LESOTHO HIGHLANDS DEVELOPMENT AUTHORITY

ANNUAL FLOW RELEASES

INSTREAM FLOW REQUIREMENT (IFR)

IMPLEMENTATION AND MONITORING

(October 2004 to September 2005)

TOWER ON MALIBAMATSO RIVER @ KAO

REPORT N0.6

SEPTEMBER 2006

STRATEGIC AND CORPORATE SERVICES DIVISION

MONITORING AND EVALUATION BRANCH

Aquatic Systems Section
HYDROLOGY

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EXECUTIVE SUMMARY

This Report: “Annual Flow Releases for IFR Policy Implementation and Monitoring – October 2004 to September 2005” provides information on the operations and monitoring of the Lesotho Highlands Water Project (LHWP) structures regarding inflow into these structures, Hydrological Year classification and flow releases for Instream Flow Requirements downstream of the Katse Dam, the Mohale Dam, the ‘Muela Dam and the Matsoku Diversion Weir and Tunnel for the period October 2004 to September 2005.

Generally the Katse Reservoir has experienced the ‘Plus 1’ river classification conditions during the 2004/2005 Hydrological Year (wetter than normal year) with the total inflow of **745.23** MCM. Quarterly conditions varied from Average to Plus 2. This inflow amount is inclusive of the estimated transfers of **25.16** MCM from Matsoku Diversion Weir and Tunnel[1]. No transfers into Katse Reservoir were effected from Mohale Dam.

The actual total amount of **74.34** MCM was released from the Katse Dam from October 2004 to September 2005. The target dam release, as specified in the IFR Policy, amounts to **36.90** MCM for low flows, **4.50** MCM for freshets and **36.00** MCM for within year floods and thus the total flow releases were **3.06** MCM (**3.95%**) lower than the total target release of **77.40** MCM for the entire period, October 2004 to September 2005. The target releases were based on the calculated quantities required to supplement the KhohlontŠo inflows to achieve the prescribed flow requirements at IFR site 2.

[1]The estimated transfer of 25.16 MCM to Katse Dam is not comparable to the Plus 1 required transfer of 60.3% of the Matsoku MAR because this value needed to be estimated due to the malfunctioning of Measuring Devices. This problem is being rectified and the future flows will be measured.

The volume recorded at the Katse Bridge Hydrometric Station on IFR river reach 2 downstream of the Katse Dam amounted to **80.34** MCM whilst the target IFR volume for IFR site 2 stands at **103.21** MCM. This gives a **22.87** MCM (**22%**) difference, but as the Hydrometric Station is upstream of the Khohlontšo tributary, which is not metered, the unrecorded and hence unknown contribution from this tributary is not included.

There was no spillage experienced from the Katse Dam for the period reported on.

The Mohale Reservoir has experienced the 'Average' river classification conditions with the total inflow of **360.64** MCM for the Hydrological year 2004/2005.

The total amount of **44.32** MCM was released from the Mohale Dam through the operation of a 500 mm diameter Sleeve Valve and a 200 mm diameter Sleeve Valve. The target dam release as specified in the IFR Policy amounted to **22.54** MCM for low flows and **3.90** MCM for within year flood releases and thus the targeted total dam release stands at **26.44** MCM for the period October 2004 to September 2005. Releases from Mohale Dam exceeded this requirement by **17.88** MCM (**40.3%**).

The volume recorded at IFR site 7 amounted to **62.85** MCM whilst the target IFR flow volume stands at **67.82** MCM. This therefore indicates that the total deficit experienced at IFR site 7 for the period October 2004 to September 2005 stands at **4.97** MCM (**7**%).

There was no spillage experienced from the Mohale Dam. The dam was still on its impoundment phase and it had reached 69.5% full on the 30th September 2005.

'Muela Dam released **1.84** MCM which is approximately **39**% of the long term Mean Annual Runoff (**4.72 MCM**) of the Nqoe River as had been

derived from the upstream Hydrometric Station – Nqoe River at 'Muela. No spill occurred at 'Muela Dam.

Downstream releases are estimated as **18.92** MCM from the Matsoku Diversion Weir. The estimations are based on the downstream Hydrometric Station (Matsoku River at Seshote) records and on the fact that the design operation of the Weir demands that flows below and up to **0.6** m^3/s be released downstream prior to any transfers into the Katse Dam. The measuring devices were malfunctioning and therefore there is no record for the flows passing the Matsoku Diversion Weir for the period October 2004 to September 2005. The volume of **25.16** MCM is the estimated transfer into the Katse Dam based on the design operation. No spill was experienced nor recorded.

The tables and figures indicating all the downstream releases and river flows are included in this report for clarity, good understanding and timely reference.

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FOREWORD

This Report is the sixth publication of the “Annual Flow Releases for IFR Policy Implementation and Monitoring” report. It is now being produced on an annual basis due to the need to publish the Annual IFR Report that details the efforts taken towards implementing the requirements of the IFR Policy and Procedures and thus monitoring the compliance of the releases to the predetermined flow regimes.

This report captures activities and tasks done from October 2004 to September 2005 for all the Dam Structures namely the Katse Dam, the Mohale Dam, the ‘Muela Dam and the Matsoku Diversion Weir and Tunnel.

It is also important to note that some of the information regarding downstream flow releases and their compliance to the Instream Flow Requirement (IFR) Policy and Procedures is produced monthly. These monthly reports are then consolidated at the end of the Hydrological year for the production of the Annual Flow Releases for IFR Policy Implementation and Monitoring Report.

