LESOTHO HIGHLANDS DEVELOPMENT AUTHORITY

FLOW RELEASES DOWNSTREAM OF

THE LESOTHO HIGHLANDS WATER PROJECT (LHWP) STRUCTURES

(October 2002 to March 2003)

TOWER ON MALIBAMATŠO RIVER @ KAO

JULY 2003

OPERATIONS AND MAINTENANCE GROUP

Operations Planning
Branch - HYDROLOGY
SECTION

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EXECUTIVE SUMMARY

This Report: “Flow Releases Downstream of the Lesotho Highlands Water Project (LHWP) structures – July 2003” provides an update of the amounts of water that have been released downstream of the four operational structures of the LHWP (i.e. Katse Dam, ‘Muela Dam, Matsoku Diversion Weir and Tunnel and Mohale Dam) from October 2002 to March 2003.

The report indicates that 276.830 MCM (17.605 m^3/sec) has been released (including spillage) from the Katse Dam. The IFR Policy that was approved on the 13th December 2002 indicates the Bulk release from Katse Dam of 66.9 MCM per year (2.1 m^3/sec). It can therefore be seen that the total downstream releases from Katse Dam far exceeds the IFR Policy Bulk releases. Table 1 in the text also shows that the average release from October 2002 to March 2003 has been well in excess of IFR Policy Requirements. 2.359 MCM (0.15m^3/sec) has been released from ‘Muela Dam.

It is estimated that the total flow downstream of the Matsoku weir and tunnel is 23.619 MCM (1.502 m^3/sec). For Mohale Dam, the flow released downstream from impounding date of the 1st November 2002 up to March 2003 was 21.996 MCM (1.39 m^3/sec)

Overall, the above flow releases from the LHWP two operational structures, (Katse Dam and Matsoku Diversion Weir and Tunnel) have been consistently higher than the recommended target releases while ‘Muela Dam has only released the Nqoe mean annual runoff. Mohale Dam is still in its impoundment phase.

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FOREWORD

The first Report “Flow Releases Downstream of LHWP structures” as published in April 2002 is to be updated every six (6) months. The Treaty specifies the minimum amounts of water that must be released downstream of the LHWP Reservoirs as discharge in cubic metres per second (m^3/s) and as volume in Million Cubic Metres (MCM) before the IFR Policy was approved during December 2002

This report provides an update of records from January 2003 to March 2003. However it publishes records from October 2002 that are included in the previous report to cover the six (6) months and to adjust the future reporting that is to suit the Hydrological Year.

It is noted that there are some developments that have occurred regarding the compensation valve capacity and operations for Katse Reservoir to – date, however, this report is restricted to the developments, which occurred within the period October 2002 to March 2003, which is the period covered in this report. All other developments achieved outside this period will be reported on in the next reporting cycle, which will be April to September 2003.

The In – stream Flow Requirements (IFR) Policy that looks into the well being of the river reaches through appropriate and adequate amounts of water releases downstream of LHWP structures was approved on the 13th December 2002. The Policy stipulates the planned Bulk releases of 66.9 MCM per year from Katse Dam, 31.9 MCM per year from Mohale Dam and 34.4 MCM per year from Matsoku Diversion Weir and Tunnel. Muela Dam has to release its annual mean runoff.

This report is therefore published to check if both the Treaty requirements and the planned IFR releases are met. It is thus

deduced that all the Treaty requirements as well as IFR releases were satisfactorily met and exceeded for the period October 2002 to March 2003.

INTRODUCTION

The Report “Flow Releases Downstream of the Lesotho Highlands Water Project (LHWP) structures” is being published to provide a record of flow volume, in Million Cubic Metres (MCM), released downstream of the existing and operating LHWP structures for the six (6) months period. The operational structures that are being reported on are the Katse Dam, the 'Muela Dam, the Matsoku Diversion Weir and Tunnel and the Mohale Dam.

Katse Reservoir started impoundment in October 1995 when the two Diversion Tunnels that were used to pass water downstream were closed. Construction was still in progress at that stage and impoundment was thus restricted to rise at a pace lagging behind construction.

The discharge facilities at Katse Dam are composed of a ten (10) bay spillway with a crest level of 2053 metres above sea level (masl) designed for a Probable Maximum Flood (PMF) of 6252 m^3/s at a surcharge level of 7.2 m above its crest. There are two (2) Low - Level Outlets (LLOs) at an elevation of 1938 masl, each with a capacity of 422 m^3/s at Full Supply Level (FSL). Each LLO has one emergency gate and one radial gate installed in series. A third discharge facility consists of a compensation pipe capable of discharging between 300 to 800 litres per second through a sleeve valve and the fourth discharge facility consists of a Mini – Hydro pipe capable of discharging the maximum up to 0.5 m^3/s.

The ‘Muela Dam is provided with a compensation pipe with a capacity of 0.4 m^3/s and one bottom outlet (sleeve) valve capable of discharging 7.6 m^3/s at full supply level. The spillway is designed for a PMF of 584 m^3/s.

Matsoku Diversion Weir and Tunnel was inaugurated and commissioned on the 26th October 2001. That is, Matsoku became operational from its inauguration date. The weir is equipped with a tunnel facility to transfer water from Matsoku River to Katse Reservoir. The facility has been designed such that all the flows up to 0.60m^3/s (600 litres per second) pass through a discharge valve downstream. Water in excess of 0.60 m^3/s is diverted via the tunnel into Katse Reservoir up to a maximum of 47 m^3/s. All amounts of flow in excess of 47 m^3/s will then spill downstream over the weir. This weir has, therefore been transferring water since its inauguration and commissioning date, 26th October 2001.

Impoundment of Mohale Dam began on the 1st November 2002 with the lowering of the stoplogs to close the second diversion tunnel. The first diversion tunnel had been plugged in 2002. Initially water was released through valves built into the stoplogs until the reservoir rose to sufficient level (1985.0 masl) to allow safe releases through the Low Level Outlet (LLO) system and then once the reservoir level reached 2005.0 masl through the compensation pipe work and the LLO. Any release through the stoplogs has to be piped through the concrete plug being constructed to permanently close the tunnel behind the stoplogs; the pipe will be blocked once the plug has cooled and has been grouted.

