parys to Orkney

The Vaal River at Parys was of irrigation type C2-S1, i.e., medium sallinity water. As a result of addition of further mining and industrial effluents via the Mooi River and the Koekemoerspruit the irrigation type deteriorated to class C3-S1 at C2M07 (Vaal River at Pilgrim's Estate), i.e., high salinity water. The mean TDS at C2M07 over the past two years was 611 mg/ℓ.

A number of the branch-rivers joining up with the Mooi River show evidence of excessive pollution with sulphate and nitrate. For instance at Wonderfonteinspruit, on the northern border of region 300 (C2M23), the mean TDS was 1980 mg/ℓ, the sulphate concentration 1270 mg/ℓ and the nitrate 12 mg/ℓ (as N) giving a water of class C4-S1, quite unsuitable for irrigation. At C2M25 (Wonderspruit at Gemsbok) the water is class C3-S1, highly saline water, with a TDS of 1530 mg/ℓ and a sulphate concentration of 1020 mg/ℓ. The Mooi River Loop at Blaaubank (C2M69) is of class C3-S1, with a TDS of 940 mg/ℓ, sulphate concentration of 470 mg/ℓ and nitrate concentration of 10 mg/ℓ (as N). The Mooi River Loop at Welverdiend also shows evidence of uranium pollution, having a uranium concentration of 0,12 mg/ℓ which is about sixty times higher than the background concentration for unpolluted rivers (Vogel and Kronfeld, 1981).

The Koekemoerspruit just above Orkney is responsible for pollution of the Vaal River with sulphate and heavy metals, notably manganese, arsenic and uranium. These pollutants arise from industrial mining activities in the area. At Station C2M07 on the Vaal River, the mean sulphate and manganese concentrations were 249 mg/ℓ and 1 mg/ℓ respectively. The arsenic concentration in June 1981 was 0,3 mg/ℓ which is above the median drinking water criterion for arsenic of 0,05 mg/ℓ (Kempster et al, 1980). A uranium concentration of 0,095 mg/ℓ i.e., about 48 times above the background concentration of 0,002 mg/ℓ was measured in the Vaal River during the low winter flow (Verhoef, 1981). The groundwater

in the neighbourhood of the Koekemoerspruit's junction with the Vaal River has also been polluted by the mining activity, and a fountain on the bank of the Vaal River was observed to contain as much as 140 mg/ℓ manganese (Verhoef, 1981). The maximum manganese criterion for irrigation water is 2 mg/ℓ (Kempster et al, 1980).

The high salinity of the Vaal River at C2M07 is somewhat ameliorated by the good quality water carried into the Vaal via the Renoster River draining the agricultural area of the northern OFS. The Renoster River at C7M03 had a mean TDS of 191 mg/ℓ, with chloride and sulphate concentrations of 15 mg/ℓ and 14 mg/ℓ respectively.

2.6 Vaal River from Orkney to Bloemhof Dam

Between Orkney and Bloemhof Dam there is a considerable improvement in the quality of the Vaal River due to dilution by water from side branch-rivers containing smaller TDS values than the Vaal River.

At C2M22 (Vaal River at Balkfontein) the TDS of the Vaal River was 470 mg/ℓ, with a sulphate concentration of 172 mg/ℓ and irrigation class C2-S1 i.e., medium salinity water. The Vals River, which joins the Vaal River at Bothaville, has a TDS of 316 mg/ℓ (C6M02, Vals River at Bothaville) and is of irrigation type C2-S1. Higher up the Vals River, the TDS is smaller. Thus at

Kroonstad (C6M01) the TDS of the Vals River was 170 mg/ℓ with the water of class C1-S1. At Lindley (C6M04) the mean TDS of the Vals River was 201 mg/ℓ. The major salt in the Vals River water was sodium bicarbonate. The bicarbonate, sulphate and chloride concentrations of the Vals River at Bothaville were 143 mg/ℓ, 48 mg/ℓ and 30 mg/ℓ respectively.

Between Bothaville and Bloemhof Dam further small side branch rivers add water with very little sulphate to the Vaal River water to further dilute the high sulphate concentration which arose from the Witwatersrand complex. Thus the C2M65 and C2M66 branch rivers draining the Wolmaransstad area had sulphate concentrations of 9 mg/ℓ and 16 mg/ℓ respectively.

2.7 Vet River

The Erfenis Dam (C4R02) on the Vet River has high quality water of irrigation class C1-S1. The mean TDS was 165 mg/ℓ, the predominant anion being bicarbonate (105 mg/ℓ). The sodium, sulphate and chloride concentrations in the Erfenis Dam were 15 mg/ℓ, 7 mg/ℓ and 6 mg/ℓ respectively.

The Allemanskraal Dam (C4R01) on the Sand River also has high quality water of irrigation type C1-S1. The TDS was 178 mg/ℓ with sodium, sulphate and chloride concentrations of 20 mg/ℓ, 8 mg/ℓ and 6 mg/ℓ respectively. The major anion was bicarbonate at a concentration of 111 mg/ℓ.

