APPENDIX 2

SYSTEM OPERATION REPORT
Haumann, K

TABLE OF CONTENTS

LIST OF TABLES

1. GENERAL BACKGROUND

Agricultural expansion and industrialization has necessitated the development of water resources structures in the Letaba catchment. Major water resources development has been taking place since the end of the 1950's on an ad hoc basis.

Most of the bulk water supply schemes used to operate on a demand basis. This has caused failure of the system in the past. To avoid such problems, farmers and water control officers used to impose water restrictions on conventional knowledge basis. This exposed the water users to prolonged periods of high risk and unnecessary severe and lengthy restrictions.

A comprehensive study was made on existing and possible water resources development in 1990 to maximize water availability by introducing innovative operating and control procedures. The need to maintain the river health or sustainability of riparian ecology, especially in the Kruger National Park, necessitates reevaluation of the water supply scheme. Water resources development affects the quantity and frequency of water flow down a river. The riparian ecosystem responds to the change by making some adjustment. However, if the hydrological change is beyond a threshold level that the river ecosystem can tolerate it may disrupt the ecological stability and diversity.

Ecological reserve requires low flow, maintenance flow and high flow to maintain a natural stability. In general, supplying these requirements without severely affecting other water users requires drafting and implementing of a water management plan that incorporates water demand and conservation measures along with efficient operational rules. Because most of the bulk water structures, as well as the weirs in Letaba catchment, have been constructed with minor consideration of riverine ecology, maintaining the high flows (flood) might not be only be a question of efficient water resources planning, but depends on the capability of the outlet structures to release a required amount of flow.

2. OVERVIEW OF THIS REPORT

The main aim of this report is to determine the operational characteristics of the main dams and weirs in the catchment together with their release capabilities, in order to assess the extent of their potential influence on the setting of the ecological water requirements in the various downstream river reaches.

3. GENERAL OPERATION OF THE SYSTEM

Broadly the Letaba water system can be group into four major subsystems. These are, the Dap Naude/Ebenezer/Mogoebaskloof/Tzaneen subsystem (Groot Letaba subsystem), Thabina (Letsitele and Nwanedzi) subsystem, Middle Letaba and Nsami Dam subsystem (Middle and Klein Letaba (B82)) subsystem, and Lower Letaba subsystem.

The first water system is in the Groot Letaba Subcatchment mainly along the Groot Letaba River. This is the subsystem where major economic activity takes place. Due to its major contribution to the hydrology of the whole Letaba catchment it has great significance to stability of riparian ecology in Kruger National Park.

The major Dam in the Letsitele and Nwanedzi subsystem is the Thabina dam on the Thabina River. The Middle Letaba and Klein Letaba subsystem consists of the Middle Letaba and Nsami Dams. Though there is no major water supply scheme in Lower Letaba there are three dams. The impact of these three dams on water resources is insignificant because there are no major activities in the area. However, their operation or outlet structure may affect the provision of high flows to downstream riparian ecology.

The Letaba River runs from the mountainous Heanertsburg area through the Ebenezer dam into the Tzaneen dam; a distance of some 30 kilometers, by way of a fast flowing stream. No major weirs are operational between the Ebenezer and Tzaneen dams except the two small weirs that divert water, which is released from Ebenezer Dam, from the river to irrigation farms. These weirs are George's Valley and Pusela.

Downstream, for over ± 120 kilometers, to the Kruger National Park (KNP), there are five weirs, namely:

The Yamorna Weir
The Junction weir
The Jasi weir
The Prieska weir
The Nondweni weir

These weirs are opened and closed by way of manually operated sluice gates, which are frequently blocked by trees, debris.

The weirs have limited capacity, having been in use from more than 20 years and subjected to silting up.

The weirs are opened and closed in order to relieve demands for water at any given time, usually at a point where the flow of the river gets too low to deliver 0.6 cumec to KNP, after primary, industrial and irrigation allocation (or rational allocations upstream) have been satisfied.

The objective is to obtain water from the nearest weir and then to "refund" the particular weir from weirs upstream and then eventually from the Tzaneen dam in order to conserve as much water in the over-allocated Tzaneen dam as possible, to lengthen the assured delivery.