The LLO leads to a 1400mm sleeve valve, which can safely discharge between 5 m^3/s and 36 m^3/s at 1985.0 masl, and between about 10 m^3/s and 65 m^3/s at full supply level.

The compensation pipe work leads from a series of intake valves at 10m vertical intervals in the compensation intake structure to a bifurcation, one branch terminating in a 200mm sleeve valve and the other in a 500mm sleeve valve, allowing safe releases in the range 0.1 m^3/s to nearly 5 m^3/s at the 2005.0 masl reservoir minimum operating level. (There is also a connection built in for a future mini-hydro set currently closed by a blank flange.)

A 200mm bypass allows water from the LLO system to be discharged into the compensation pipe work. The dam is protected by a 50m wide free discharge ogee spillway at 2075 masl.

This report provides information on the quantity of water that has been discharged downstream of LHWP structures from October 2002 to March 2003. Firstly, the chronology of events and the summaries of flow releases as well as the figures and the tables for each of the four operational structures are presented. Finally, conclusions and recommendations are also presented.

1.0 CHRONOLOGY OF EVENTS AND SUMMARIES OF FLOW RELEASES FROM THE FOUR OPERATIONAL STRUCTURES.

1.1 Chronology of Events of the Katse Dam:

1.1.1 Compensation Outlet

The sleeve valve of the compensation pipe at the Katse Reservoir had been designed to safely discharge water within the range of 0.3 m^3/s to 0.8 m^3/s for reservoir levels ranging from Minimum Operating Level (MOL) to Full Supply Level (FSL). This valve is, however, capable of discharging 1.897 m^3/s under FSL conditions but it is recommended that this should only be done for short periods. The valve is constantly set at 35% to release the discharge of 0.75 m^3/s ± 10%

deviation. The deviation of ± 10% had been included to cater for the variations in reservoir levels, as the discharge through the sleeve valve of the compensation pipe is a function of the reservoir level. The total volume of water released through the sleeve valve of the compensation pipe from October 2002 to March 2003 is 11.036 MCM, an average flow rate of 0.70 m^3/s.

1.1.2 Low level Outlet for Water Quality Testing (Test 2 December 2002)

The Low – Level Outlets (LLOs) were opened on the 18th December 2002 in order to conduct the second Water Quality test on water released from the bottom of the reservoir. The test was conducted in two steps of LLO gate opening, the step up opening and then the step down opening. One LLO gate was initially opened at 57% releasing the discharge of 165.80 m^3/s for 42 minutes from 06:18 hours to 07:00 hours to fill up the tail water pond. The volume released was 0.42MCM. Thereafter that LLO was closed and the second one opened at 20% releasing 56.2 m^3/s for three (3) hours, from 07:00 hours to 10:00 hours. The volume released was approximately 0.61MCM. The LLO opening was then stepped up to 25% releasing 71.2 m^3/s for three hour, from 10:00 hours to 13:00 hours. The volume released was 0.77 MCM. The LLO gate was finally stepped up to 30% opening for the completion of the step up test. It was also opened for three hours, from 13:00 hours to 16:00 hours with a release rate of 85.4 m^3/s, which converts to a volume of 0.92 MCM.

The gate was then closed down in a step down manner from 30% to 25% to 0% for three (3) hours each. The volume released in a step down closure was 0.77 MCM for 25% opening and thereafter the gate was completely closed.

The total volume released for the whole test was 3.49 MCM. The water level in the reservoir continued to rise indicating that the reservoir inflow was in excess of the releases.

1.1.3 Low level Outlet for Water Quality Testing (Test 3 February 2003)

The third Water Quality test was conducted on the 25th February 2003. One LLO gate was opened at 45% for 31 minutes, from 09:06 hours to 09:37 hours at the beginning of the test to fill up the tail water pond. The flow rate at this percentage opening was 133.74 m^3/s, which converts to a volume of 0.25 MCM. The percentage opening was increased to 47% to still release 133.74 m^3/s for 8 minutes from 09:37 hours to 09:45 hours. The released volume was 0.06 MCM. Therefore the total volume released for tail water pond filling was 0.31 MCM.

Water began to spill over the tail water pond at 09:45 hours and that was the beginning of the test with 47% gate opening. The discharge was 133.74 m^3/s flowing for 2.5 hours, from 09:45 hours to 12:15 hours. The volume released was 1.20MCM. The gate opening was then stepped up to 50% releasing 150.74 m^3/s for 2.52 hours, from 12:15 hours to 14:46 hours. The volume released was 1.37 MCM. The last step up percentage for this test was at 55% gates opening. It also lasted for 2.52 hours from 14:46 hours to 17:17 hours releasing 167.24 m^3/s, which converts to a volume of 1.52 MCM.

The gate was then stepped down to 50% opening, which lasted 3.02 hours, from 17:17 hours to 20:18 hours, releasing the flow rate of 150.68 m^3/s. Its corresponding volume was

1.64 MCM. It was already late then, so the gate was completely closed at 20:18 hours, after the first step down test.

The total volume released for the third LLO test was 6.08 MCM. The total volume of water released downstream of the Katse Dam for the second and third tests amounts to 9.57 MCM.

1.1.4 Routine discharges through the Low level Outlet

The operational procedure at Katse Dam is to open the Low Level Outlets to prevent discharge over the dam crest spillway to protect the right bank immediately downstream of the dam wall. It was thus arranged that the openings must be done at night to make it easy for people to cross the river downstream during the day as it takes a lot of time for the river flow to reduce to near normal after the LLOs are opened and then closed.

The LLOs were opened during evenings to minimize impeding access for downstream communities and to lower the reservoir level to prevent water from spilling over the spillway. One gate was opened at 38% on the 23rd December 2002, from 20:40 hours to 21:40 hours. The released flow was 101.2 m^3/s flowing for an hour. The water level was still increasing in the reservoir and the percentage opening of the gate was increased to 75% and releasing 242.48 m^3/s from 21:40 hours until 09:40 hours of the following day, the 24th December 2002. The volume released amounted to 10.84 MCM.