The Vet River at Nooitgedacht (C4M04), below the junction of the Sand and Vet Rivers had a mean TDS of 281 mg/ℓ and is of irrigation type C2-S1. The sodium, bicarbonate, sulphate and chloride concentrations were 33 mg/ℓ, 131 mg/ℓ, 27 mg/ℓ and 38 mg/ℓ respectively.

2.8 Bloemhof Dam

Of the two main rivers flowing into Bloemhof Dam, viz, the Vaal and the Vet Rivers, the Vaal River has a 67% greater TDS than the Vet River (Table 5).

TABLE 5

COMPARISON OF WATER QUALITY OF THE TWO MAIN RIVERS FLOWING INTO BLOEMHOF DAM VIZ, the VAAL RIVER (C2M22) AND THE VET RIVER (C4M04).

Determinand	Concentration	
	Vaal (C2M22)	Vet (C4M04)
TDS	470 mg/ℓ	281 mg/ℓ
Sodium	40 mg/ℓ	33 mg/ℓ
Bicarbonate	123 mg/ℓ	130 mg/ℓ
Chloride	39 mg/ℓ	38 mg/ℓ
Sulphate	172 mg/ℓ	27 mg/ℓ
SAR	1,1	1,3
Irrigation type	C2-S1	C2-S1

Note that the primary difference between the water quality of the Vaal River and Vet River is the high sulphate concentration

in the Vaal River water. The Vaal River at Balkfontein has more than 6 times more sulphate than the Vet River at Nooitgedacht.

The mean water quality of Bloemhof Dam (C9R02) over the past 10 years was as follows: Total dissolved salts 280 mg/ℓ, with a SAR of 0,9 and of irrigation type C2-S1, i.e., medium salinity water. The sodium, bicarbonate, sulphate and chloride concentrations were 25 mg/ℓ, 117 mg/ℓ, 63 mg/ℓ and 19 mg/ℓ respectively. The mean nitrate-nitrogen and phosphate-phosphorus concentrations were both 0,2 mg/ℓ.

2.9 Vaal River from Bloemhof Dam to De Hoop

There is little change in the quality of the Vaal River between Bloemhof Dam and De Hoop (near Kimberley) as indicated by the mean concentrations at C9R02 (Bloemhof Dam) and C9M09 (Vaal River at De Hoop) for the past decade. The mean TDS at Bloemhof Dam was 280 mg/ℓ, while the mean TDS at De Hoop was 270 mg/ℓ. The corresponding means for sulphate were 63 mg/ℓ and 49 mg/ℓ respectively.

At Vaalharts Dam (C9R01) the mean TDS over the past 2 years was 382 mg/ℓ and the mean sulphate concentration 96 mg/ℓ. Comparing this 2 year mean with the 10 year means for the Bloemhof Dam and the Vaal River at De Hoop, it appears that there has been at least a 36% increase in the TDS of the waters during the past decade, primarily due to a sulphate increase.

2.10 Harts River

All four stations on the Harts River had mean TDS values in excess of 488 mg/ℓ, indicating high salinity i.e., irrigation class C3 water. Schweizer-Reneke Dam (C3R01) had a TDS of 740 mg/ℓ, with sodium, bicarbonate, sulphate and chloride concentrations of 130 mg/ℓ, 360 mg/ℓ, 38 mg/ℓ and 127 mg/ℓ respectively.

At Station C3M03 (Harts River at Taung) the TDS was 582 mg/ℓ, while at C3M07 (Harts River at Espagsdrif) the TDS was 791 mg/ℓ. The sodium, bicarbonate, sulphate and chloride concentrations at C3M07 were 103 mg/ℓ, 232 mg/ℓ, 174 mg/ℓ and 136 mg/ℓ respectively, with a SAR of 2,4 and water of irrigation type C3-S1. Note how drainage water from the Vaalhartz irrigation scheme results in an increase in TDS from the value of 382 mg/ℓ at Vaalhartz Dam, to a TDS of value of ~~[illegible]~~ 791 mg/ℓ at C3M07 (Hartz River at ~~Taung~~ Espagsdrif). This is an increase in TDS of ~~[illegible]~~ 409 mg/ℓ caused by irrigation runoff!

The mean TDS at Spitskop Dam (C3R02) over the past 6 years was 641 mg/ℓ, with sodium, bicarbonate, sulphate and chloride concentrations of 93 mg/ℓ, 218 mg/ℓ, 120 mg/ℓ and 118 mg/ℓ respectively. This water had a SAR of 2,4 and was of irrigation type C3-S1, i.e., high salinity water unsuitable for salt sensitive crops.

While the high sulphate and chloride content of the Harts River water is partially due to irrigation practices itself, there appears to be a geological reason too. Thus, for instance, the Groot Boetsap Oog in the Boetsap Nature Reserve (C3M09) also showed high TDS, sulphate and chloride concentrations of 962 mg/ℓ, 83 mg/ℓ and 89 mg/ℓ respectively.

