ANNEXURES

ANNEXURE A: SUMMARY OF PREVIOUS WATER RESOURCE PLANNING STUDIES

ANNEXURE B: REGISTERED DAMS IN THE THUKELA WMA

ANNEXURE A : SUMMARY OF PREVIOUS WATER RESOURCE PLANNING STUDIES

1. LIST OF STUDIES

This annexure lists the issues raised and recommendations made in previous water resource planning studies pertaining to the Thukela WMA. These issues and recommendations were used to compile the first draft of the strategy tables that were discussed and revised during the two workshops. **Table 1.1** presents a chronological list of the DWAF studies undertaken in the WMA.

Table 1.1: List of study reports.

No.	Document reference	Report Title
Vaal Augmentation Planning Study: Tugela-Vaal Transfer Scheme (1993 – 1994) – Reconnaissance Phase		
1	V000/00/0894	Vaal Aumentation Planning Study : Tugela-Vaal Transfer Scheme - WST consortium : Reconnaissance report
2	Recon A.1	Base Conditions
3	Recon A.2	Water Demands
4	Recon A.3	Streamflow hydrology : Volumes 1 & 2
5	Recon A.4	Water Quality
6	Recon A.5	Environmental Aspects
7	Recon A.6	Development Options
8	Recon B.1	Basic data: Volume 1
9	Recon B.2	Basic data: Volume 2
10	Recon B.3	Basic data: Volume 3
Vaal Augmentation Planning Study: Tugela-Vaal Transfer Scheme (1994 – 1996) – Pre-feasibility Phase		
11	V000/00/0894	Vaal Augmentation Planning Study : Tugela-Vaal Transfer Scheme - WST consortium : Pre-feasibility Report
12	Pre-feas A.1	Design
13	Pre-feas A.2	Environmental Aspects
14	Pre-feas A.3	Costing and Economics
15	Pre-feas A.4	System Analysis
16	Pre-feas A.5	Regional Economics
17	Pre-feas A B.1	Basic data
Vaal Augmentation Planning Study: Tugela-Vaal Transfer Scheme (1995 – 1996) – Interim Study (Pre-feasibility Phase)		
18	V000/00/1296	Vaal Aumentation Planning Study : Tugela-Vaal Transfer Scheme - WST consortium : Interim Phase Report
19	-	Various Interim Phase supporting documents, which amongst others include:
20	V000/00/0195	Tugela River (Pre-feasibility) IFR Workshop Site visit document
21	V000/00/0295	Tugela River (Pre-feasibility) IFR Workshop Starter document
22	-	
Thukela Water Project Feasibility Study (1997 – 2001) – Feasibility Phase		
23	V000/00/0198	Klip dam site: Geological Pre-feasibility report
24	V000/00/0298	Jana dam site: Geological Pre-feasibility report
25	V000/00/9600	Executive Summary: overview brochure
26	V000/00/9700	Main Feasibility Report
27	V000/00/3199	Engineering Module Report
28		13 Engineering Supporting Reports
29	V000/00/6099	Evaluation of Alternative Sources of Water for Ladysmith-Emnambithi
30	V000/00/5599	Water Resources Module Report
31		3 Supporting Water Resources Reports
32	V000/00/0089	Public Involvement Programme Module Report
33	V000/00/9000	Decision Register (12 public involvement programme files)
34	V000/00/6200	Environmental Module Report
35		18 Environmental Supporting Reports
36	V000/00/8799	Regional Development
37	V000/00/9900	Legal & Hydro-political Aspects
38	V000/00/9100	Economical & Financial Viability Report

No.	Document reference	Report Title
Other studies		
39	V000/00/0284	Sentraal -Tugela - wateroordragskema : voorlopige ondersoek na ′n gesamentlike skema met Eskom
40	C000/00/6486 V000/00/0586	Vaal River System Analysis - BKS Tugela - Vaal subsystem analysis (1986)
41	V000/00/0686	Hydrology of the Tugela Basin: volume A: :text