On the same day, the 24th December 2002 the gate was opened again at 50%, releasing 150.74 m^3/s for two (2) hours. The percentage opening was increased to 100% to release 410.64 m^3/s for nine (9) hours from 21:00 hours to 06:00 hours

of the 25th December 2002. The released volume amounted to 14.39 MCM and the water level was 2052.93 masl.

The reservoir level continued to rise and it reached 2053.02 masl on the 28th December 2002. The gate was then opened at 100% for thirty minutes to release 410.8 m^3/s from 01:30 hours to 02:00 hours. The released volume was 0.74 MCM

On the 9th January 2003 the gate was opened at 50% to release 150.8 m^3/s at the reservoir level of 2053.09 masl for thirty – five (35) minutes from 22:05 hours to 22:40 hours. At 22:40 hours the gate opening was increased to 100% to release 410.8 m^3/s for three (3) hours from 22:40 hours to 01:40 hours of the 10th January 2003. The reservoir level decreased from 2053.09 masl to 2052.95 masl. The volume released amounted to 4.75 MCM.

The reservoir level had, however, increased to 2053.07 masl at 14:10 hours of the 10th January 2003. The gate was then opened at 30% to release 86.2 m^3/s for an hour from 14:10 hours to 15:10 hours. There was no decrease in reservoir level and the gate opening was increased to 50% to release 150.8 m^3/s for 3.83 hours from 15:10 hours to 19:00 hours. Gate opening was then increased to 100% to release 410.8 m^3/s for 6 hours from 19:00 hours to 01:00 hours of the following day, the 11th January 2003. The released volume amounted to 11.265 MCM. The reservoir level had reduced from 2053.07 masl to 2052.80 masl.

The reservoir level had increased to 2052.94 masl at 21:00 hours on the 11th January 2003. The gate was again opened at 100% to release 410.64 m^3/s for 11.5 hours from 21:00 hours to 08:30 hours of the following day, the 12th January 2003. The

reservoir level reduced to 2052.81 masl. Released volume amounted to 17.000 MCM.

At 21:00 hours on the 12th January 2003 the reservoir level had increased from 2052.81 masl to 2052.89 masl. The gate was then opened at 100% to release 410.48 m^3/s for 2 hours from 21:00 hours to 23:00 hours. Released volume amounted to 2.96 MCM. The gate was thereafter closed until the 17th February 2003.

The water level rose to 2052.93 masl on the 17th February 2003. The gate was opened at 50% for 9 hours to release 150.74 m^3/s from 21:00 hours to 06:00 hours of the following day, the 18th February 2003. The reservoir level reduced to 2052.82 masl. Released volume was 4.88 MCM.

The reservoir level rose again to 2052.97 masl on the 20th February 2003. The gate was opened at 100% to release 410.64 m^3/s for 23.5 hours from 09:00 hours to 08:30 hours of the following day, the 21st February 2003. Released volume was 34.74 MCM and the reservoir level reduced to 2052.91 masl.

On the 22nd February 2003 the reservoir level had risen to 2052.99 masl. The gate was again opened at 80% to release 262.48 m^3/s for 12.5 hours from 20:00 hours to 08:30 hours of the 23rd February 2003. The reservoir level reduced to 2052.91 masl and the released volume was 11.81 MCM.

On the 2nd March 2003 the reservoir level rose again to 2052.96 masl. The gate was opened at 100% to release 410.64 m^3/s for 4 hours from 20:00 hours to 24:00 hours. Released volume was 5.91 MCM and the reservoir level reduced to 2052.79 masl.

The gate was opened again on the 4th March 2003 at 100% to release 410.64 m^3/s for 4 hours from 20:00 hours to 24:00 hours. The reservoir level had risen to 2052.92 masl. Released volume was 5.91 MCM and the reservoir level reduced to 2052.80 masl.

The reservoir level rose steadily to 2052.88 masl on the 6th March 2003. The gate was opened at 100% to release 410.48 m^3/s for 2.5 hours from 21:00 hours to 23:30 hours. Released volume was 3.69 MCM and the reservoir level reduced to 2052.80 masl. Thereafter the reservoir level experienced steady variations until the 21st March 2003.

The reservoir level dramatically rose to 2053.04 masl on the 21st March 2003. The gate was opened at 100% to release 410.80 m^3/s for 24 hours from 08:30 hours to 08:30 hours of the following day, the 22nd March 2003. The reservoir level continued to rise irrespective of the releases and it had reached 2053.15 masl at 08:30 hours of the 22nd March when the gate was closed. Released volume was 35.49 MCM.

The reservoir level had risen to 2053.24 masl at 19:00 hours of the 22nd March 2003. The gate was opened at 100% to release 411.12 m^3/s for 13.5 hours from 19:00 hours to 08:00 hours of the 23rd March 2003. Released volume was 19.98 MCM and the reservoir level reduced slightly to 2053.18 masl.

At 19:00 hours of the 23rd March the reservoir level had risen to 2053.26 masl. The gate was opened at 100% to release 411.12 m^3/s for 13.5 hours from 19:00 hours to 08:30 hours of the 24th March. Released volume was 19.98 MCM and the reservoir level slightly reduced to 2053.19 masl.

The reservoir level had risen to 2053.29 masl at 19:00 hours of the 24th March. The two LLO gates were then opened one at 100% and the other at 20% to release 467.76 m^3/s for 13.5 hours from 19:00 hours to 08:30 hours of the 25th March. Released volume was 22.73 MCM. The reservoir level was only reduced to 2053.05 masl.

The reservoir level rose to 2053.10 masl at 19:00 hours of the 25th March. The gate was opened at 100% to release 410.96 m^3/s for 13.5 hours from 19:00 hours to 08:30 hours of the following day, the 26th March. Released volume was 19.97 MCM and the reservoir level reduced to 2052.92 masl. It could be noticed that the maximum reservoir level reached during the reporting period was 2053.29 masl and that the spill could not be avoided as the reservoir level was dramatically rising due to high amounts of rainfall that were being experienced. The gate was thereafter closed and the reservoir level decreased continuously after the 26th March 2003 until the end of the period reported on, the 31st March 2003. The total volume released through LLOs during the reservoir management from December 2002 to March 2003 amounts to 247.056 MCM

1.1.5 Discharge over the spillway

Spill events were experienced irrespective of the releases through LLOs during the period October 2002 to March 2003. The first spill event occurred on the 23rd December 2002 at the reservoir level of 2053.02 masl. The spill took an hour with the discharge of 0.745 m^3/s and converts to the volume of 2,683.05 m^3. The reservoir level reduced to 2052.99 masl with the assistant from LLOs.