The IFR Policy was approved on the 13th December 2002 and the associated IFR Procedures were approved in July 2003. The full implementation of the IFR Policy and Procedures regarding flow releases from Mohale Dam, proper recording of flows and monthly reporting on the performance of the IFR sites and the IFR Policy was effected from the 1st August 2003; before then the Washington Agreement was in force for impounding and filling Mohale Dam. The proper implementation of the IFR Procedures was not effected for the Katse Dam until the approval of the IFR Procedures themselves since monthly release schedules for low flow and flood releases in different hydrological years had not been issued (as the Procedures had not been approved), however, the IFR Policy (after its approval in

December 2002) was applied to the extent that annual IFR release targets under the IFR Policy were met whilst the minimum rate of flow required by the LHWP Treaty also continued to be observed.

INTRODUCTION

The IFR Policy was approved on the 13th December 2002, and the associated IFR Procedures were approved in July 2003. The Policy stipulates the amounts of water that must be released from dam structures to meet target flows at designated IFR sites downstream of the dams in order to sustain the environment, aquatic quality and social activities downstream. The compliance of the releases to the required IFR Policy amounts is then monitored and this report provides the recorded flow volumes, in Million Cubic Metres (MCM), and the required IFR flows released downstream of the existing and operating LHWP structures for the period October 2004 to September 2005 for the Katse Dam, the Mohale Dam, the 'Muela Dam and the Matsoku Diversion Weir and Tunnel.

All IFR sites are marked on Figure 1, which shows the major affected river systems within the Highlands of Lesotho. Figure 2 shows the Katse Dam, the Downstream Hydrometric Station (Katse Bridge), the Khohlontšo Stream and the IFR site 2 reach. The Hydrometric Station is situated 1.06 km downstream of the Katse Dam wall and there is no flow measuring station at IFR site 2. The main flow contributing stream to the Malibamatšo River, the Khohlontšo Stream is situated 2 km downstream of the Katse Dam wall and 1 km downstream of the Flow Measuring station, the Katse Bridge Hydrometric Station. Therefore there are no flow records available for this stream and for IFR site 2. The IFR site 2 is located 3.06 km downstream of the Katse Dam wall.

Figure 3 gives the locations along the Senqunyane River where IFR site 7 is situated 28 km downstream of the Mohale Dam wall.

Five (5) out of the scheduled six (6) within year floods for the Hydrological year 2004/2005 were released from the Katse Dam.

One flood scheduled for January 2005 was not released and half the required flood scheduled for February 2005 was released in March 2005. Rainfall patterns and thus naturally occurring floods were not envisaged, reservoir levels were also very low, ranging from 2031 masl in January 2005 to 2036 masl in February 2005. This situation did not quite improve in March 2005 but it was decided that half of the required February flood should be released as there was some naturally occurring floods and the Katse reservoir level had rose to 2037 masl. The future deviations will be supported by the weather forecasts from the Lesotho Meteorological Services in an effort to coincide within year flood releases with durations of naturally occurring floods.

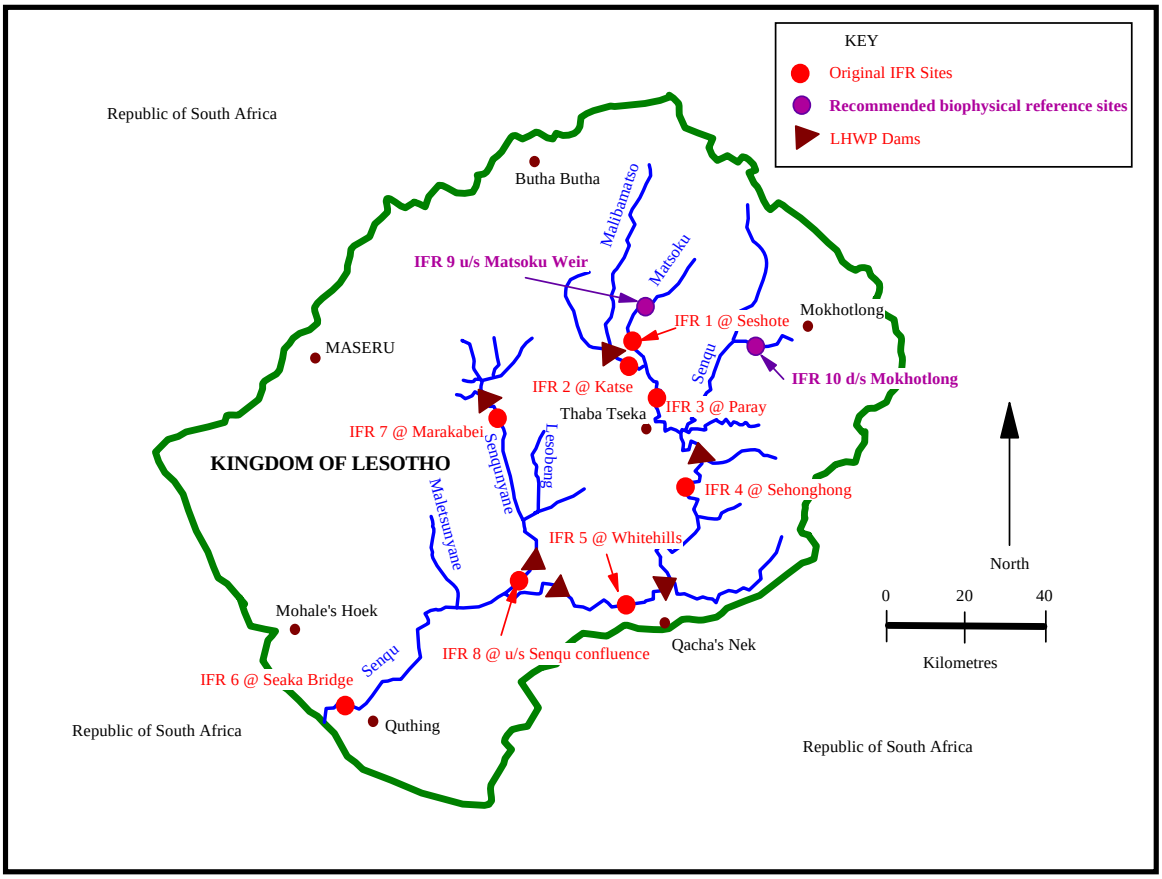
Only one (1) out of the three (3) scheduled freshets was released from the Katse Dam.