These actions are activated through visual inspections and observations by the Letaba Water User Association's water bailiffs, and through messages from various sources along the river and interpreted in view of their (the bailiffs) long experience of the behavior of the river.

There are therefore no hard and fast operational rules.

The DWAF Regional Office has, up to now, been responsible for implementing the operating rules for Ebenezer and Tzaneen dams.

Application of the current operating rules is conducted as follows:

At the end of each month, the inflow is calculated by comparing the gauged level (current dam level) with the previous month's level, adding the released volumes and the calculated

evaporation. The last 12 months of the inflow record are then compared with the long-term history of inflow into the dam.

A primary reserve for domestic and industrial use sets the lower monthly limits below which no releases for irrigation will be made.

These trends are produced graphically on an Excel spreadsheet and discussed with the irrigators who apply their own restrictions during declining dam volumes in order to minimize the risk of reaching the minimum reserve levels.

According to the information obtained from WUA (water use association) executive officer there are about 150 pumping station from Ebenezer for about 150 km downstream. The water use record of each station is kept with the WUA.

4. BRIEF DESCRIPTION OF MAJOR WATER STRUCTURES IN LETABA CATCHMENT

4.1 DAP NAUDE/EBENEZER /MOGOEBAKSLOOF/ TZANEEN (GROOT LETABA) WATER SUBSYSTEM

Of each the four water systems, this subsystem has the highest economic activities. Most of the hydrology or flow in the Letaba catchment is generated in this subsystem, especially in quaternary catchments upstream of Tzaneen Dam.

This subsystem consists of four major dams and one balancing dam. A brief description of the operation and characteristics of the four major dams is incorporated in the following sections.

4.1.1 Dap Naude Dam

The dam is located in the upper reaches of the Groot Letaba, upstream of Ebenezer Dam. It has 2.1 million cubic meters full supply volume, which is about 18% of MAR. The purpose of the dam is exclusively to meet part of the domestic and industrial water demand of Polokwane via a 60 km gravity pipeline. The dam was commissioned in 1958 and is controlled and operated by Polokwane Municipality. The releases are controlled by a system of valves, which close automatically as soon as the service reservoir is full. A constant amount of 28 l/s (0.88 x $10^6 m^3/a$) is released from the dam as compensation.

The following table below shows the release from the dam from the year 1977 to 2001.

Table 4.1: Annual River releases and inflow of Dap Naude Dam.

Year	River Release (Ml)	Industry and town (Mi)	Gross Evapo (Ml)	Rain (Ml)	Streamflow (Ml)
1977/1978	1623	4693	78	22	975
1978/1979	3369	5204	189	238	8401
1979/1980	7846	4950	204	286	1232
1980/1981	16068	4395	188	356	14209
1981/1982	5112	5327	204	251	10067
1982/1983	860	5050	184	174	5418
1983/1984	1276	3933	196	222	5903
1984/1985	9660	2779	236	379	12383
1985/1986	7192	4102	251	351	11107
1986/1987	5953	3090	222	392	8731
1987/1988	15524	4345	208	515	19326
1988/1989	7054	5645	201	282	12294
1989/1990	5539	5203	210	357	10562
1990/1991	7780	5282	201	349	13279
1991/1992	559	3154	166	107	2864
1992/1993	328	3624	157	205	4012
1993/1994	448	3800	171	173	3449
1994/1995	991	3795	171	216	5123
1995/1996	20577	3910	184	424	16165
1996/1997	13297	3980	185	359	17482
1997/1998	4637	3610	224	315	7488
1998/1999	6315	3989	182	361	8546
1999/2000	38697	5331	169	342	24564
2000/2001	9400	4093	127	117	9698

4.1.2 Ebenezer dam

Storage capacity: 68,9 Mm^3 (125% of MAR)
Yield: 31Mm^3/a
Full supply level: 1353 m.a.s.l.
Minimum operation level: 1312 m.a.s.l.
Outlet capacity: 12,4 m^3/s through 2 x 610mm sleeve valves
Control: Manual / Hydraulic

Ebenezer dam is located at the confluence of the Helpmekaar and Broederstroom rivers on the Groot Letaba River. The dam was built to meet domestic water demands of Tzaneen and Polokwane and its environs as well as to provide for irrigation downstream. It is owned and operated by DWAF and it was built in 1959.