The reservoir level rose to 2053.02 masl again on the 28th December 2002. The spill discharge of 0.745 m^3/s occurred for 30 minutes and converts to the volume of 1,341.52 m^3. The reservoir level was also drawn down through the operation of LLOs.

The reservoir level had risen to 2053.09 masl on the 9th January 2003 and a spill flow of 5.96 m^3/s was experienced for 35 minutes from 22:05 hours to 22:40 hours. The spilled volume was 12,516.00 m^3. The LLO gate was opened at 22:40 hours to draw down the reservoir level.

The reservoir level has drawn down to 2053.03 masl at 22:40 hours on the 9th January 2003 and a further spill discharge of 1.37 m^3/s occurred for 3 hours from 22:40 hours to 01:40 hours of the 10th January. The reservoir level was also drawn down through the operation of LLOs and it had reached 2052.95 masl at 01:40 hours on the 10th January. The spilled volume was 14,796.00 m^3.

The reservoir level rapidly increased to 2053.07 masl by 14:10 hours on the 10th January 2003 releasing the spill discharge of 3.87 m^3/s for an hour from 14:10 hours to 15:10 hours. The LLO gate was also opened at 30% to draw down the reservoir level but the level remained unchanged. The spilled volume was 13,932 m^3. The LLO percentage opening was increased to 50% at 15:10 hours and the spill discharge of 4.88 m^3/s was experienced for 3.83 hours from 15:10 hours to 19:00 hours on the 10th January. The spilled volume was 67,344.00 m^3. The reservoir was drawn down from 2053.07 masl to 2053.06 masl. The spill continued to occur and the LLO opening was increased to 100% at 19:00 hours. Therefore the spill of 2.95 m^3/s was experienced for 6 hours from 19:00 hours to 01:00

hours of the 11th January 2003. The spilled volume was 63,720 m^3 and the reservoir level reduced to 2052.80masl.

The last and the largest spill event experienced during the period reported on occurred from the 21st to the 25th March 2003. The total volume spilled was 7,813,460.00 m^3. It could be noted that the percentage opening of the LLOs were increased beyond 100% in attempting to lower the reservoir level during the occurrence of this last spill event. There was a lot of rainfall contributing inflows into Katse reservoir. The volume discharged through spillway from October 2002 to March 2003 is 7.990 MCM.

1.2 Summary of Flow Volumes Released from the Katse Dam

1.2.1 Spillage

Katse Dam has spilled four times since October 2002 to March 2003. The period of spill and its amount are as shown below.

PERIOD	DISCHARGE
-23rd Dec. 2002 to 23rd Dec. 2002	2,700.00 m^3
-28th Dec. 2002 to 28th Dec. 2002	1,340.00 m^3
-09th Jan. 2003 to 11th Jan. 2003	172,229.00 m^3
-21st Mar. 2003 to 25th Mar. 2003	7,813,460.00 m^3

The low – level outlets were regularly used to draw down the Reservoir level prior to the spill event in an effort to prevent its occurrence. However, the spills eventually took place because the level could not be drawn down due to high and prolonged rainfall that fell for extended number of days and hours, especially during the months of January and March 2003. It can be seen that the first and the second spill discharges were small and lasted for very short periods. The total volume discharged over the spillway for the period, October 2002 to

March 2003, was therefore 7,989,714.00 m^3 (7.990 MCM), which converts to a corresponding average spill discharge of 0.51 m^3/s.

1.2.2 Discharges through the Low Level Outlet

The volume released through the LLOs amounts to 256.626 MCM for this period, and equates to an average discharge of 16.320 m^3/s. This amount includes the LLO discharges for water quality testing as had been indicated earlier. The periods of LLO discharges and their amounts for water quality testing are as shown in the table below.

PERIOD	DISCHARGE
-18th Dec. 2002 to 18th Dec. 2002	3.490MCM
-23rd Dec. 2002 to 24th Dec. 2002	25.230MCM
-28th Dec. 2002 to 28th Dec. 2002	0.740MCM
-09th Jan. 2003 to 12th Jan. 2003	35.974MCM
-17th Feb. 2003 to 17th Feb. 2003	4.880MCM
-20th Feb. 2003 to 22nd Feb. 2003	46.550MCM
-25th Feb. 2003 to 25th Feb. 2003	6.080MCM
-02nd Mar. 2003 to 02nd Feb. 2003	5.910MCM
-04th Mar. 2003 to 04th Mar. 2003	5.910MCM
-06th Mar. 2003 to 06th Mar. 2003	3.690MCM
-21st Mar. 2003 to 25th Mar. 2003	118.150MCM

1.2.3 Compensation and Mini Hydro Discharges

The actual total volume of water released through the compensation and mini-hydro outlets is 12.214 MCM, which converts to 0.78 m^3/s for the same period.

1.2.4 In - stream Flow Requirements (IFR)

The IFR Policy became effective on the 13th December 2002 and indicates the Bulk release from Katse Dam of 66.9 MCM per year, an average flow rate release of 2.1 m^3/s. It can be seen from Table 1 below that the average release up to the end of March 2003 has been well in excess of IFR Policy requirements. Summary of Discharges from Katse Dam are shown in Table 1 below.

Table 1: Flow Releases from Katse Dam

Discharge Facility	**Volume (MCM)**	**Average Flow Rate (m^3/s)**
Spillway	7.990	0.51
Low Level Outlet (including tests)	256.626	16.320
Compensation Outlet	11.036	0.702
Mini – Hydro Outlet	1.178	0.075
IFR Bulk	0.000	0.00
Total	**276.830**	**17.605**

1.2.5 Hydrometric Monitoring

The Hydrometric stations downstream of the Katse Dam were also monitored and their discharges calculated. The Paray Hydrometric station registered a volume of 562.449 MCM, which converts to an average flow of 35.768 m^3/s for the period October 2002 to March 2003. And the volume recorded at the Weir at Paray amounts to 579.743 MCM and it is equivalent to the average flow of 36.868 m^3/s.