The single within year flood release from Mohale Dam for the Hydrological Year 2004/2005 was scheduled for February 2005. It was, however, released later in March 2005 from Mohale Dam to coincide with the natural flood to mimic nature for environmental health.

This report provides, in detail, the results obtained in all these activities.

Figure 1: Hydrological Map showing Location of the original IFR sites and reference sites

IFR Site 1*Matsoku near Seshote
IFR Site 2*Malibamatšo 3 km downstream from Katse road bridge
IFR Site 3*Malibamatšo at Paray
IFR Site 4Senqu at Sehong-hong
IFR Site 5 Senqu at Whitehills



IFR Site 6Senqu at Seaka
IFR Site 7*Senqunyane at Marakabei
IFR Site 8*Senqunyane upstream of the Senqu confluence.

Figure 2: The Katse Dam and the IFR site 2 reach

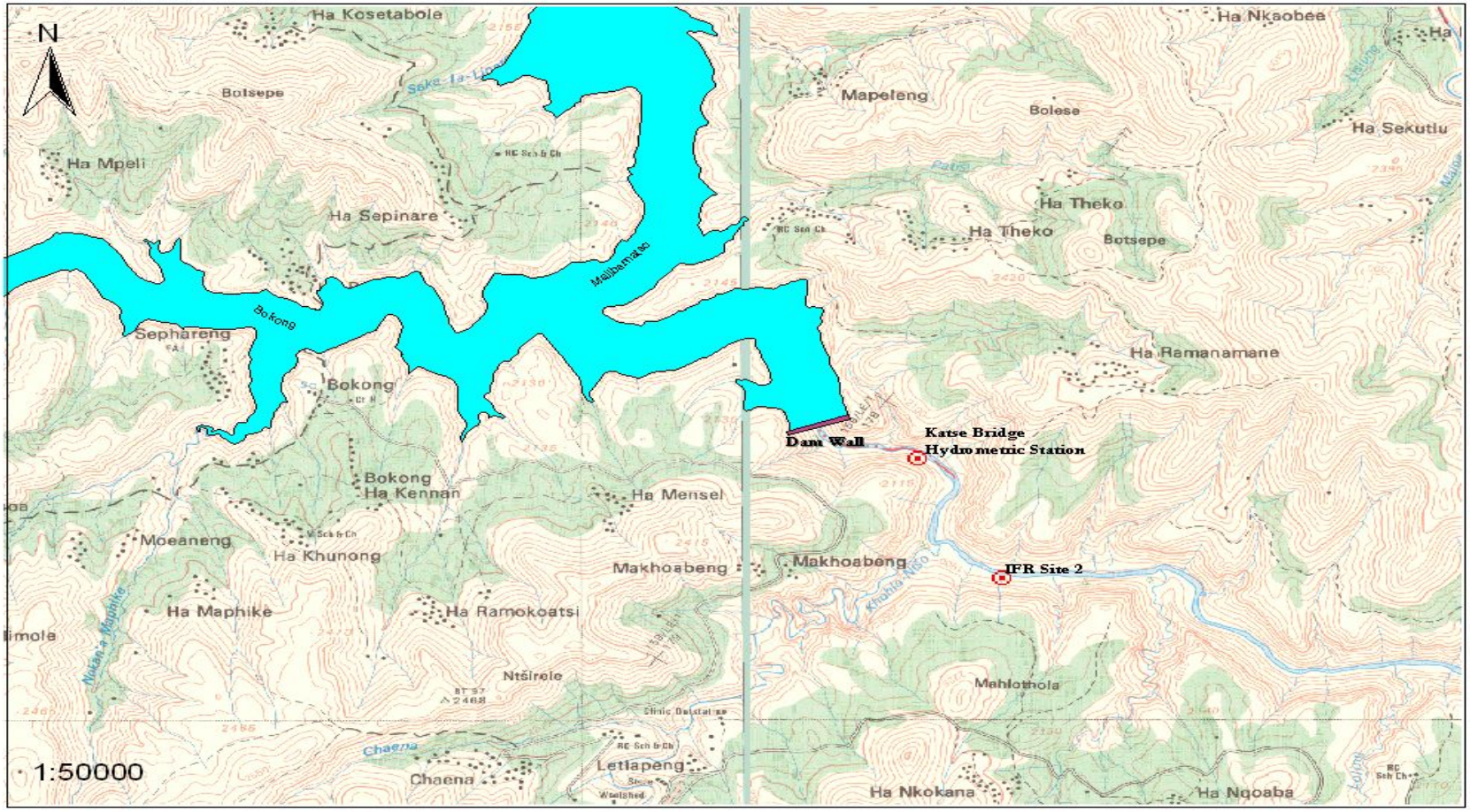
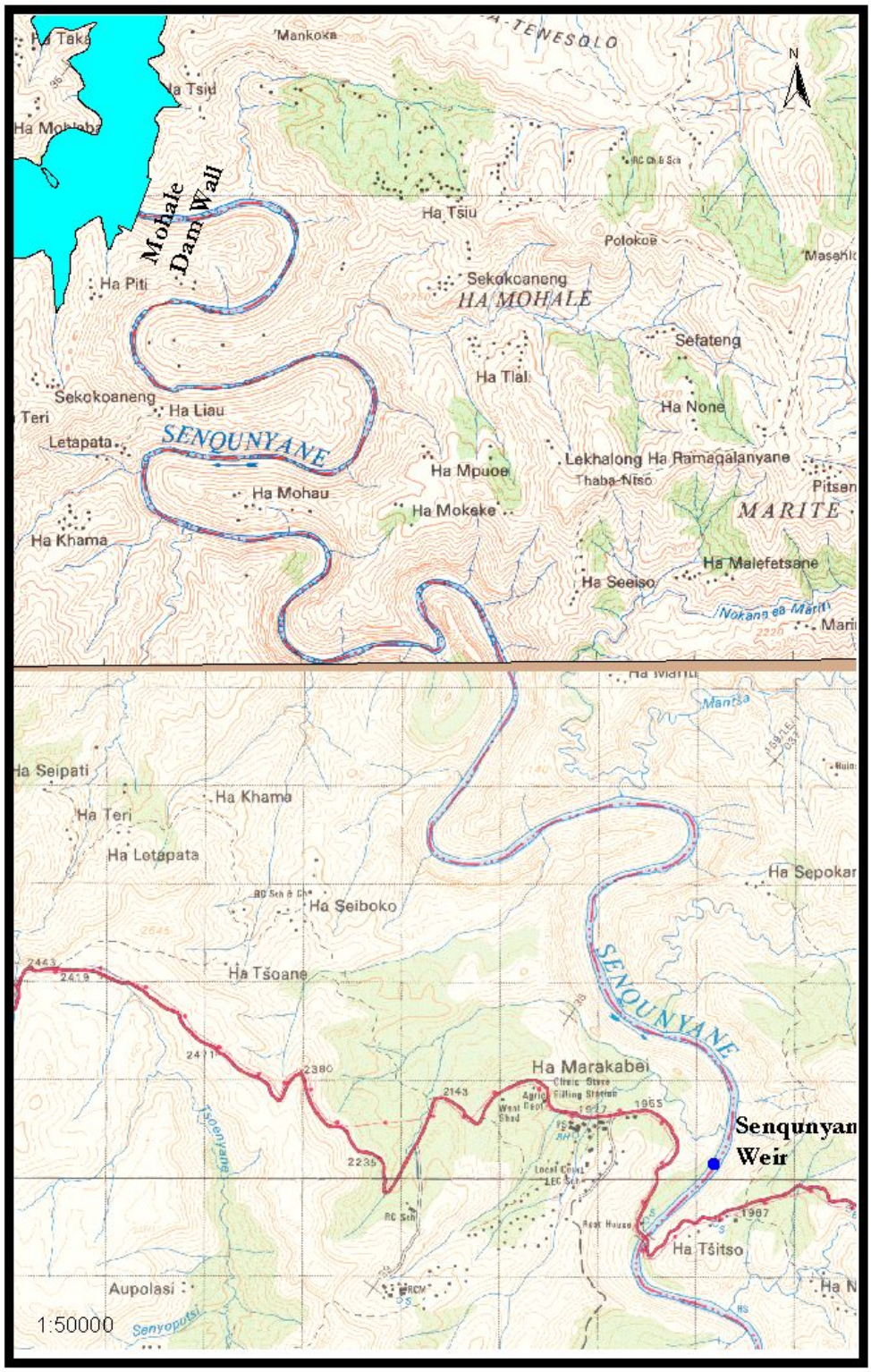


Figure 3: The Mohale Dam and the IFR site 7 reach



1. KATSE DAM

The 2004/2005 Hydrological Year for the Katse Dam has experienced, on average, 'Plus 1' hydrological conditions with a total inflow of **745.23** MCM. The Plus 1 Hydrological Year Class ranges from **603.70** MCM to **757.20** MCM therefore the inflows into Katse Dam fall within this range. Actual quarterly conditions varied from Average to Plus 2. The required target release at dam site was **77.40** MCM, which was calculated to achieve the target river flow of **103.21** MCM at IFR site 2 downstream of the Katse Bridge Hydrometric station. Table 1 on page 9 provides details of the target volumes of water releases as stipulated in the IFR Policy and Procedures and the actual released amounts downstream of the Katse Dam and at the Katse Bridge hydrometric station just upstream of IFR site 2, since October 2004 to September 2005. It also provides the overall total at the end of the period.

The flood magnitude of 8.80 MCM was released in November 2004. Another flood magnitude of 4.49 MCM was released in March 2005 that was half the scheduled February flood magnitude of 9.00 MCM. The January flood was not released. All other scheduled within year floods were appropriately released as detailed in table 1. Thus a total of 28.67 MCM, which is 8.23 MCM (22%) less than the targeted within year flood release of 36.90 MCM was released as within year floods for the Hydrological Year 2004/2005 for Katse Dam.