Water to Tzaneen is released directly into the stream and is pumped from an abstraction point some 15km downstream. Water supply to Polokwane is released to a purification works just below the dam from where it is pumped to a header reservoir before being gravitated to Polokwane.

Irrigation water is released downstream and is either abstracted by direct pumping from the river or by diversion to the George's Valley or Pusela Weirs, approximately 10km and 18km downstream of the dam respectively.

The following table shows the releases of the dam from 1959 to 2001

Table 4.2: Annual River releases and inflow of Ebenezer Dam.

Year	River Release (Ml)	Industry and town(Ml)	Gross Evapo (Ml)	Rain (Ml)	Streamflow (Ml)
1959/1960	9390	0	3373	1823	43838
1960/1961	25579	0	4121	4491	51521
1961/1962	36186	0	4846	2746	28612
1962/1963	31265	0	4470	3047	27598
1963/1964	50888	0	3380	1903	17045
1964/1965	28803	0	2636	2933	35534

Year	River Release (Ml)	Industry and town(Ml)	Gross Evapo (Ml)	Rain (Ml)	Streamflow (Ml)
1965/1966	43330	0	2332	1789	25629
1966/1967	19696	0	2028	1780	44859
1967/1968	40956	0	2425	1890	17085
1968/1969	25282	0	1798	1399	30935
1969/1970	26975	0	1610	1132	14413
1970/1971	2785	0	1171	783	5942
1971/1972	22968	0	2978	4286	84399
1972/1973	48	0	4014	3218	-30829
1973/1974	56825	182	3547	6324	87044
1974/1975	42352	2724	3784	5816	40769
1975/1976	43510	2508	3821	5351	45027
1976/1977	46602	3289	3868	4914	51788
1977/1978	81063	3357	3873	5242	82871
1978/1979	22303	2698	3926	4200	24123
1979/1980	34679	3404	3974	4572	38088
1980/1981	77336	3777	3728	6363	78555
1981/1982	27329	2684	3235	2402	24045
1982/1983	23448	5053	3689	2339	14285
1983/1984	24467	3073	2931	2816	13041
1984/1985	20385	3659	2872	3452	35070
1985/1986	22222	5708	3149	2784	25159
1986/1987	21727	5542	3294	3047	34039
1987/1988	37518	6813	3562	5078	59722
1988/1989	32603	8559	3825	3826	36822
1989/1990	25185	9242	3626	3965	30661
1990/1991	27178	9813	3761	4250	40548
1991/1992	20262	12982	3625	1370	10204
1992/1993	28562	11513	2709	2070	18927
1993/1994	12370	7741	1682	1360	12854
1994/1995	9602	7789	1463	1216	15512
1995/1996	13756	10613	2124	2064	37318
1996/1997	7020	11042	3526	5912	9504

Year	River Release (Ml)	Industry and town(Ml)	Gross Evapo (Ml)	Rain (Ml)	Streamflow (Ml)
1997/1998	13324	11176	4156	2310	13391
1998/1991	0	12211	3566	5682	0
1999/2000	0	10614	3435	5625	0
2000/2001	0	6467	2540	2504	0

4.1.3 Magoebaskloof dam

Storage capacity: 5,5 Mm^3
Yield: 4,92 Mm^3/a
Full supply level: 839 m.a.s.l.
Minimum operation level: 806 m.a.s.l.
Outlet capacity: 5,4 m^3/s through 2 x 381mm + 1 x 203 mm sleeve valves
Control: Manual / Hydraulic

Allocation from the dam totals 13.1Mm^3/a, which is broken down as follows:

Domestic use 2.034 Mm^3/a
Agricultural use 11.044 Mm^3/a

The Magoebaskloof Dam is located on the Politsi River, a major tributary of the Groot Letaba River. The Magoebaskloof Dam was constructed to supply urban and industrial consumers, members of the now disbanded Tzaneen Irrigation Board and Sapekoe. The latter two are irrigation water users. The Magoebaskloof Dam was originally intended to supply water for irrigation purposes only, however, the need later arose for domestic and industrial water in Politsi, Duiwelsskloof and Ga-Kgapane.