No.	Document reference	Report Title
42	V000/00/0686	Hydrology of the Tugela Basin: volume B: appendices
43	V000/XX/0180	Moontlike water ontwikkeling in die Tugela opvanggebied vir KwaZulu - Dept. Samewerking & Ontw
44	V000/00/0184	Vloei - en netto verdampingsrekords vir terreine en damme in die Sentraal - Tugelaskema
45	V000/00/0385	Investigation into the irrigation potential of the Tugela catchement area -MBB
46	V000/00/0191	Streamflow gauges in the Mhlatuze, Mfolozi and Tugela basins -WLPU
47	V000/xx/0195	Thukela basin investment strategy: Preliminary feasibility study - Deloitte & Touche
48	V100/xx/0187	Upper Tugela study
49	V100/XX/0287	Base line data study - KwaZulu : Dept. Economic Affairs
50	V100/xx/0287 V100/xx/0387	Survey of agricultural potential and development needs of the Driefontein block (Klip River) - Development Aid Volumes I & II
51	V100/xx/0188	Ladysmith flooding : Progress report no .1 - Technical working group
52	V100/xx/0288	A proposed structure plan for the Upper Tugela Location and Adjacent black occupied areas - A' Bear, Davis, Krone
53	V100/xx/0388	Role of Wetlands and landuse in flood attenuation: Klip River above Ladysmith -Institute of Natural Resources
54	V100/xx/0488 V100/xx/0588	Ladysmith flooding: Recommended solution - Technical working group: Volumes 1 & 2
55	V100/xx/0189	Waayhoek pumped - storage scheme : Feasibility report - Eskom
56	V100/xx/0195	Braamhoek pumped - storage scheme : Feasibility report - Eskom
57	V100/07/DE01 V100/00/0196	Ladysmith flood control scheme : Qedusizi Dam (Social assessment and public involvement) - WST consortium: Summary Report
58	V100/00/0296	Volume 1 : Report
59	V100/00/0396	Volume 2 : Appendices
60	V100/xx/0196	Provincial growth and development strategy for KwaZulu - Natal - Development Planning Committee of KwaZulu - Natal
61	V100/00/0496	National water management program: Development of the water resources of the Tugela River
62	V200/xx/0181	Tugela - Vaal III : Dartingtondamterrein, Hlatikulurivier : Eerste geologiese verkenningsverslag - Geologiese opname
63	V200/06/1975	Tugela - Vaal III : Glenfern Dam site: First geological reconnaissance report - geological survey
64	V200/09/1976	Tugela - Vaal III : Prosperity Dam site : First geological reconnaissance report - Geological survey
65	V200/00/0183	Umgeni ; Mearns Dam site : First engineering geological reconnaissance report - A.v.Schalkwyk
66	V200/00/0283	Verkenningsverslag : Mlambonjadamterrein (Bergville) : Eerste fase –SRK
67	V200/00/0383	Contingency plan to augment water resources of the Umgeni River (into Mooi River)
68	V200/xx/0183	Umgeni WSS : Mearns Dam site (Mooi River district) : First geological feasibilty report - Geological survey
69	V200/00/0184	Quantities and cost for tunnels
70	V200/00/0185	Intergrated catchment management : Guidelines & recommendations based on pilot study in Mooi & Mgeni catchments
71	V200/00/0594	Mooi River transfer sedimentation report - Sigma Beta
72	V200/00/2559	Mooi - Mgeni : Spring Grove dam site: first Engineering geological reconnaissance report - geological survey
73	V200/xx/0294	RDP Msinga water supply - Anderson, Vogt & Partners
74	V200/00/0694	Mooi - Mgeni : preliminary water quality assessment - Keeve Steyn + Ninham Shand
75	V200/00/0565	Mooi - Mgeni : Wellington tunnel: First engineering geological feasibility report - geological survey
76	V200/xx/0394	Initial impact assessment of proposed Mearns weir, transfer tunnel and receiving stream (Mpofana) - Lee Henderson
77	V200/00/0794	Mooi - Mgeni : Initial natural environmental assessment (final draft) - Lee Henderson
78	V200/xx/0494	RDP : Water services in Umgeni Water's new supply area (Hlanganani) : Summary report - SRK
79	V200/00/0994	ROIP : Mooi - Mgeni feasibility - G. J. Munro 1: Proposed Mearns and Spring Grove Dams
80	V200/00/0694	2: Proposed Dartington Dam
81	V200/00/0794	3: Receiving stream - Mpofana /Lions
82	V200/00/0894	4: Proposed transfer tunnel / pipeline
83	V200/00/0795	Mooi river IFR workshop 15-18 May 1995
84	V200/xx/0195	Mooi River IFR workshop : Site visit document
85	V200/xx/0295	Mooi River instream flow assessment - Ninham Shand
86	V200/00/0895	Flood hydrology of the proposed Spring Grove , Dartington & Mearns dam sites
87	V200/xx/0395	Mooi-Mgeni transfer : Planning analysis - BKS
88	V200/xx/0495	Mooi - Mgeni : Receiving rivers impact management study: workshop - SRK
89	V200/xx/0595	Mooi - Mgeni : Receiving rivers impact management study : social impact & appendices - Seneque & Maughan - Brown
90	V200/00/1295 V200/00/0995	Mooi-Mgeni transfer feasibility study - Keeve Steyn 3 : River Engineering
91	V200/00/1095	4.1 : Initial environmental assessment
92	V200/00/1195	4.2 : Initial environmental assessment : Appendices
93	V200/00/1295	4.3 : Mooi River storage options : pre-feasibility study

No.	Document reference	Report Title
94	V200/00/1295 V200/00/1795	Mooi-Mgeni transfer feasibility study - Keeve Steyn 4.4 : Instream flow requirements
95	V200/00/1895	5 : Social environment and value resources
96	V200/00/1295 V200/00/1995	Mooi-Mgeni transfer feasibility study - Keeve Steyn 6 : Water quality
97	V200/00/2095	7 : Costing
98	V200/00/2195	8.1 : Water balance analysis : Text
99	V200/00/2295	8.2 : Water balance analysis : Appendices
100	V200/00/2395	9.1 : Water resources analysis : Text
101	V200/00/2495	9.2 : Water resources analysis : Appendices
102	V200/00/2595	Mooi-Mgeni : Addendum to social environment & value of resources
103	V200/00/0196	Overseas economic cooperation fund: Japan (Questionnaire on Mooi - Mgeni project)
104	V200/0295	Towards integrated management of the Mgeni catchment
105	V300/00/0170	Will Water Affairs be able to supply Newcastle at the crucial times (1970)
106	V300/xx/0177	Preliminary hydrogeological assessment of channel alluvium in the Buffelsrivier to the west of Nqutu - Loxton Hunting
107	V300/xx/0277	Buffelsrivier (Ngutu) WVS - Chunnett, Myburgh & Vennote Uitvoerbaarheidstudie : Finale verslag
108	V300/xx/0178	Uitvoerbaarheidstudie : Addendum tot finale verslag
109	V300/04/0279	Chelmsford Dam: Capacity determination
110	V300/00/0179	Uitkering van Slang - na Vaalrivier
111	V300/00/0183	Contingency plan to augment the water supplies of Newcastle
112	V300/00/0283	Buffalo: Engineering geological reconnaissance report on Weir / canal alternatives for Newcastle 0 George , Orr
113	V300/xx/0183	Moontlike bronne vir watervoorsiening aan volksrust - de Wet, Shand
114	V300/00/0383	Langtermn vloeirkords vir terreine in die Buffels - en Sondagsrivier
115	V300/00/0483	Samestelling van langtermynvlorirekords vir drie punte in die Sondagsrivier (Natal)
116	V300/00/0185	Langtermyn vloeirekords vir die Buffels - en Ngaganerivier
117	V300/02/0184	Voorgestelde Slangrivier SWS
118	V300/02/0285	Uitbreiding van Slangsrivier - SWS : Oorplasing van water na die Vaalrivier
119	V300/28/2116	Slang River GWS : Uitkyk balancing reservoirs : First engineering geological report for design - Geological Survey
120	V300/00/0386	Vaal River system analysis: Buffalo - Vaal subsystem analysis - BKS
121	V300/xx/0190	Ngagane regional water supply system : Planning update - Umgeni Water
122	V300/xx/0195	Nqutu regional WSS: Project preparation assistance study (water supply model)
123	V400/00/0170	Map of Lower Tugela dam sites
124	V400/xx/0183	Feasibility report on Mvumase irrigation scheme - Bosch & Associates
125	V400/00/0184	Vloei - en netto verdampingsrekords vir terreine en damme in die Sentraal - Tugelaskema
126	V400/00/0186	Vloei - en verdampingsrekords vir die Smaungu terrein in die Sentraal - Tugelaskema
127	V400/xx/0186	Additional Tugela pumping Western Natal region : Feasibility costing - A. Hepburn (Escom)
128	V400/xx/0187	Madadeni / Osizweni bulk water supply : Urban water requirements - Goulty Moller & Associates
129	V500/00/0174	Simulasie v. vloeirekords by terreine op Assegaairivier en verlenging v. vloeirekords op riviere wat in Swaziland invloei
130	V500/xx/0281 V500/xx/0181	Feasibility study of 1200 MW Mvumase pumped storage scheme on Lower Tugela - Escom Volumes 1 & 2
131	V500/xx/0187	Lower Tugela basin development : Executive summary of overall feasibility report-Escom
132	V500/20/UB01	Tugela - Mhlathuze River GWS : Pre-feasibility study on the Middledrift community water supply - Stewart, Scott
133	V600/01/0172	Feasibility study of water supply scheme for the Newcastle - Platberg colliery, Elandslaagte farmers association et al. From the possible Slangdraai (Waterfall) Dam, Sundays River (Natal)
134	V600/00/0183	Samestelling van langtermynvloeirkords vir drie punte in die Sondagsrivier (Natal)
135	V700/00/0192	Wagendrift Dam: Yield analysis