No spill was experienced for the entire Hydrological Year.

Table 1:

Monthly Flow Releases and the Target IFR flows from the Katse Dam

Months Since October 2004 to September 2005	Assumed Hydrological Categories	Inflows at Dam site	Target Dam Release MCM				Actual Dam Release MCM				IFR Site 2 Target Flow Volume	Katse Bridge Hydrometric Station Actual Volume	Actual Recorded at IFR Site 3 Reach (Malibamatšo at Paray Weir)	Actual Water Delivered to RSA
		MCM	Floods	Freshets	Low Flows	Total	Floods	Freshets	Low Flows	Total	MCM	MCM	MCM	MCM
Oct-04	Average	28.78	0.00	0.00	2.95	2.95	0.00	0.00	2.85	2.85	5.02	4.54	8.28	52.27
Nov-04	Average	22.22	9.00	0.00	3.11	12.11	8.80	0.00	2.83	11.63	14.32	13.40	16.63	49.67
Dec-04	Average	129.22	0.00	0.00	3.21	3.21	0.00	0.00	3.35	3.35	5.16	4.17	9.18	50.13
Jan-05	Average	208.13	4.50	0.00	3.48	7.98	0.00	0.00	3.41	3.41	11.50	3.93	18.05	56.75
Feb-05	Average	54.47	9.00	0.00	3.14	12.14	0.00	0.00	3.12	3.12	15.71	3.78	10.39	52.42
Mar-05	Average	115.58	0.00	0.00	3.48	3.48	4.49	0.00	8.16	12.65	6.90	10.22	18.25	57.79
Apr-05	Plus 2	116.82	4.50	0.00	3.24	7.74	4.51	0.00	3.60	8.11	10.40	7.09	16.32	62.66
May-05	Plus 2	32.39	0.00	1.50	3.21	4.71	0.00	2.16	3.70	5.86	6.30	5.68	8.93	74.39
Jun-05	Plus 2	9.25	4.50	0.00	2.85	7.35	0.05	0.00	3.54	3.58	8.20	5.73	6.19	77.21
Jul-05	Plus 2	10.31	0.00	1.50	2.95	4.45	4.40	0.00	3.60	8.00	5.40	8.47	8.99	73.21
Aug-05	Plus 2	11.63	4.50	0.00	2.68	7.18	6.43	0.00	2.73	9.16	7.90	9.64	1.07	73.58
Sep-05	Plus 2	6.43	0.00	1.50	2.59	4.09	0.00	0.00	2.61	2.61	6.40	3.68	0.00	60.89
Total for Year 2004/2005		**745.23**	**36.00**	**4.50**	**36.90**	**77.40**	**28.67**	**2.16**	**43.50**	**74.34**	**103.21**	**80.34**	**122.28**	**740.95**

** There is no gauging station at IFR site 2, the designated point for demonstrating compliance with IFR Policy.

1.1. Summary of Flow Volumes Released from the Katse Dam

1.1.1. Spillage

Katse Dam did not spill between October 2004 and September 2005.

1.1.2. Discharges through the Low Level Outlet

The volume released through the Low Level Outlet (LLO) amounts to **28.67** MCM for this period. This amount is 7.33 MCM (20.4%) less than the target flood of 36.00 MCM. The flood that was scheduled for January 2005 (4.50 MCM) was not released and half (4.49 MCM) of the required February flood (9.00 MCM) was released in March 2005 as has been explained on page 4.

1.1.3. Dam Releases

The actual total volume of water released from the Katse Dam Outlets is **74.34** MCM, which is **3.06** MCM (**3.95%)** lower than the targeted IFR release requirement of **77.40** MCM. The discharge or flow volume released downstream of the Katse Dam is driven by the reservoir level. That is, when the reservoir level is high more discharge will be released downstream and when the reservoir level is low the discharge will be lower at the same percentage opening. Thus the lower Katse reservoir level during October 2004 to September 2005, along with the January flood and same freshets for July and September that were not released contributed to the overall 3.95% variance in releases at dam site, which is within the acceptable range.

1.1.4. Recorded Flows at the Katse Bridge Hydrometric Station

The total volume of water recorded at the Katse Bridge Hydrometric Station was **80.34** MCM. The LHDA decided to use the records of this flow recording station to give indications of the response of IFR site 2 reach to the Dam releases and the catchment contributions due to the absence of the recording station at the actual IFR site 2 (see figure 2). The amount of recorded water at the Katse Bridge Hydrometric Station was **22.87** MCM (**22%)** less than the stipulated IFR target flow at the IFR site 2 for the considered period, October 2004 to September 2005 but does not include the contribution from the Khohlontšo tributary.

The above figures, although indicating that there was again a deficit being experienced both in dam releases and at the Hydrometric Station (IFR site 2 Reach), show that there has been improvement in the implementation and monitoring of the IFR Policy and Procedures.