Water is released from the bottom outlets of the dam into a canal where it is conveyed to the users. Some of the irrigation users draw their water directly from the canal. The bulk of the water released from Magoebaskloof Dam is for irrigation. Water releases are therefore, to a large extent, dictate by irrigation needs.

The Magoebaskloof Dam was commissioned in 1971 and is owned and operated by the Department of Water Affairs.

The following table below shows the releases for the dam from 1971 to 2001

Table 4.3: Annual River releases and inflow of Magoebaskloof Dam

Year	River Release (Ml)	Irrigation (Ml)	Gross Evapo (Ml)	Rain (Ml)	Stream flow (Ml)
1971/1972	0	4814	508	923	67407
1972/1973	0	2922	524	415	2861
1973/1974	0	0	453	840	0
1974/1975	0	0	440	679	0
1975/1976	2595	0	464	631	0
1976/1977	45800	0	550	767	0
1977/1978	65691	0	578	770	0
1978/1979	12255	0	592	721	0
1979/1980	26507	0	580	1029	0
1980/1981	46289	3433	417	810	32302
1981/1982	12476	7752	409	411	16869
1982/1983	431	9782	405	266	7150
1983/1984	258	6147	210	216	4835
1984/1985	11458	5762	259	511	8817
1985/1986	8415	9082	427	487	15988
1986/1987	11229	6842	329	507	15504
19871988	42184	5823	191	760	18841
1988/1989	19442	7246	275	428	17060
1989/1990	18785	6081	305	547	21192
1990/1991	21976	6765	380	619	27121
1991/1992	246	8745	349	167	4874
1992/1993	44	4261	278	188	4505
1993/1994	4118	4713	380	353	8998
1994/1995	1733	5402	338	262	6766
1995/1996	47241	3220	306	957	39556

Year	River Release (Ml)	Irrigation (Ml)	Gross Evapo (Ml)	Rain (Ml)	Stream flow (Ml)
1996/1997	34645	3713	431	736	30523
1997/1998	14014	4639	423	291	10800
1998/1999	30026	3232	505	943	32800
1999/2000	115816	2430	453	407	35512
2000/2001	29808	3732	283	282	15563

4.1.4 Tzaneen Dam

Storage Capacity: 156 x $10^6 m^3$
Yield Capacity: 130 x $10^6 m^3/a$
Full supply level: 724 m.a.s.l.
Minimum operation level: 694 m.a.s.l.
Outlet capacity: 18,5 m^3/s through 2 x 914 mm + 1 x 381 mm sleeve valves
Control: Manual / Hydraulic

Tzaneen Dam was constructed mainly to meet the irrigation water demands along the Groot Letaba River valley. The irrigation water is released directly to the Groot Letaba River by means of a system of pipe outlets. The released water is abstracted directly from the river by pump irrigators and also diverted from the river by diversion weirs. The weirs also serve of providing reserve storage and the water is conveyed from these weirs to the irrigators by means of a bulk water supply canal.

Tzaneen Dam was commissioned in 1977 and is owned and operated by the Department of Water Affairs.

The following table below shows the releases for the dam from 1977 to 2001.

Table 4.4: Annual River releases and inflow of Tzaneen Dam.

Year	River Release (Ml)	Irrigation (Ml)	Industry and town (Ml)	Gross Evapo (Ml)	Rain (Ml)	Streamflow (Ml)
1977/1978	291826	12752	0	14411	742	28319
1978/1979	65812	16739	0	13986	9326	34912
1979/1980	81451	21295	0	12435	12872	106081
1980/1981	251366	31518	0	13351	17364	287790
1981/1982	76394	28665	0	13579	8930	66634
1982/1983	75185	26267	0	9151	4173	24342
1983/1984	23213	21025	0	3978	2941	23282
1984/1985	8965	17580	0	4569	3436	55647
1985/1986	31434	22889	0	5442	3946	48622
1986/1987	25352	24139	0	5242	3792	46216
1987/1988	21256	19528	0	8675	7657	155593
1988/1989	71382	26886	0	13044	7428	79635
1989/1990	38048	27648	0	12284	12473	77837
1990/1991	56511	32494	377	10585	10941	89028
1991/1992	79618	36128	855	11110	2921	20356
1992/1993	22345	28033	1328	3386	1562	25993
1993/1994	15074	9741	32	2185	1221	26098
1994/1995	6312	10938	0	1031	509	15973
1995/1996	17433	14000	634	7018	9301	182929
1996/1997	193105	23023	706	12989	12730	105896
1997/1998	84971	25037	518	14509	5074	51622
1998/1999	141268	22647	886	11962	15589	200604
1999/2000	717324	12775	918	12217	9814	276375
2000/2001	180053	12761	804	13225	6017	151817