2. OVERVIEW OF STUDIES UNDERTAKEN

2.1 Vaal Augmentation Planning Study : Tugela-Vaal Transfer Scheme - Reconnaissance Phase

This study was initiated in response to the future need to augment water supplies to the Vaal River System. Further development of the water resources of the Thukela River Catchment was proposed as an option.

2.1.1 Base conditions

This review was directed at compiling information relating to water utilization/resources. Information was collated by examining reports pertaining to existing and planned developments involving utilization of water resources, namely water supply, transfer schemes, pumped storage, urbanization, nature reserves, mining, irrigation and afforestation in the Thukela Basin. Although this was mainly a desktop study, it included questionnaires to local authorities and visits to major water users. This report presented the following information that has bearing on the ISP:

Land Use : Drakensberg forms the higher lying, high rainfall areas. Mainly nature areas, holiday resorts and to a limited extent forestry are the main land uses being practiced in the Drakensberg mountains. Main industrial centres that place a demand on the water resources and that have an impact on water quality in the receiving streams were identified at Newcastle, Dundee, Estcourt, Ladysmith, and Mandini (SAPPI). Water usage was expected to double between the years 1990 and 2010. *(A smaller growth in demand has been experienced between 1990 and 2002)*. A domestic population/water demand growth rate of 3% was predicted for the same time period. Numerous mines (mainly coal mines) have closed down. Water quality related problems are described below.

Agriculture : Government Water Control Areas: 7700ha of irrigation (quotas 51×10^6 m^3/a). Thukela / Spioenkop = 1543 ha; Bushmans / Wagendrift = 1593ha; Ngagane / Chelmsford = 238 ha; Mnyavubu / Craigieburn = 2157 ha; Buffalo = 3049 ha. Other irrigators (Water Boards and Private irrigation): Total 86 000ha (= 655×10^6 m^3/a). *(Not sure if this irrigation area is entirely being used today)* This reconnaissance study noted that the whole catchment (especially in homeland areas) was totally overstocked with domestic animals and that the telltale signs of soil erosion were evident.

Afforestation : In 1990, the upper parts of Thukela catchment (mainly the Biggersberg to Newcastle stretch) contain about 20 000 ha of forestry. The Thukela-Mhlatuze watershed also allows afforestation. DWAFs management aim was not to allow large scale afforestation and to try and limit the impact of this sector on the MAR to a streamflow reduction of 10% of the MAR. In view of potential expansion it was found that 82000ha of suitable forestry land exists in the Thukela Basin and a further 65000ha of marginal could also be utilized.

Ecology : The Thukela River Mouth was cited as a concern in this report. The authors were concerned about the impact of the various planned abstraction weirs in the lower Thukela River on the migration of marine/riverine fauna. Maintenance of sufficient low flows to ensure that the mouth remains open for most of the time was also mooted. Minimum discharges to dilute Sappi effluent was also noted as a major concern (request that a minimum flow of greater than $4m^3/s$ be maintained 95% of the time).

Large Dams : Ten dams in catchment with a combined firm yield of 950×10^6 m^3 /annum. Upper dams (Woodstock, Driel Barrage and Kilburn) reserved for transfer. Chelmsford (Ngagane Regional GWS and CA) problems with allocations to irrigators. Spioenkop (Tugela GWS and CA) - u/s abstractions allowed and compensation releases of 1 to $2m^3/s$ allowed.

Other Regional Schemes and Transfers : Ngagane, Biggersberg, Emnanbithu, Nqutu managed by Uthukela Regional Council (more recently some have been handed over to the Thukela Water Partnership).

Major transfers : Tugela Vaal Transfer Scheme – some concern by Thukela Basin residents that they don't see the benefit of this transfer and that local development may be hindered in future. (More recently, it may be possible for the proposed Thukela Catchment Management Agency to charge a water resource levy on water transferred to the Vaal River System. Furthermore, it has been mentioned that local water users take precedence over Vaal River users when it comes to the allocation of water resources in the Thukela River Basin). Slang / Zaaihoek (Buffalo GWS): Majuba Power Station takes priority on the water in the Zaaihoek Dam. (It has been noted that the large dead storage in the Zaaihoek Dam is not being utilized). It was noted that there could be a water transfer from the lower Thukela River to Richards Bay and environs in future. Also a further transfer to the Mgeni River System from the Mooi River. The possibility of the Waaihoek or Braamhoek Pumped Storage Scheme was also mentioned.

2.1.2 Water Requirements

The water requirements were discussed in detail in these reports (updated values are now available and are reflected in this ISP). Indications are that the in-basin requirement projections made in the earlier studies were very conservative. Lower demands are now being experienced and projected.

2.1.3 Water Resources

The Mean Annual Runoff at the Thukela River Mouth was estimated at 3865x 10^6 m^3 /annum. (More recent studies [Pitman and McKenzie(1996)] showed a 0.4% decrease in the MAR estimates).

2.1.4 Water Quality

A comprehensive assessment of the water quality issues in the whole Thukela River catchment was conducted during these feasibility studies. Dr Herold provided the following general recommendations regarding water quality management in the catchment: Suitable relationships and other prediction tools need to be developed to estimate :

- Future quality of effluent discharged to streams in the Thukela Catchment;
- The present and future salt export from operating, abandoned unrehabilitated and abandoned rehabilitated coal mines;
- The diffuse source export of problematic pollutants from industrial areas; and
- Diffuse wash-off of pollutants from urban areas (especially informal/semi formal settlements).