1.2.6 Monthly Releases from Katse Dam

Table 2 below gives the volumes of water released downstream of the Katse Dam since October 2002 to March 2003 for each month. It also gives the overall total at the end of the period.

Table 2: Monthly Flow Releases from the Katse Dam

Months Since October 2002	Low – level Outlet (Radial Gates) Volume in Cubic Metres	Compensation Volume in Cubic Metres	Mini – Hydro Volume in Cubic Metres	Spillway Volume in Cubic Metres	Monthly total in Million Cubic Metres (MCM)	Paray Hydrometric Station Flows in cubic metres (m^3)	Paray Weir Station Flows in cubic metres (m^3)
Oct-02	-	2,006,649	214,272	-	2.22	10,297,498	8,231,501
Nov-02	-	1,871,796	200,448	-	2.07	13,587,696	11,783,491
Dec-02	29,453,976	2,007,416	214,762	4,025	31.68	39,541,738	39,909,629
Jan-03	35,973,912	1,838,077	195,668	172,229	38.18	37,221,379	37,501,229
Feb-03	57,517,762	1,624,399	172,923	-	59.32	29,653,862	29,337,293
Mar-03	133,680,528	1,688,107	179,664	7,813,460	143.36	82,757,894	93,258,605
Volume in MCM	**256.626**	**11.036**	**1.178**	**7.990**	**276.830**	**562.449**	**576.743**
	Comp + Mini =	**12.214**					
Total water released downstream of Katse					**276.830**	**MCM**	

Figure 1 compares the Treaty required guaranteed minimum flow and the IFR Policy releases with the flow from the Katse compensation pipe. It is seen that the outflow from the compensation pipe has consistently been more than the Treaty guaranteed minimum flow.

Figure 2 shows the different outlet flows at Katse and how they compare with the Treaty required guaranteed minimum flow and the IFR Policy releases, the annual average of the total outflows and the IFR bulk releases.

Figure 3 gives the Hydrometric station and the Weir flows of Malibamatšo River at Paray as compared with all the releases from the Dam. These indicate that the flows at the above recording stations had always been higher than the releases from the Katse Dam.

(N.B. Figures 1, 2, and 3 have vertical logarithmic scale, which tends to compress the vertical scale especially as it moves upward).

FIGURE 1 - Historic Monthly Flow Releases - Katse Reservoir
Actual vs Treaty guaranteed Minimum and IFR Policy Flows

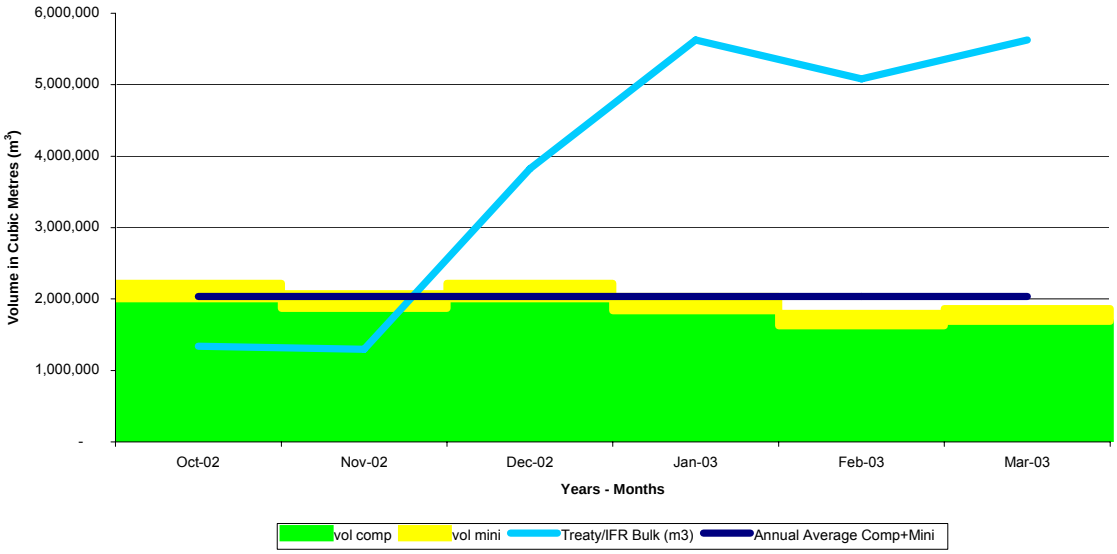


FIGURE 2 - Historic Monthly Flow Releases - Katse Reservoir
All flow Releases vs Treaty guaranteed Minimum and IFR Bulk Flows.

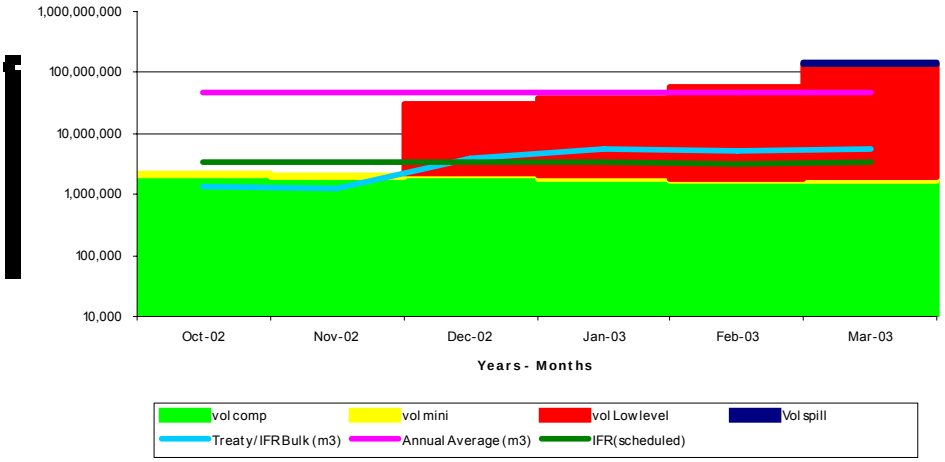


FIGURE 3 - Historic Monthly Flow Releases - Katse Reservoir
Comparison with Paray Hydrometric Station, IFR Bulk and Weir data