4.2 LETSITELE AND NWANEDZI SUB CATCHMENT

There is only one major dam in this subsystem. Assessment has been made in the past to investigate the potential of surface water development. However, all the potential alternatives found to be economically unfeasible. According to the DWAF report on the Groot Letaba Water resources development *(PB B810/00/0398)* the total small farm storage dam in the Letsitele catchment is estimated to be 2.2 million cubic meters.

4.2.1 Thabina Dam

Thabina Dam commissioned in 1984. It has a full supply capacity of 2.6 million cubic meters (30% MAR). The main function of this dam is to supply domestic water for villages in the Lebowa district. Water release from this dam is regulated automatically with the assistance of a water level in the service reservoir of the purification works.

4.3 MIDDLE AND KLEIN LETABA SUBCATCHMENT

4.3.1 Middel Letaba Dam

Storage Capacity: 179 x $10^6 m^3$
Full supply level: 534 m.a.s.l.
Minimum operation level: 516 m.a.s.l.
Outlet capacity: 5,0 m^3/s through 2 x 900mm sleeve valves
Control: Manual / Hydraulic

The Middle Letaba Dam is located on the Middle Letaba River about 7 Km upstream of the confluence of the Middle and Klein Letaba rivers. The dam was constructed to meet irrigation, domestic and stock water demands. Domestic water from the dam also augments water supplies from Hudson Ntsan'wisi Dam (now called Nsami Dam) located throughout Giyani area in the northern province.

The Middle Letaba Dam was commissioned in 1984 by Department of Water and Forestry. Water required to meet both irrigation and domestic water demands is released from the dam via an outlet tower and outlet works from a canal.

The following table below shows the releases for the dam from 1986 to 2001

Table 4.5: Annual River releases and inflow of Middle Letaba Dam.

Year	River Release (Ml)	Irrigation (Ml)	Industry and town (Ml)	Gross Evapo (Ml)	Rain (Ml)	Streamflow (Ml)
1986/1987	18	12802	0	6665	2498	20786
1987/1988	51	14693	0	11896	4443	61750
1988/1989	21	24585	97	12017	2896	3439
1989/1990	90	23363	189	8562	3420	14845
1990/1991	76	25242	199	9220	380	1333
1991/1992	18	23826	60	7919	519	2565
1992/1993	44	13196	0	5674	801	0
1993/1994	1	16507	0	4245	1026	0
1994/1995	17	12590	0	4936	152	0
1995/1996	62	17235	0	12571	3137	0
1996/1997	91	18880	0	22148	4356	0
1997/1998	99	28787	0	21219	4797	0
1998/1999	116	19047	0	167340	7465	0
1999/2000	318000	15284	0	18257	10157	0
2000/2001	5466	20762	0	22288	8697	0

4.3.2 Nsami Dam

(Previously called Hudson Ntsan'wisi Dam)

Storage Capacity: 29,5 x $10^6 m^3$
Full supply level: 445 m.a.s.l.
Minimum operation level : 437 m.a.s.l.
Outlet capacity: 2,1 m^3/s through 900 mm disc valve
Control: Manual
Nsami Dam is located on the Nsami River, a major tributary of the Klein Letaba River. The dam is sited about 10 km north of Giyani. The Dam was initially intended to supply water mainly for domestic use. Water is drawn from Nsami Dam to irrigate some of the hectors located downstream of the dam. Irrigation is drawn from Nsami Dam through the bottom outlets and discharge to an Irrigation canal located downstream of the dam.

Nsami Dam was commissioned in 1976 and is owned by the department of works.

4.4 LOWER LETABA SUBCATCHMENT

There are three dams in this catchment. The two dams, Black Heron and Mingerhoutstuwal Dam, are found upstream of IFR7 site. Black Heron and Mingerhoutstuwal dam have capacities of 0.03 million cubic meters and 0.02 million cubic meters respectively. These dams are used for game watering, have no outlet capacity and act as weirs. The third dam,

Charles Engelhout dam, is found further downstream. It is used for game watering and has no release capability.