Short term monitoring programme recommended to meet requirements for estimating diffuse source pollution loads. Conjunctive use of dams (existing and new) to meet needs of water use and simultaneously solving existing downstream water quality problems should be considered.

The following specific issues were highlighted:

Upper Tugela R (V110 tertiary catchment) : Spioenkop Dam grossly under-utilised. No significant water quality problems. The rapid development of the Action Homes settlement above Spioenkop could cause eutrophication and excessive organic load problems in the dam in future. Similarly the relatively high density of rural population in the area above the Woodstock Dam. *(Recently Rand Water has conducted studies and rehabilitation projects in this area to limit soil erosion and sedimentation of the Woodstock Dam).* It was believed that this area was 75% overstocked with livestock (ie carrying capacity 2 ha per Livestock Unit (LSU) vs actual 3.5ha per LSU on the ground in the early 1990s).

Little Tugela (V130) : Informal settlements in upper subcatchment and formal irrigation scheme in lower parts. Overstocking (ie double the livestock carrying capacity).

Klip River (V120) : Ladysmith-Ezakheni pollution sources - high coli and total coliforms , high phosphates. Rapid growth in informal settlements: Driefontein , Watermeet and Peace Town = high organic loads. Overgrazing as well (double carrying capacity).

Middle Tugela / Bloukrans River (V140) : Overgrazing: 80% over carrying capacity. TDS, Sulphate and Phosphate on Bloukrans somewhat elevated *(possibly due to Cornfields Tembahlile settlements).*

Bushmans River (V700 tertiary catchment) : 60% overstocked. High industrial component (60%) in Estcourts sewage effluent results in poor final effluent quality. Noted as a major issue – please see tables later in this report.

Sundays/Tugela River (V600) : Urban development - Glencoe - Sithembile, Ekuvukeni, Waaihoek and Uitkyk. Sithembile = frequent blockages of sewers with spillages into Uithoekspruit and hence into the Wasbankspruit. High rural population density (56 per km^2) could contribute to the occasional high phospate concentrates observed in Sundays River (up to 450μg/l) and the Wasbankspruit (1320μg/l). Natural drainage from geological formations and especially from coal mine workings also contain appreciable amounts of nitrates and phosphate. Two dormant and six closed coal mines are located in the Wasbankspruit and Sundays River catchments. Evidence of salination of Upper Sundays River at gauging point V6H004 with sulphate concentrations reaching 214mg/l (compared with 18mg/l further upstream at V6H006). Large informal settlements in vicinity of Tugela Ferry = organic pollution. Livestock - 140% overstocked = soil erosion very evident.

Mooi River (V200) : Mooi Textiles has own sewage treatment works. *(Factory now closed).* Livestock numbers exceed carrying capacity by 70%. Several Piggeries in catchments.

Upper Buffalo (V310) : Half of urban population in Thukela catchment centred in Newcastle, Volksrust, Dannhauser and Charlestown areas. Iscor, Karbochen; AECI, and Coal mines are main industrial and mining activities. Operational coal mines (Durnacol [*now closing*], CBR and Witklip); 8 dormant and 6 closed coalmines in this area. Ncandu, Ngagane and Buffalo (immediately upstream of its confluence with Ngagane) are the rivers most severely impacted by urban, industrial or mining developments. High salinity from acid mine drainage. Mercury contamination of groundwater (in vicinity of AECI factory adjacent to Ngagane River). Organic and faecal eutrophication - raw sewage spillage from western portion of Madadeni township. Sodium and Flouride pollution (near Ngagane Buffalo confluence, associated with Iscor). Taste and problems associated with chlorinated phenols (observed in the Horn and Ngagane rivers at Iscors raw water intakes). Catchment overstocked by 40% (ie 2 vs 5ha per LSU) = soil erosion and high turbidity.

Middle Buffalo River (V320) : The main water scheme is the Biggarsberg Regional Water Services, which obtains raw water from McHardy Dam (on the Sterkstroom), Verdruk Dam amd Mpati Dam and Tayside weir (on the Buffalo River). The main urban centers receiving water from the scheme are Madadeni and Osizweni (located adjacent to the Buffalo River immediately downstream of the Ngagane confluence), Utrecht to the Dorpspruit), Dundee / Sibongile, Hattingspruit and Washbankspruit (located in the Mzinyashane River catchment). The catchment has a large rural population of 171 000, with a relatively high population density of 43 per km^2. Consul Glass (located near Dundee in the Mzinyashane River catchment) is the most significant industrial development. Six operating coal mines (Welgedact Utrecht and Umgala sections, Bergaskool and Welgedact Lignite in the Dorpspruit catchment, and Carnarvon and Springlake in the Mzinyashane River catchment)(*closed or not?*); eighteen dormant coal mines (one in the Dorpspruit catchment, twelve in the Mzinyashane River catchment and five on other smaller tributaries entering the Buffalo River); and seventeen closed coal mines (two in the Dorpspruit catchment, twelve in the Mzinyashane River catchment and three on smaller tributaries of the Buffalo) are located in the Middle Buffalo catchment.

The Middle Buffalo River is about 70% over stocked with livestock. Mzinyashane River system is the most severely affected by acid mine drainage from coal mining activates. The eutrophication of streams downstream of coal mining areas is thought to be attributable to the relatively high nitrate and phosphate concentrations present in the acid mine drainage. It has been reported that organic pollution downstream of Dundee resulting in replacement of the normal fauna by worm-midge (Tubifex-Chironomus). High COD levels (up to 362 mg/l) in Dundee's treated sewage effluent samples recently (1993) collected by the DWAF's Dundee office indicates that this situation could still persist. Nutrient rich effluent from the Madadeni and the Osizweni STWs together with runoff from these urban areas and the densely populated informal development that has sprung up between these two urban areas contributes to the reported severe eutrophication of the Buffalo River during low flow conditions between the Ncandu confluence and de Jagersdrift (which is upstream of the road bridge on the R33 Dundee - Vryheid road near the Buffalo - Eerstelingspruit confluence. High turbidity also occurs in the Buffalo River. The Buffalo River at Vaalbank weir (hydrological station V3H015) immediately downstream of the Dorpspruit is severely salinized, with peak TDS concentrations reaching 700mg/l. High sulphate concentrations point to acid mine drainage sources in the Dorpspruit catchment and from upstream sources in the V310 catchment. However, equally high sodium and chloride concentrations indicate significant contributions from other sources as well. High sodium concentrations (up to 144mg/l together with episodes of high fluoride concentrations (up to 4,4mg/l) point to Iscor as the likely source.