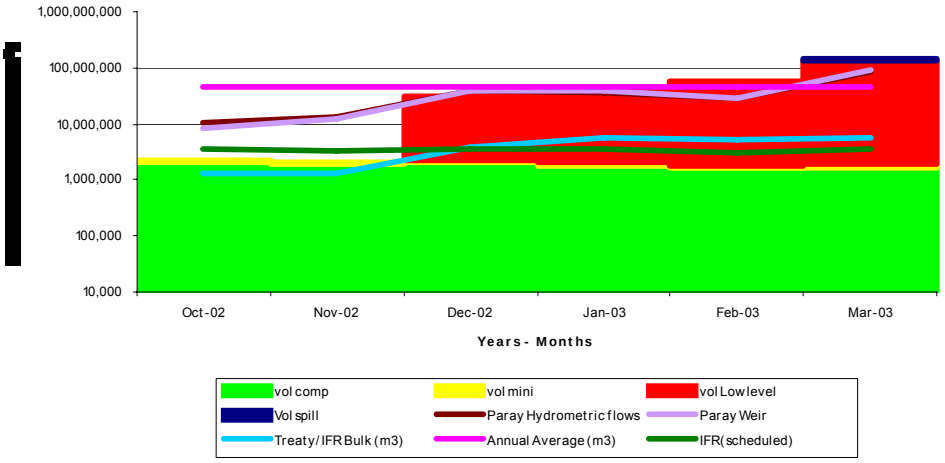
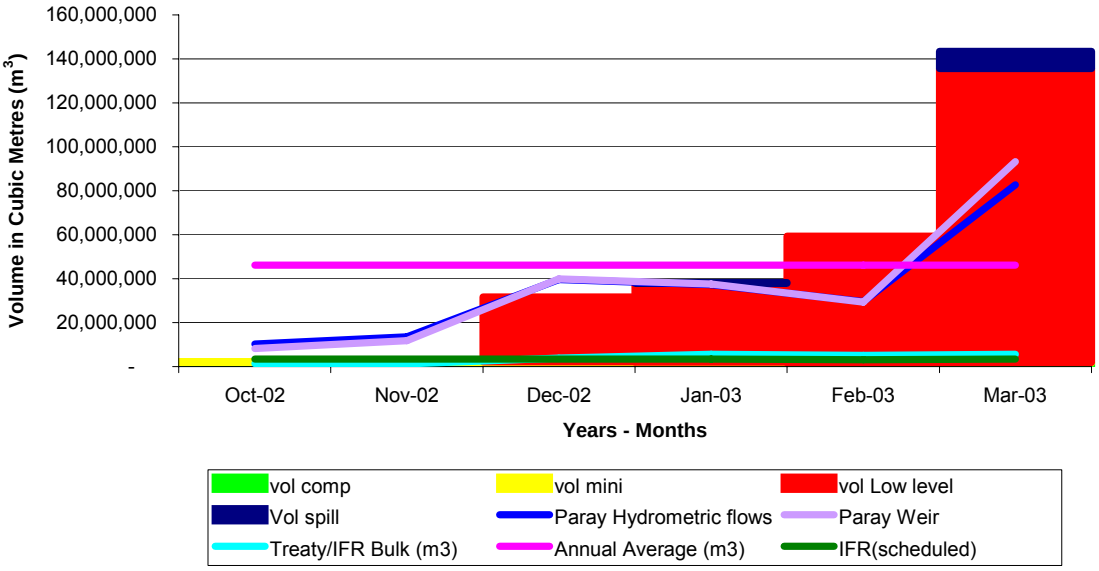


FIGURE 4 - Historic Monthly Flow Releases - Katse Reservoir
Indicating the comparison of Releases with Paray Hydrometric Station and Weir data in Cubic Metres.



1.3 Chronology of Events of the 'Muela Dam

The volume of water released downstream of the 'Muela Reservoir into the Hololo River from October 2002 to March 2003 amounts to 2.359 MCM and converts to an average flow of 0.15 m^3/s. This amount, which is equivalent to an estimated Nqoe catchment MAR, was released through the compensation pipe. (The LLO was not used at 'Muela during the period under consideration. There was no spill flow either).

1.4 Flow Releases from 'Muela Dam

Table 3 below gives the monthly volumes of water released downstream of 'Muela Dam from October 2002 to March 2003.