5. SUMMARY

Most of the dams' outlets in the Letaba catchment appear to be capable of releasing the maximum flood required by IFR sites downstream except for Middle Letaba Dam (See table (5.1)). The maximum flow required by IFR5 is 10.45 m^3/s while as the maximum flow that can be released through the outlet of Middle Letaba Dam is 5.4 m^3/s. As shown in table (5.1) the outlet capacity of the dam is also below the flood required under class I flood range.

Water release to Kruger National Park from Groot Letaba catchment measured at Letaba Ranch (Gauging station B8H008). DWAF controls the release of accurate amount of water. Releasing flood does not appear to be a problem during high flood because there are two big flap gates on the left and right bank of Nondweni weir, which let flood pass with out creating big sedimentation problem in the weir. However, during low flow Prieska weir appears to be critical. This weir is almost silted up. In some cases air compressor is used to clean up the outlet from downstream so that water can be released downstream.

As long as there is sufficient water from upstream the two small dams in lower Letaba cannot be major constraints in provision of instream flow requirement.

Though the outlets of most dams seem capable to release maximum flood required by IFR sites downstream, a thorough investigation of their present status is required to draw realistic conclusion. That is, age associated problems (wear and tear of gates) and sedimentation can be determinate factors in operating and controlling of water supply schemes.

Table 5.1: Flood class ranges (m^3/s) and the maximum capacity of Dams just upstream.

IFR	I	II	III	IV	V	Maximum Flood Required under Pristine condition (m^3/s)*	Maximum Cap. Of Dam Upstream (m^3/s)
1	1.2 -2.5	2-5	4.5-10.5	20-28	43-94 (1:5)	4.16	
2	2.5-4	3.5-6	15			4.19	Thabina Dam 4.5
3	6-10	12-18	50-90	150-220		15.85	Tzaneen Dam 18.5(Restricted) 42 (unrestricted)
4	4-8	10-22	60-80	250-420	650-1000(1:10)	29.21	Tzaneen Dam 18.5(Restricted) 42 (unrestricted)
5	8-12	14-25	60-126	175-480		10.45	Middle Letaba 5.4
6	5-8	10-27	80-150	300			
7	5-8	10-27	80-150	300		23.38	

N.B: * Taken from the IFR requirement generated using desktop method.

Table 5.2: Summary of Characteristics of Major Dams in Letaba Catchment.

Dam	Relevant IFR site	FS Capacity (million cu.meters)	FS Level (m)	Min Op. Level (m)	Main Fun.	Outlet Capacity (m^3/s)	Outlet Type	Size (mm)	Ownership	Year of Cons.
Dap Naude	IFR1	2.1			Domestic				Polokwane Municipality	1958
Ebenezer		70	1353	1312	Irr. & Domestic	12.4	Sleeve valve	2X610mm	DWAF	1959
Magoebaskloof		5	839	806	Irr. and Domestic	5.4	Sleeve valve	2x381mm 1x203mm	DWAF	1971
Tzaneen	IFR3 & 4	158	724	694	Irr and Domestic	18.5(Restricted) 42 (unrestricted)	Sleeve valve	2x914mm 1x381mm	DWAF	1977
Thabina	IFR2	2.6	785	749	Domestic	4.5	Sleeve valve	1X610mm		1984
Middle Letaba	IFR5	184	534	516	Irr. , stock and domestic	5.4	Sleeve valve	2x900mm		1984
Nsami		24.4	445	437	Domestic	2.1	Self centered disc valve	1X900mm		1976

REFERENCES

The Groot Letaba Water Resources study Report: Feasibility Study Report: Volume 2: Water requirement and system analysis: DWAF Rep., PB B810/00/0398.

The Groot Letaba Water Resources study Report: Feasibility Study Report: Volume 1: Main Report: DWAF Rep., PB B810/00/0298.

Water Resources Planning of the Letaba River Basin: Study of the development Potential and Management of the Water Resources. Basin Study Report: Annexure 21: Operation of major Water Control Structures: DWAF Rep., P B 800/00/2390