Lower Buffalo River (V330) : The Nqutu Regional Water Services abstracts raw water from the Buffalo River near hydrological station V3H001, just downstream of the Bloed River confluence. The rural population density is high, at 79 per km^2. The catchment appears to be about 107% over stocked with livestock. General degradation of catchment vegetation, leading to soil erosion and high river turbidity, and organic pollution are the most prominent impacts on surface water quality.

Lower Tugela / Nsuzi River (V400) : Kranskop is the only significant urban development in the Nsuzi catchment. The rural population density of 60 per km^2 is relatively high. The livestock numbers are about 85% higher than the sustainable carrying capacity of the catchment. Turbidity and organic pollution problems can be anticipated.

Lower Tugela River (V500) : The main urban centres are Sundumbili, Mandeni, Tugela Rail and smaller villages supplied with water by the Tugela Development Services Board *(at that stage – now the district municipalities)*. Sappi Kraft's Mandeni Paper Mill and Isithebe Industrial Estates are the main industrial developments. The rural population density is the highest in the Tugela Basin (101 per km^2). Livestock densities are the lowest in the Tugela basin and appear to be well within the carrying capacity of the catchment. Afforestation covers about 15% of this sub-catchment area. Sappi's plant effluent discharged to the Tugela River is characterized by high BOD, COD, OA, suspended solids, sodium levels, colour problems and high temperatures of up to 46°C. Problems have been experienced with the drop in dissolved oxygen (DO) in the Tugela River downstream of Sappi's effluent discharge. During drought times water has to be released from Spioenkop Dam to provide additional dilution of the lower Tugela River to counteract the drop in DO. Mandeni Sappi themselves have complained of severe turbidity problems at their raw water intakes. Sappi has also indicated that during a flood event in October 1993, the suspended solids present in the Tugela River reached 3,5% to 4,0%, resulting in siltation of the sedimentation tanks and the total shutdown of the paper mill. Chloride peaks of he order of 100mg/l during the height of the last drought were also reported to have caused problems for the plant. The Polmon database revealed high electrical conductivity (up to 1700 mS/m), sodium, and COD levels in the Mandeni River upstream of Sappi's second discharge point, presumably attributable to pollution sources at Isithebe Estates.

2.1.5 Environmental Aspects

The following environmental concerns were also raised in a specially dedicated report on the evaluation of various dam sites in the whole catchment and associated schemes :

- Existing Tugela-Vaal Transfer Scheme Canal from Driel Barrage - insufficient consideration of social impacts during construction – unhappiness with local inhabitants.
- The possibility of tapping water from the TVTS systems. Policy at the time not to allow this (ie expensive water).
- Water resources need to be well managed to encourage and support recreation, conservation and tourism (resorts).
- Black fly infestations may occur in the Thukela if the river system is not managed properly.
- Biological translocations of fish and other noonoos through the TVTS into the Vaal River System.
- Wetlands need protection.
- Land tenure planning and associated pressure on natural resources must be conducted well in order to avoid soil erosion and silting of the rivers and dams of the Thukela catchment.

2.1.6 Development Options at Reconnaissance Level

In planning the potential further development of the water resources of the Thukela River Basin, 73 dam sites were identified and investigated. During the Reconnaissance study these number of dam sites were reduced to 26 and eventually 17.

2.1.7 Economic Analysis at Reconnaissance Level

An economic analysis further reduced the 17 sites to 4 scheme layouts (with approx 3 dam sites in each layout). These recommendations were then referred to a more intensive and focussed Pre-feasibility Study.

2.2 Vaal Augmentation Planning Study : Tugela-Vaal Transfer Scheme : Pre-Feasibility Phase

At the end of the Reconnaissance Phase it was found that water delivered via the so-called southern tributary component of the TVTS to the Vaal River System would be cheaper than water from other VAPS alternatives (ie Lesotho Highlands Project further phases; the Orange-Caledon River scheme; and the Umzimvubu Transfer Scheme). Furthermore, the TVTS was the only scheme that could be implemented in time to meet the 2006 Vaal River System augmentation deadline that existed at that time.

The Pre-feasibility Phase study was then conducted and in turn identified the two most attractive schemes which could be developed separately or in combination. The Southern Tributary Transfer Scheme (STTS) could deliver 12,8 m^3/s for transfer via the existing Drakensberg Pumped Storage Scheme. The Northern Tributaries Transfer Scheme (NTTS) could deliver 22,0 m^3/s via a transfer pumping station at Chatsworth (Braamhoek). The NTTS was found to be less economical than the STTS option.

2.3 Vaal Augmentation Planning Study : Tugela-Vaal Transfer Scheme : Interim Phase

At the end of the Pre-feasibility Phase, a number of uncertainties about the layout of the STTS still existed and it was decided to address these in a so-called Interim study to ensure that a properly defined option could be taken through to the Feasibility Phase that was scheduled to follow.

During this process it was decided that a combination of the STTS and the NTTS be recommended. The so-called Thukela Water Project was formulated (ie a major dam on the mainstem of the Thukela near Ladysmith at the Jana or Klip sites; a major dam on the Bushmans River just upstream of the Weenen Nature Reserve [Mielietuin site] and a canal aqueduct from the two selected dam sites back up to the existing Kilburn Dam.

2.4 Thukela Water Project: Feasibility Phase

A full Feasibility Study was conducted into the viability of the Thukela Water Project between 1997 and 2000. Initially it was found that the Jana Dam site was the most technically and economically viable. Some environmental concerns (ie destruction of the natural valley environment) still existed. The Jana and the Mielietuin dams were then investigated at a reasonably detailed level and the aqueduct options (canal or pipeline) considered at a normal feasibility level.

The results emanating from this study indicated that the TWP was indeed viable from all perspectives. The deadline of the next augmentation of water supplies to the Vaal River System has subsequently shifted out from 2006 to beyond 2020 for various reasons. DWAF is now conducting a low key Thukela Water Project Decision Support Phase, which is wrapping up any loose ends associated with the project and packaging the project for easy start-up when it is indeed required somewhere in future (could be 2025 or much later depending on whether the Lesotho Highlands Water Project Phase II is to supercede the Thukela Water Project or not).

2.5 Other Relevant Water Resource Related Planning Studies

Numerous other reports on studies within the WMA have been perused. Issues from these studies have been highlighted in **Table 2.1**.

Table 2.1: Issues raised in other Thukela WMA studies.