TABLE 3: Monthly Flow Releases from 'Muela Dam

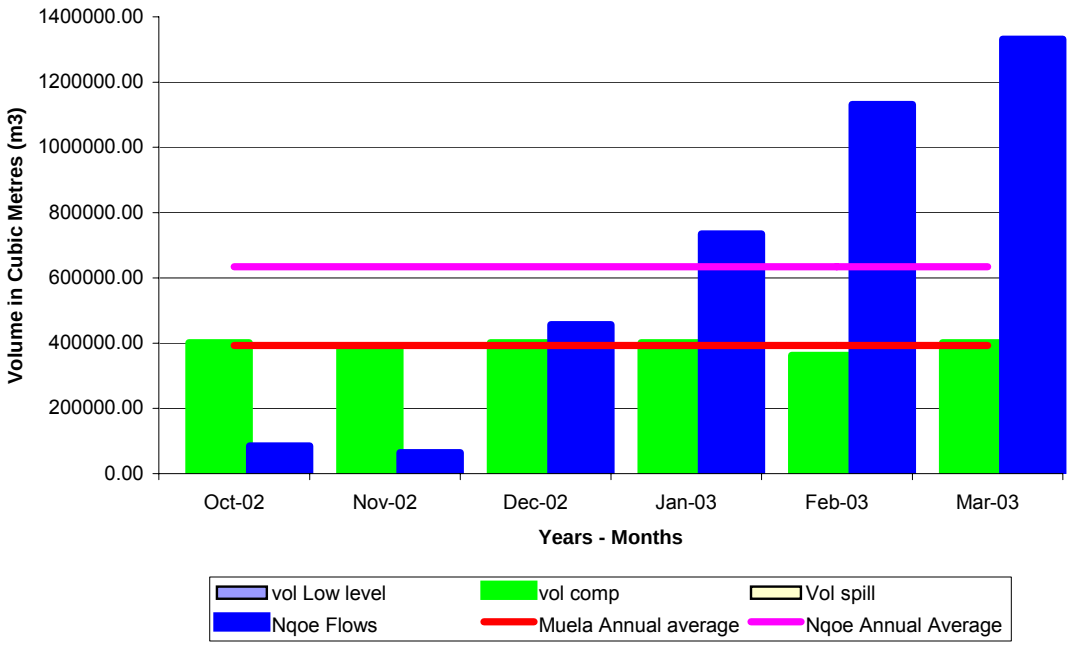
Months Since October 2002	Low – level Outlet (Radial Gates) Volume in Cubic Metres	Compensation Volume in Cubic Metres	Spillway Volume in Cubic Metres	Monthly total in Million Cubic Metres (MCM)	Nqoe Hydrometric Station Flows in Cubic Metres (m^3)
Oct-02	-	401,760.00	-	0.40	84,931.20
Nov-02		388,800.00		0.39	64,281.60
Dec-02		401,760.00		0.40	457,228.80
Jan-03		401,760.00		0.40	734,227.20
Feb-03		362,880.00		0.36	1,131,667.20
Mar-03		401,760.00		0.40	1,331,683.20
			-		
	-	2,358,720.00	-	2.36	3,804,019.00
Volume in MCM	**-**	**2.359**	**-**	**2.359**	**3.804**
Total water released downstream of 'Muela Dam				**2.359**	

Figure 5: 'Muela Dam Releases from the Compensation Pipe and Mean Annual Runoff (MAR) of Nqoe River

Figure 5 shows the flows from the 'Muela Dam outlets as compared with those from the Nqoe River. The annual averages of these two

flows are also shown on this figure. It is observed that the Nqoe annual average flows are constantly higher than the 'Muela Dam outflows. The Nqoe flows exceeded the 'Muela Dam releases with increasing magnitude from 0.457 MCM in December 2002 to 1.33 MCM in March 2003. Thus more water was accumulated in 'Muela Dam for the period October 2002 to March 2003.

FIGURE 5- Muela Dam Releases from compensation pipe and Nqoe Mean Annual Runoff (MAR) (Compensation vs Nqoe MAR)



1.5 Chronology of Events of Matsoku Diversion Weir

The construction of Matsoku Diversion Weir and Tunnel was completed and commissioned before any flow measuring instruments and/or devices could be installed as a result no records have been collected from the Matsoku Weir. The process of installing is advanced and the next report will be adequately covered. The flows of Matsoku river hydrometric station downstream of the Weir at Ha Seshote are therefore used and transferred to the Matsoku weir by using the weighting factor of the catchment areas at the hydrometric station at Ha Seshote and at the Matsoku weir. It seems that the total flow downstream of the Matsoku Weir and Tunnel for the period October 2002 to March 2003 is 23.619 MCM, which converts to 1.502 m^3/s. This amount is consistently higher than the average flow of 0.60 m^3/s, which is the flow that the weir has to release downstream whilst transferring excess water into Katse Reservoir. This is in accordance with the designed operational procedures of the Matsoku Diversion Weir.

The Matsoku River Hydrometric station at Ha Seshote was used to evaluate the performance of the Matsoku Weir. This station recorded the volume amounting to 25.319 MCM (1.61 m^3/s) for the same period.

1.6 Flow Releases from Matsoku Diversion Weir:

The Table 4 below shows the Matsoku Weir and Tunnel estimated flows against the Matsoku River at Seshote Hydrometric Station for the period October 2002 to March 2003.

Table 4: Estimated Monthly Flow Releases from Matsoku Weir.

Months Since October 2002	Matsoku Weir Compensation Volume in Cubic Metres	Spillway Volume in Cubic Metres	Monthly total in Million Cubic Metres (MCM)	Matsoku Hydrometric Station Flows
Oct-02	2,475,657	**-**	2,475,657	2,878,934
Nov-02	2,763,184	-	2,763,184	3,213,302
Dec-02	7,088,256	**-**	7,088,256	6,095,343
Jan-03	2,165,318		2,165,318	2,518,042
Feb-03	3,343,151		3,343,151	3,887,741
Mar-03	5,783,220		5,783,220	6,725,290
	23,618,791	-	23,618,791	25,318,652
Volume in MCM	**23.619**	**-**	**23.619**	**25.319**
Total water released downstream of Matsoku Weir				**23.619**

1.7 Chronology of Events of Mohale Dam

In accordance with the construction contract requirements, releases to the riverbed downstream were maintained throughout the initial stages of impounding at or above 0.3 m^3/s as construction allowed.

At this stage, the measuring weir just downstream is available but the recorder has not yet been installed. All the quoted releases from the Mohale Dam are therefore from uncalibrated valve openings or field estimates/observations for now.

Impoundment of Mohale Dam commenced on 1st November 2002 when the stoplogs were lowered in diversion tunnel No. 2. Downstream discharge of 300 litres/second then commenced via valves in the stoplogs.

Following the reservoir level rising through 1985.0 masl on 8-Dec-02, after press releases, radio announcements, and visits to downstream

residents, the LLO was opened up to 10% opening on 16-Dec-02 with the expectation of releasing 6.0 m^3/s for some days. During the event, the valve-opening indicator seemed to be misaligned and release was limited to about 3.5 m^3/s. Temporary power supply problems hampered operation of the valve – the permanent supply will not be fully complete until April – and prudence dictated that the valve be closed on 20-Dec-02 through Christmas, and the maximum release possible using the bypass between LLO and the compensation pipe work was left running.

From impounding on 1-November-02 until the end of the month 0.80 MCM was released. Up to 16-Dec-02 a further 0.44 MCM was released thus an average of 0.30 m^3/s. Thereafter to year's end a further 2.32 MCM, an average of 0.44 m^3/s, was released. At year's end, stored volume was 85.03 MCM while a total of 3.43 MCM an average of 0.65 m^3/s had been released. Instructions to operators are that average releases from 16-Dec-02 are to be 2.45 m^3/s at the dam.