2.11 Riet and Modder Rivers

The Modder River is of low salinity (type C1-S1) at Rustfontein Dam (C5R03), but rapidly increases in salinity as it flow westwards. At Krugersdrift Dam (C5R04) northwest of Bloemfontein, the water is of medium salinity type C2-S1, with a TDS of 366 mg/ℓ and a chloride concentration of 54 mg/ℓ. At C5M18, just before the Modder River joins the Riet River, the TDS of the Modder River was 609 mg/ℓ and the chloride concentration 114 mg/ℓ. At this point the Modder River was of high salinity type C3-S1.

The Riet River showed a similar behaviour, changing from low salinity water at its source in the east to high salinity water as it flows westwards. The intermediate Stations C5R01 (Tierpoort Dam), C5M12 (Riet River at Rietwater) and C5M20 (Trompsburgfontein) were all of irrigation type C2-S1, with bicarbonate as the predominant anion. Further down-stream at Kalkfontein Dam (C5R02) the TDS was 586 mg/ℓ, with sodium, bicarbonate, sulphate and chloride concentrations of 63 mg/ℓ, 216 mg/ℓ, 41 mg/ℓ and 59 mg/ℓ

respectively and irrigation type C2-S1. At C5M16 (Riet River at Aucampshoop), the water is of high salinity type C3-S1, with TDS, sodium, bicarbonate, sulphate and chloride concentrations of 1150 mg/ℓ, 195 mg/ℓ, 295 mg/ℓ, 214 mg/ℓ and 297 mg/ℓ respectively.

At C5M16, the means for winter and summer showed less than 10% difference in TDS indicating a constant high salinity at the lower parts of the Riet and Modder Rivers.

2.12 Vaal River from De Hoop to Douglas Dam

The effect of the highly saline, type C3 water added to the Vaal River by both the Harts and the Riet Rivers is to raise the TDS of the Vaal River water from 267 mg/ℓ at de Hoop to 568 mg/ℓ at Douglas Dam.

At De Hoop (C9M09) the water has a mean TDS of 267 mg/ℓ and is of medium salinity type C2-S1, with sodium, sulphate and chloride concentrations of 24 mg/ℓ, 49 mg/ℓ and 19 mg/ℓ respectively.

At Gamagara (C9M10), where the Harts River joins the Vaal River, the TDS is 416 mg/ℓ, and is of medium salinity type C2-S1, with sodium, sulphate and chloride concentrations of 46 mg/ℓ, 73 mg/ℓ and 52 mg/ℓ respectively.

At Douglas Dam, after the junction of the Riet River with the Vaal River, the water is of high salinity type C3-S1, with sodium, sulphate and chloride concentrations of 77 mg/ℓ, 130 mg/ℓ and 97 mg/ℓ respectively.

SUMMARY

The mean TDS of the Vaal Dam over the past 13 years has been 134 mg/ℓ i.e., low salinity class C1-S1 water. The TDS increases to 330 mg/ℓ at the Barrage due to salinity inputs from the Witwatersrand. The water at the Barrage was of medium salinity type C2-S1. The inflow of high sulphate content water from the Mooi River and mining effluents in the West Rand area causes the Vaal River water to deteriorate to high-salinity type C3-S1 water, with a mean TDS of 611 mg/ℓ at Orkney. Below this point the inflow of water of type C2-S1 leads to a return to medium salinity type C2-S1.

At Bloemhof Dam the water is of type C2-S1 with a mean TDS of 280 mg/ℓ. This quality is maintained until the inflow of highly saline type C3-S1 water from the Harts River, which increases the mean TDS of the Vaal River to 416 mg/ℓ at Gamagara. The inflow of further high salinity type C3-S1 water from the Riet River increases the TDS of the Vaal River further, so that at Douglas Dam the water has a mean TDS of 568 mg/ℓ, and is of type C3-S1, i.e., high salinity water unsuitable for irrigation except for plants with a good salt tolerance.

Apart from the pollution by chloride and sulphate salts, the Witwatersrand-Potchefstroom-Klerksdorp industrial activity has polluted the Vaal River with heavy metals, notably manganese, arsenic and uranium.

The Sasol-I effluent into the Vaal River was characterised by the presence of phenolic compounds, in addition to the inorganic salt load.

In conclusion, the water quality of drainage region 300 can be summarized as follows: The branch rivers arising east of the Vaal River have low to moderate salinity water of good quality, with the exception of the Riet River in the southern part of the drainage region. The branch rivers arising north of the Vaal River have moderate to high salinity water arising from industrial pollution in the Witwatersrand area and from irrigation practices in the western part of the drainage region. The nett effect is for the water of the Vaal River system to change from low salinity type C1-S1 water in the north-east, through medium salinity type C2-S1 water, to high salinity type C3-S1 water in the south-western part of the region 300.

4. ACKNOWLEDGEMENTS

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DREINERINGSTREEK 300

DRAINAGE REGION 300

Fig.1

TOS 50% nie-oorskrydingswaarskynlikhede

TDS 50% non-exceedance probabilities

TDS TOS (mg/l)*	
	0 tot 200
	201 tot 400
	401 tot 600
	601 tot 1000
	> 1000

*TOS- Totale Opgeloste Soute
TDS- Total Dissolved Salts