Document No.	Title	Issue
V000/00/0284	Sentraal -Tugela - wateroordragskema : voorlopige ondersoek na ′n gesamentlike skema met Eskom	Operation of Tugela Vaal Transfer Scheme of strategic importance. Security of supply to the Vaal needs to be assured.
V000/00/0686	Hydrology of the Tugela Basin: volume A: :text	Calibration of gauging weirs and hence the reliability of base data needs to be improved.
V000/00/0385	Investigation into the irrigation potential of the Tugela catchement area -MBB	Study claims that there is 340 000ha of irrigable land in the catchment (not clearly shown on map). Also claims that 146 500ha will be utilized by 2020 and that this would amount to a system utilization of $644*10^6$ m^3/annum (based on 4354 m^3/ha/annum).
V000/xx/0195	Thukela basin investment strategy: Preliminary feasibility study - Deloitte & Touche	Stated that there was a USA loan offer of US$500 million in 1994 for investing in the Thukela region. Strategy proposed by the consultant was to follow the Tennessee Valley example and concentrate on boosting manufacturing for export, mining and agriculture, and agro-industry. It also suggested that a form of water transfer levy be imposed on the TVTS to plough something back into the Thukela River catchment.
Various reports	Ladysmith flooding	Various options to attenuate flooding in Ladysmith: ie Mt Pleasant Dam (Qeduzisi); use of wetlands and small dams; land use; canal system through Ladysmith.
V100/xx/0189 V100/xx/0195	Waayhoek and Braamhoek pumped - storage schemes : Feasibility report - Eskom	Eskom proposals that could tie in with the proposed Northern Tugela Transfer Scheme described above.
V200	Various Reports on the Mooi river and transfer to the Mgeni	All the various transfer options considered. Priority was given to the Mgeni above the proposed transfer to the Vaal River.
V300/xx/0177	Preliminary hydrogeological assessment of channel alluvium in the Buffelsrivier to the west of Nqutu - Loxton Hunting	Alluvial groundwater scheme proposed to supply Nqutu.
V500/xx/0281 V500/xx/0181	Feasibility study of 1200 MW Mvumase pumped storage scheme on Lower Tugela - Escom Volumes 1 & 2	Not sure what has become of these planning proposals.

ANNEXURE B: REGISTERED DAMS IN THE THUKELA WMA

Quaternary catchment	Dam Name	Purpose	Capacity (million m3)	Full supply area (km2)
V11C	KILBURN	Hydro Power	35.56	1.95
V11C	KILBURN-OMGEWINGS NO.3-	Leisure	0.318	0.06
V11F	SHAMROCK	Irrigation	1.37	0.52
V11J	DRIEL BARRAGE	Domestic Water Use	8.694	2.99
V11J-	WOODSTOCK	Domestic Water Use	380.4	29.15
V11L	ACTON VALLEY	Irrigation	1.04	0.5
V11L	FAIRFIELD	Irrigation	0.24	0.12
V11L	ROODEBULT	Irrigation	0.22	0.05
V11L	SPIOENKOP	Domestic Water Use	279.63	15.38
V11L	ZUURLAGER DAM NO 1	Irrigation	0.25	0.1
V12A	FOUR WINDS	Irrigation	0.09	0.03
V12E	BRINLEY	Irrigation	0.15	0.11
V12E	LOWER ARCADIA NO 3	Irrigation	0.054	0.02
V12F	ARCADIA BIG	Irrigation	0.126	0.02
V12F	BROOKFIELD	Irrigation	0.1	0.03
V12F	KRANTZKLOOF	Irrigation	0.1	0.02
V12F	MARIAS HEUWEL NO. 1	Irrigation	0.064	0.03
V12F	MARIAS HEUWEL NO. 2	Irrigation	0.051	0.02
V12F	WINDSOR	Domestic Water Use	0.77	0.83
V13B	BELL PARK	Irrigation	7.5	1.05
V13B	CLYDESDALE BIG	Irrigation	0.242	0.09
V13B	CLYDESDALE TREE	Irrigation	0.05	0.03
V13B	DRAKENSBERG SUN	Leisure	0.38	0.08
V13B	ERASMUS	Irrigation	0.2	0.02
V13C	DANKBAAR DAM NO 3	Irrigation	0.2	0.04
V13C	GLENSIDE DAM NO. 1	Irrigation	0.137	0.04
V13C	GROOTDRAAI	Irrigation	0.6	0.16
V13C	NOODHULP	Irrigation	0.135	0.05
V13C	NTSINGINSHANI	Irrigation	0.4	0.1
V13C	PIVOT	Irrigation	1.53	0.39
V13C	TEVREDE DAM NO 2	Irrigation	0.6	0.12
V13C	VAALBANK	Irrigation	0.2	0.02
V13D	GLEN GRAY	Irrigation	0.433	0.12
V13D	HONGERSPOORT N0.1-	Irrigation	0.075	0.02
V13D	HONGERSPOORT NO.2-	Irrigation	0.175	0.05
V13D	HONGERSPOORT NO.3-	Irrigation	0.125	0.04
V13D	MEERSIG RIVER	Irrigation	0.23	0.09
V13D	VALHALLA	Irrigation	0.24	0.05
V13D	VENTERSSPRUIT	Irrigation	0.07	0.06
V13D	VENTERSSPRUIT SILT TRAP	Irrigation	0.08	0.05
V13E	GRUNAU DAM NO. 1	Irrigation	0.15	0.06
V13E	GRUNAU DAM NO. 2	Irrigation	0.15	0.06
V13E	MARA STRYDPOORT	Irrigation	0.67	0.37
V13E	RUSTENBURG NO. 1-	Irrigation	0.05	0.02
V13E	RUSTENBURG NO. 2-	Irrigation	0.08	0.03