An average flow rate of 1.3 m^3/s was released from the Mohale Dam since the 20th December 2002 until the middle of January 2003. The flow rate was then increased to 5.80 m^3/s for two days, 12th and 13th January 2003, after which an average flow rate of 2.44 m^3/s was released.

The flow rate was increased to 4.70 m^3/s on the 23rd January 2003 and then to an average flow rate of 6.77 m^3/s from the 24th January to the 4th February 2003. The flow rate was thereafter maintained at an average release of 0.89 m^3/s up until the 27th February 2003 when the release was increased to an average flow rate of 8.23 m^3/s until the 4th March 2003. The flow rate was then maintained at 0.89 m^3/s until the end of March 2003.

The total amount of water released downstream of the Mohale Dam from 1st November 2002 to 31st March 2003 is thus estimated at 21.996 MCM, an average flow rate of 1.39 m^3/s.

The average flow at Marakabei weir for the period November 2002 to March 2003 was 2.037 m^3/s and corresponds to a volume of 32.209 MCM.

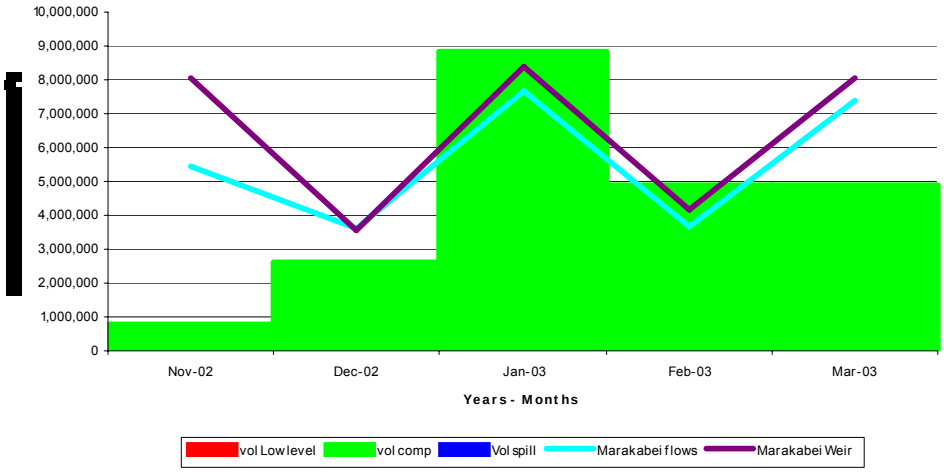
1.8 Flow Releases from Mohale Dam

The Table 5 below shows the Mohale Dam flows against the flow records on Senqunyane River @ Hydrometric Station and the weir for the period November 2002 to March 2003.

Table 5: Flow Monthly Releases from Mohale Dam

Months Since November 2002	Mohale Dam Compensation Volume in Cubic Metres (m^3)	Spillway Volume in Cubic Metres	Monthly total in Million Cubic Metres (MCM)	Low – level Outlet Volume in Cubic Metres (m^3)	Marakabei Hydrometric station flows in Cubic Metres (m^3)	Marakabei Weir Station Flows in Cubic Metres (m^3)
Nov-02	803.520	0.00	0.804	0.00	5,422,982	8,067,341
Dec-02	2,623,104	0.00	2,623	0.00	3,599.770	3,544,474
Jan-03	8,816,476	0.00	8.816	0.00	7,670,678	8,383,910
Feb-03	4,866,912	0.00	4.867	0.00	3,683,923	4,183,747
Mar-03	4,885,920	0.00	4.886	0.00	7,387,546	8,029,670
Volume in MCM	**21.996**	**0.00**	**21.996**	**0.00**	**27.765**	**32.209**
Total water released downstream of Mohale Dam in MCM				**21.996**		

FIGURE 6: Mohale Dam Releases since impoundment up to 31st March 2003



2.0 CONCLUSIONS

There have been various discharges downstream of the Katse and 'Muela Dams. The flow through the compensation pipe at Katse has consistently been above the required Treaty guaranteed minimum flow of 500 litres per second until December 2002, when the IFR Policy was approved.

The flow release of 0.75 m^3/s ± 10% variation from the Dam had been implemented since the 25th April 2002 and the Hydrometric station downstream of the Katse Dam, about 1Km from the dam wall, to monitor all the releases has been rehabilitated. It is therefore awaiting the development of the rating equations for the calculations of the flow rates from the Dam.

The flow downstream of the 'Muela Dam has been lower than the annual average inflow from the Nqoe River for the period October 2002 to March 2003. The compensation valve at Muela is constantly

set to release the long – term mean annual runoff of Nqoe River, which is estimated at 0.15 m^3/s.

The Hydrometric Station flows of Matsoku River at Ha Seshote have been used to estimate the flows that have been released downstream of Matsoku weir whilst transferring excess water into the Katse reservoir. It is thus deduced that its performance has consistently satisfied the design flows of 0.60 m^3/s for the Diversion Weir and Tunnel on Matsoku River.

Mohale impoundment started on the 1st November 2002 with an average release of 0.30 m^3/s (i.e. 300ℓ/sec) up to the 18th December 2002. From the 19th December an average of 1.30 m^3/s was released till the end of December 2002.
A volume of 21.996 MCM was released downstream of Mohale Dam from November 2002 to March 2003. A flow – measuring weir is now completed just downstream of the Mohale Dam Wall but the continuous recorder has not yet been installed to measure water level, which could then be converted into the discharge by the use of the developed rating equation.

3.0 RECOMMENDATIONS

It is being recommended that the process of addressing the snag list of the Matsoku Diversion Weir and Tunnel must be speeded up (by Engineering and Consultants/Contractors) for the records to be obtained and Matsoku Weir to function as per its design with appropriate quantities of water being measured and known.

The Project Authorities have made a decision that this report must be issued every six (6) months. While this decision is being observed, it is therefore recommended that the production of the report should also be done on the basis of the Hydrological year to enable the

analysis to be done with the records from other Hydrometric stations for hydrological publications.

It is also recommended that the process of recorders and measuring devices installations must be speeded up to enable valuable data records to continue to be obtained.