It must, however, be noted that the Katse Bridge Hydrometric Station was rehabilitated to directly capture the releases from the Katse Dam, but it must be realized that this station is also capturing some of the incremental catchment flows. That is why the flows recorded at the Katse Bridge Hydrometric Station are higher than the releases from the Katse Dam and lower than the IFR site 2 target flows. This becomes more evident during high flows when Khohlontšo tributary contributes considerably higher flows to the IFR Site 2. The Khohlontšo Tributary stream is located downstream of the Katse Bridge Hydrometric Station and its flow is therefore not measured. It is, hence not possible to accurately determine how much of the mentioned deficit of 22%

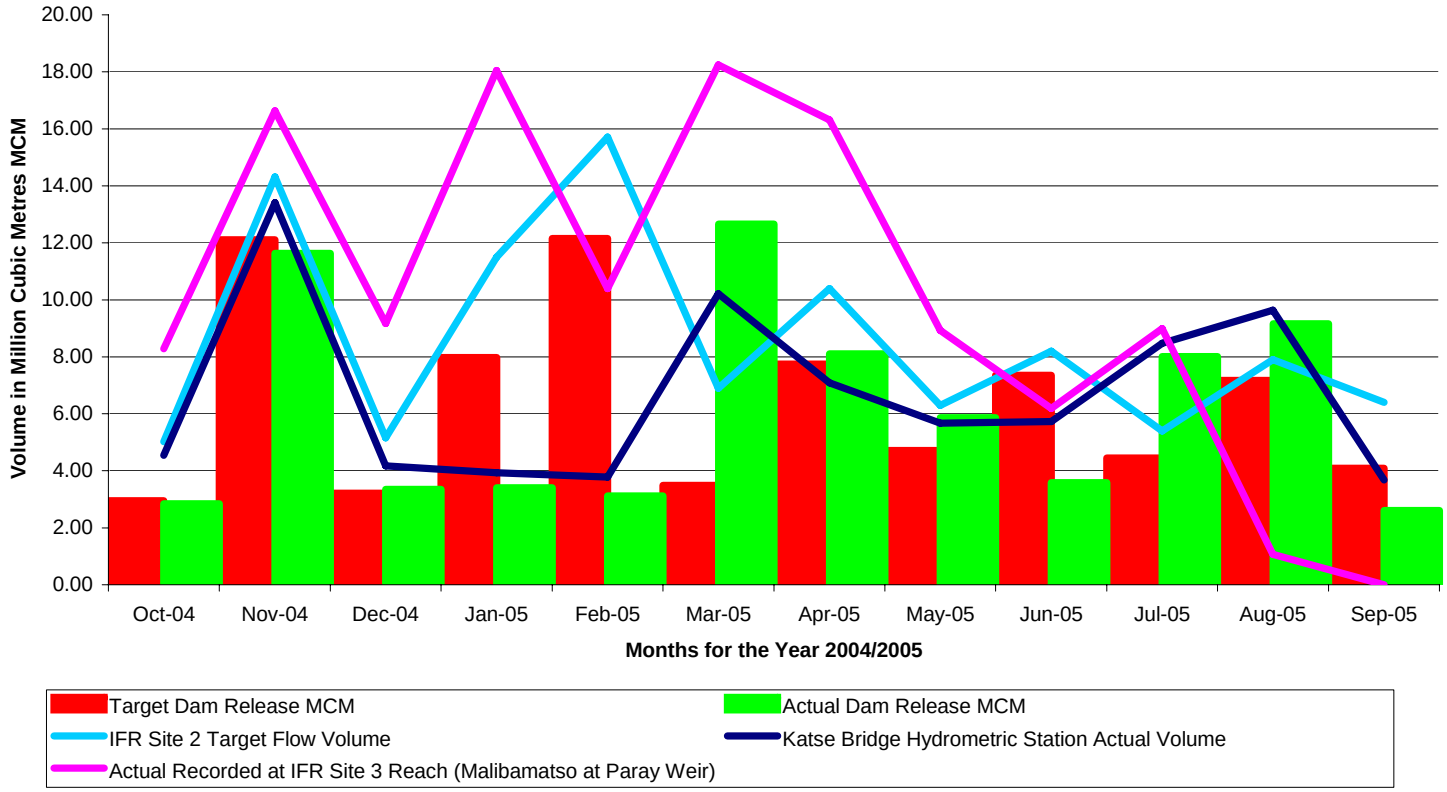
would have been met by these unmeasured contributions to the flow at IFR site 2. A measuring Hydrometric Station is now being constructed and it is expected to be completed during the first week of October 2006.

Figure 4:

The Monthly Flow Releases and the target IFR releases from the Katse Dam.

Figure 4 on page 13 graphically presents the recorded Monthly Flow Releases from the Katse Dam, the recorded flows at the Hydrometric station on Malibamatšo River at Paray Weir (IFR site 3 reach), the Hydrometric Station at Katse Bridge just downstream of the Katse Dam (labeled IFR Site 2 Reach) and upstream of IFR site 2 reach, and the target IFR releases at both the Katse Dam site and IFR site 2.

FIGURE 4: Actual Versus IFR target Flow Releases From Katse Reservoir for the Hydrological Year 2004/2005



2. MOHALE DAM

The 2004/2005 Hydrological Year for Mohale Dam has experienced, on average, 'Average' river classification conditions with the inflow of **360.64** MCM. However, actual quarterly conditions covered the full spectrum from Minus 2 (extremely dry) to Plus 2 (extremely wet). The average Hydrological Year Class ranges from **299.10** MCM to **376.60** MCM therefore the inflows into Mohale Dam fall within this range.

The required target release at dam site was **26.44** MCM, which was calculated to achieve the target river flow of **67.82** MCM at IFR site 7 downstream of the Mohale Dam. Table 2 on page 15 gives the volumes of water as stipulated in the IFR Policy and Procedures and the actual released aggregate amounts from the Mohale Dam and actual aggregate recorded flows at IFR site 7. It also provides the overall total at the end of the period October 2004 to September 2005.