V13E	RUSTENBURG NO. 3-	Irrigation	0.09	0.03
V13E	RUSTENBURG NO. 4-	Irrigation	0.15	0.04
V13E	RUSTENBURG NO. 7-	Irrigation	0.18	0.05
V13E	RUSTENBURG NO. 8-	Irrigation	0.05	0.02
V13E	THE GRANGE	Irrigation	0.15	0.05
V14A	DOORNKOP TOP	Irrigation	0.485	0.2
V14C	EMPANGWENE	Irrigation	0.43	0.16
V14D	SUNNYSIDE	Irrigation	0.25	0.03
V20A	BRAMLEIGH FARM	Irrigation	0.223	0.05
V20A	DRAYTON	Irrigation	0.13	0.05
V20A	Dummy dam	Irrigation	2.1	2.14
V20A	EXCELSIOR	Irrigation	0.063	0.03
V20A	INVERMOOI LAER	Irrigation	0.175	0.08
V20A	INVERMOOI UPPER	Irrigation	0.15	0.07
V20A	RIVERSIDE TOP	Irrigation	0.09	0.04
V20A	SILVERDALE	Irrigation	0.108	0.04
V20A	SOUTAR'S HILL	Irrigation	0.086	0.03
V20B	AIRSTRIP	Irrigation	0.2	0.08
V20B	BRAKVLEI	Irrigation	0.345	0.09
V20B	BURN	Irrigation	0.18	0.08
V20B	DEFENCE	Irrigation	0.45	0.24
V20B	DEFENCE PUMP	Irrigation	0.185	0.05
V20B	EAST MESHLYNN HOUSE	Irrigation	0.075	0.06
V20B	EAST MESHLYNN TOPS	Irrigation	0.062	0.03
V20B	EREMIA	Irrigation	0.2	0.06
V20B	GRANCHESTER	Irrigation	0.266	0.08
V20B	KANGATONG	Irrigation	0.22	0.1
V20B	MESHLYNN BIG	Irrigation	0.6	0.06
V20B	MESHLYNN KLOOF	Irrigation	0.073	0.04
V20B	MOERAS VLEI	Irrigation	0.15	0.07
V20B	PROSPERITY	Irrigation	0.1	0.04
V20B	REDCLIFFE	Irrigation	0.15	0.08
V20B	REY	Irrigation	0.18	0.07
V20B	RONDAVEL	Irrigation	0.13	0.09
V20B	SOLITUDE	Irrigation	0.16	0.06
V20B	SOURVELDT	Irrigation	0.56	0.19
V20B	SPRINGVALE	Irrigation	0.15	0.08
V20B	STRAWBERRY	Irrigation	0.09	0.03
V20B	SWYTHERNBY	Irrigation	0.35	0.11
V20B	TEMBU	Irrigation	0.06	0.03
V20B	TRENT LODGE	Irrigation	0.06	0.02
V20C	FOREST LODGE	Irrigation	1.15	0.43
V20C	HLATIKULU	Irrigation	0.085	0.05
V20C	LITTLE FALLS	Leisure	0.115	0.06
V20C	POTATOES	Irrigation	0.05	0.03
V20C	STAGSTONES	Irrigation	0.22	0.08
V20C	TIGERHOEK DAM NO. 1	Irrigation	0.07	0.02
V20C	ZONK LAKE	Irrigation	0.45	0.3
V20D	AVON DAM NO. 1	Irrigation	0.15	0.05
V20D	BALLINA	Irrigation	0.05	0.02
V20D	BROEDERSHOEK	Irrigation	0.107	0.03
V20D	CARSHALTON	Irrigation	0.136	0.06
V20D	CRIEFF	Irrigation	0.182	0.07
V20D	CROMPTON	Irrigation	0.068	0.04

V20D	CROMPTON FOLD	Irrigation	0.07	0.03
V20D	DADS	Irrigation	0.45	0.06
V20D	DALCRUE	Irrigation	0.191	0.08
V20D	DANESFORT NO. 2-	Irrigation	0.2	0.08
V20D	DANESFORT NO. 4-	Irrigation	0.22	0.1
V20D	D'LORO	Irrigation	0.15	0.06
V20D	Dummy Dam	Irrigation	3.6	1.9
V20D	ELLISDALE	Irrigation	0.18	0.07
V20D	FOUNTAINVALE	Irrigation	0.097	0.05
V20D	HYTHEDGE	Irrigation	0.245	0.12
V20D	INCHBRAKIE	Irrigation	0.365	0.1
V20D	KILMASHOGUE	Irrigation	0.065	0.03
V20D	LAKESIDE	Irrigation	0.095	0.06
V20D	LIBERTY HALL	Irrigation	0.12	0.04
V20D	LOCHWOOD	Irrigation	0.08	0.03
V20D	OAKDENE	Irrigation	0.08	0.03
V20D	RIFLE RANGE	Irrigation	0.05	0.02
V20D	ROSETTA DAM II	Irrigation	0.08	0.02
V20D	SHELTERED VALE	Irrigation	0.13	0.05
V20D	SHERMILK	Irrigation	0.07	0.03
V20D	SHERWOOD DAM NO 1	Irrigation	0.189	0.12
V20D	STRATHEARN	Irrigation	0.15	0.05
V20E	BRAYHILL TOP	Irrigation	0.114	0.03
V20E	CRAIG NEVIN PUMP	Irrigation	0.05	0.01
V20E	DOORNKLOOF	Irrigation	0.18	0.06
V20E	GOOD HOPE	Irrigation	0.05	0.02
V20E	HADLOW	Irrigation	0.075	0.03
V20E	HAINAULT DAM NO. 1	Irrigation	0.18	0.08
V20E	HAINAULT DAM NO. 2	Irrigation	0.085	0.03
V20E	HILL	Irrigation	0.09	0.04
V20E	HONEYDEW DAIRIES	Irrigation	0.3	0.18
V20E	INVERNESS	Irrigation	0.17	0.07
V20E	ISLAND	Irrigation	0.185	0.11
V20E	KELVIN GROVE	Irrigation	0.201	0.09
V20E	LANGHOLM NO.1-	Irrigation	0.055	0.03
V20E	LANGHOLM NO.2-	Irrigation	0.055	0.02
V20E	LITTLE LOCH	Irrigation	0.42	0.06
V20E	LORD KENSINGTON BOTTOM	Irrigation	0.1	0.08
V20E	MAPLESTON	Irrigation	0.095	0.03
V20E	NEW DELL DAM NO. 1	Irrigation	0.22	0.08
V20E	NEW DELL DAM NO. 2	Irrigation	0.075	0.03
V20E	NIEKERKSFONTEIN	Irrigation	0.06	0.02
V20E	NORMANS	Irrigation	0.15	0.04
V20E	OAKLANDS	Irrigation	0.25	0.02
V20E	OAKSPRINGS	Irrigation	0.25	0.08
V20E	OATESDALE DAM NO. 1	Irrigation	0.07	0.02
V20E	OATESDALE DAM NO. 2	Irrigation	0.064	0.02
V20E	OATESDALE DAM NO. 3	Irrigation	0.06	0.02
V20E	PAAU	Irrigation	0.75	0.24
V20E	PLAINS	Irrigation	0.065	0.02
V20E	ROB'S	Irrigation	0.236	0.08
V20E	RONDEBOSCH	Irrigation	0.9	0.38
V20E	SAM'S	Irrigation	0.15	0.04
V20E	SHARROW	Irrigation	0.15	0.05

V20E	SINKWAZI	Irrigation	0.07	0.03
V20E	SUMMER HILL STUD	Irrigation	0.2	0.05
V20E	WARLEY COMMON	Irrigation	0.34	0.18
V20F	CRAIGIE BURN	Irrigation	23.43	2.07
V20F	DAIRY	Irrigation	0.252	0.07
V20F	GREENWICH	Irrigation	0.445	0.16
V20F	MOUNT ALIDA TOP	Irrigation	0.13	0.04
V20F	ROY'S	Irrigation	0.23	0.12
V20H	DOUBLE DIAMOND	Irrigation	0.165	0.05
V20H	Dummy Dam	Irrigation	4.94	2.4
V20H	WATERFALL	Irrigation	0.167	0.06
V31A	MARTINS	Domestic Water Use	0.295	0.02
V31A	ZAAIHOEK	Domestic Water Use	192.986	12.43
V31B	MAHAWANE	Domestic Water Use	2.1	0.51
V31C	DUMFIRMLINE	Irrigation	0.656	0.2
V31E	CHELMSFORD	Domestic Water Use	198.438	34.43
V31E	DURBAN NAVIGATION COLLIERIES DAM NO. 2	Domestic Water Use	0.091	0.09
V31E	DURBAN NAVIGATION COLLIERIES DAM NO. 3	Domestic Water Use	0.363	0.25
V31E	DURBAN NAVIGATION COLLIERIES DAM NO. 4	Domestic Water Use	0.399	0.2
V31E	DURBAN NAVIGATION COLLIERIES DAM NO. 7	Domestic Water Use	0.213	0.09
V31E	DURBAN NAVIGATION COLLIERY NO. 7 MINE SLURRY	Outflow	0.163	0.07
V31E	DURBAN NAVIGATION COLLIERY NO. 7 MINE SLURRY	Outflow	0.258	0.12
V31E	FAURE DAM 2	Irrigation	0.18	0.03
V31E	FAURE DAM NO 1	Irrigation	0.053	0.02
V31E	HAIG	Irrigation	0.22	0.06
V31E	STERKFONTEIN	Irrigation	0.197	0.09
V31F	KINGSTON-ROOI	Irrigation	0.249	0.08
V31G	ALBERTSE DAM NO. 4	Irrigation	0.3	0.05
V31G	BOYSKRAAL DAM NO. 1	Irrigation	0.16	0.04
V31G	DURBAN NAVIGATION COLLIERIES DAM NO. 1	Domestic Water Use	0.545	0.16
V31G	HATTINGSPRUIT DAM	Domestic Water Use	1.89	0.55
V31G	LANGLEY DAM NO. 2	Irrigation	0.25	0.04
V31G	LANGLEYDALE DAM NO. 3	Irrigation	0.3	0.02
V31J	BOSCHOEK WEIR	Domestic Water Use	0.255	0.1
V31K	AMCOR	Leisure	0.48	0.28
V32C	SANDSPRUIT IRRIGATION	Irrigation	0.123	0.08
V32D	BESPROEIINGS	Irrigation	0.25	0.1
V32D	KWAGGASDRIFT NO. 1	Irrigation	1	0.25
V32D	KWAGGASDRIFT NO. 2	Irrigation	0.2	0.1
V32E	ASHDENE DAM NO. 1	Irrigation	0.225	0.07
V32E	ASHDENE DAM NO. 2	Irrigation	0.054	0.04

V32E	DONALD McHARDY	Domestic Water Use	2.5	0.71
V32E	ELLIES GLEN	Irrigation	0.08	0.02
V32E	KLIPRAND	Domestic Water Use	0.24	0.11
V32E	LOWER MPATE	Domestic Water Use	0.128	0.02
V32E	PRESTON	Domestic Water Use	0.268	0.13
V32E	TOM WORTHINGTON	Domestic Water Use	1.9	0.55
V32E	UPPER MPATE	Domestic Water Use	0.264	0.05
V32E	VERDRUK	Domestic Water Use	0.809	0.29
V32G	A.F.C. MUHL MEMORIAL	Irrigation	0.75	0.34
V32G	HEYWOOD	Irrigation	0.236	0.11
V32G	WATER IRRIGATION	Irrigation	0.1	0.03
V40E	DOUGVALE	Irrigation	0.18	0.05
V50B	SILVERSTREAM	Irrigation	0.08	0.01
V50B	SILVERSTREAM DAM NO. 2	Irrigation	0.13	0.03
V50D	CROWN HILL	Irrigation	0.089	0.03
V50D	DUMBARTON	Irrigation	0.075	0.03
V60B	MIELIETUINHOEK	Irrigation	0.9	0.25
V60B	MON REPOS	Irrigation	0.05	0.02
V60B	QUAGGAS KIRK DAM NO 1 (KALLIE SE DAM)	Irrigation	0.321	0.06
V60B	QUAGGAS KIRK DAM NO. 2	Irrigation	0.09	0.02
V60B	UP GEORGE	Irrigation	0.155	0.03
V60B	WAAGSTUK	Irrigation	0.25	0.1
V60B	WATERFALL)	Irrigation	10.3	2.4
V60D	DAVELSVLAKTE DAM NO. 1	Irrigation	0.135	0.03
V60D	STRUISVOGELPOORT	Irrigation	0.023	0.01
V60D	VLEIPOORT	Irrigation	0.508	0.31
V60E	VALHALLA DAM NO 1	Information	0.09	0.03
V60E	VALHALLA DAM NO 2	Irrigation	0.062	0.03
V60E	VERMAAKSKRAAL	Irrigation	0.188	0.06
V60K	ALLENDALE LOWER	Irrigation	0.21	0.07
V70C	MERCURY	Irrigation	0.12	0.05
V70C	WAGENDRIFT	Irrigation	58.36	5.08
V70E	BAYHILL OAK	Irrigation	0.228	0.06
V70F	HILLANDALE	Irrigation	0.063	0.02
V70F	MTSHEZANA	Irrigation	0.51	0.15
V70F	OAKLANDS DAM NR. 2	Irrigation	0.15	0.04
V70G	MERTHLEY	Irrigation	1.138	0.74
V70G	TWYFELFONTEIN NO. 1-	Irrigation	0.122	0.02
V70G	TWYFELFONTEIN NO. 2-	Irrigation	0.153	0.02