The volume of water released downstream of the Mohale Dam into the Senqunyane River system from October 2004 to September 2005 amounts to **44.32** MCM. This amount is **17.88** MCM (40%) higher than the target IFR release of **26.44** MCM.

There was a scheduled flood release of 15 m^3/s (**3.90** MCM) for the month of February 2004, which was released later in March 2005. This was the only scheduled flood release for Mohale Dam during 2004/2005 Hydrological year.

Table 2:

Monthly Flow Releases and the target IFR Flows from Mohale Dam

Months Since October 2004 to September 2005	Assumed Hydrological Categories	Inflows at Dam site	Target Dam Release MCM			Actual Dam Release MCM			IFR Site 7 Target Flow Volume	IFR Site 7 Actual Volume	Actual Water Delivered to Katse Dam
		MCM	Floods	Low Flows	Total	Floods	Low Flows	Total	MCM	MCM	MCM
Oct-04	Average	18.56	0.00	2.01	2.01	0.00	5.22	5.22	6.88	6.12	0.00
Nov-04	Average	9.51	0.00	3.27	3.27	0.00	6.82	6.82	11.26	7.22	0.00
Dec-04	Average	36.79	0.00	1.45	1.45	0.00	5.73	5.73	4.95	6.40	0.00
Jan-05	Minus 2	72.05	0.00	1.12	1.12	0.00	4.56	4.56	2.82	8.22	0.00
Feb-05	Minus 2	48.16	3.90	1.45	5.35	0.00	4.00	4.00	8.68	7.34	0.00
Mar-05	Minus 2	42.49	0.00	1.55	1.55	3.89	1.65	5.54	5.07	10.35	0.00
Apr-05	Average	64.12	0.00	2.41	2.41	0.00	0.69	0.69	8.24	4.34	0.00
May-05	Average	17.38	0.00	1.58	1.58	0.00	2.90	2.90	3.70	3.10	0.00
Jun-05	Average	5.65	0.00	0.73	0.73	0.00	1.73	1.73	1.68	2.08	0.00
Jul-05	Plus 2	5.96	0.00	1.98	1.98	0.00	1.74	1.74	4.15	1.82	0.00
Aug-05	Plus 2	16.68	0.00	2.71	2.71	0.00	3.04	3.04	5.63	3.11	0.00
Sep-05	Plus 2	23.28	0.00	2.28	2.28	0.00	2.35	2.35	4.76	2.75	0.00
Total for Year 2004/2005		**360.64**	**3.90**	**22.54**	**26.44**	**3.89**	**40.43**	**44.32**	**67.82**	**62.85**	**0.00**

2.1. Summary of Flow Volumes Released from the Mohale Dam

2.1.1. Spillage

Mohale Dam did not spill since its impoundment in October 2002 until September 2005.

2.1.2. Discharges through the Low Level Outlet

The volume released through the LLOs amounts to **3.89** MCM for this period. This amount is attributed to the LLO discharges for within year flood releases as had been indicated earlier.

2.1.3. Dam Releases

The actual total volume of water released from the Mohale Dam Outlets is **44.32** MCM, which is **17.88** MCM (**40%**) higher than the targeted dam releases for IFR release requirement in order to meet the IFR requirements at IFR site 7 downstream of the Mohale Dam.

2.1.4. Flows Recorded at IFR Site 7 Reach

The total volume of water recorded at IFR Site 7 was **62.85** MCM. This is **4.97** MCM (**7%**) less than the stipulated IFR target flow at this site for the considered period, October 2004 to September 2005.

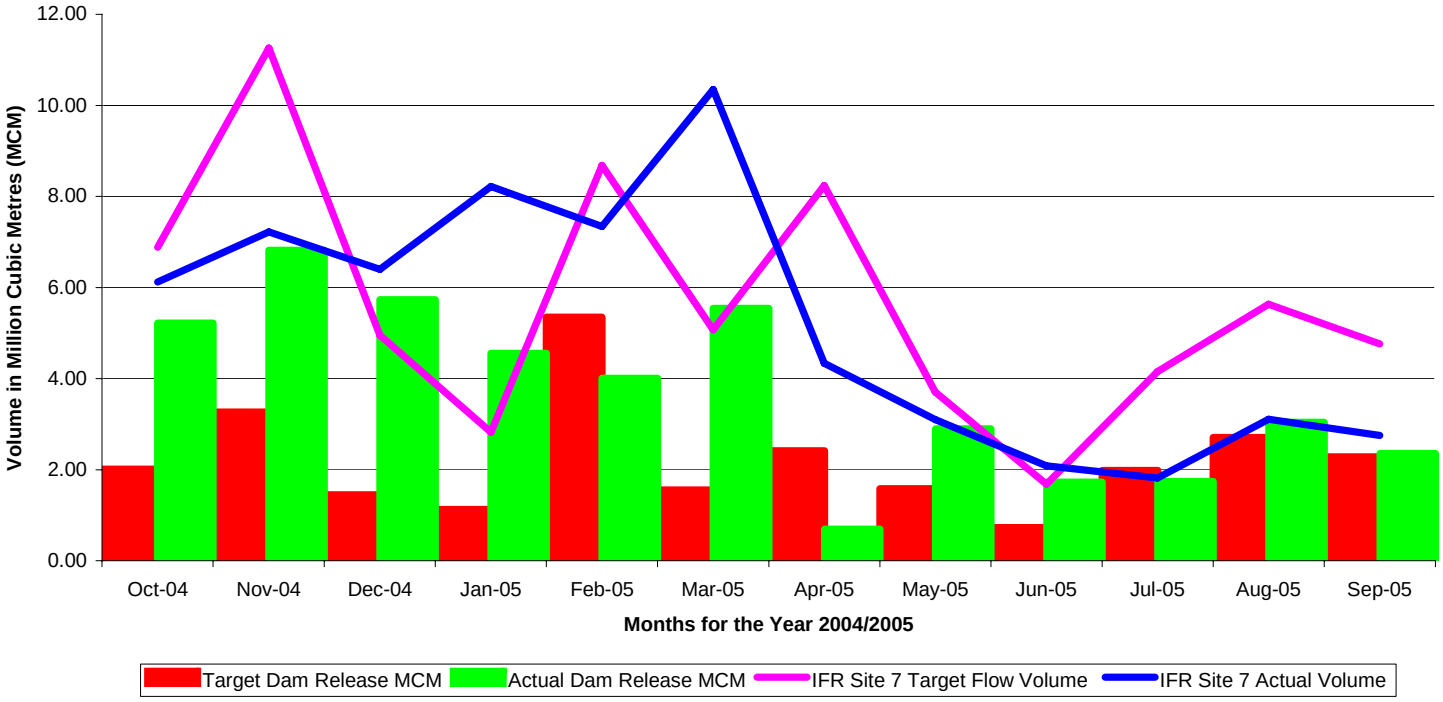
The above figures indicate that even with the over delivery of **40**% in dam releases there was still a deficit of **4.97** MCM (**7**%) experienced at IFR site 7 for the period October 2004 to September 2005. This was because inflows from the incremental catchment area between Mohale Dam and IFR site 7 were again far less than had been assumed and/or calculated when the release schedules were drawn up

Figure 5:

The Monthly Flow Releases and the target IFR releases from the Mohale Dam.

Figure 5 on page 18 presents the recorded Monthly Flow Releases from the Mohale Dam. It also shows the recorded flows from the Weir station on Senqunyane River at IFR site 7. The target IFR releases from the Mohale Dam site and the target flows for IFR site 7.

FIGURE 5: Actual versus IFR target Flow Releases From Mohale Reservoir for the Hydrological Year 2004/2005



3. ‘MUELA DAM

Table 3 on page 20 gives the monthly volumes of water released downstream of the ‘Muela Dam from October 2004 to September 2005. It also provides the overall total at the end of the period.

The volume of water released downstream of the ‘Muela Dam into Hololo River system from October 2004 to September 2005 amounted to **1.84** MCM. There is no IFR requirement stipulated for ‘Muela Dam since the Nqoe River flows are not considered to be part of the Treaty flows. Accordingly 100% of the MAR was released at a constant rate until November 2004. It was agreed in December 2004 to ‘bank’ water in LHWP structures, for later releases to the Caledone River to offset drought conditions and to meet water demand in Maseru during dry seasons. Releases were thus reduced to 25% of the Mean Annual Runoff (MAR). The Low Level Outlet valve was not used at ‘Muela during the period under consideration and there was also no spill flow experienced either.

Table 3:

Monthly Flow Releases from the ‘Muela Dam

Months Since October 2004 to September 2005	Target Dam Site Releases for IFR Requirements	Actual Dam Site Releases Measured at Hydrometric Station			Actual Recorded at Nqoe River Upstream of the 'Muela Dam	Actual Recorded at Hololo River downstream of the 'Muela Dam
	Low Flows	Floods	Spill Flow	Total Flows		
	MCM	MCM	MCM	MCM	MCM	MCM
Oct-04	0.40	0.00	0.00	0.40	0.02	0.94
Nov-04	0.39	0.00	0.00	0.39	0.53	4.23
Dec-04	0.11	0.00	0.00	0.11	1.70	14.85
Jan-05	0.10	0.00	0.00	0.11	3.52	11.57
Feb-05	0.09	0.00	0.00	0.10	0.31	0.86
Mar-05	0.10	0.00	0.00	0.11	0.20	4.53
Apr-05	0.10	0.00	0.00	0.10	0.22	3.11
May-05	0.11	0.00	0.00	0.11	0.09	0.20
Jun-05	0.10	0.00	0.00	0.10	0.04	0.16
Jul-05	0.11	0.00	0.00	0.11	0.02	0.27
Aug-05	0.11	0.00	0.00	0.11	0.02	0.44
Sep-05	0.10	0.00	0.00	0.10	0.02	0.31
Total for Year 2004/2005	**1.82**	**0.00**	**0.00**	**1.84**	**6.68**	**41.47**

3.1. Summary of Flow Volumes Released from the 'Muela Dam

3.1.1. Spillage

'Muela Dam did not spill since October 2004 to September 2005.

3.1.2. Discharges through the Low Level Outlet

There was no volume released through the LLO.

3.1.3. Dam Releases

The actual total volume of water released from the 'Muela Dam Outlets is **1.84** MCM, which is 39% of the Mean Annual Runoff of the Nqoe River System. Thus releases were reduced from 100% MAR to 25% MAR and the balance 'banked' in the project storages since December 2004.

3.1.4. Flows Recorded at Hololo River Downstream of the 'Muela Dam

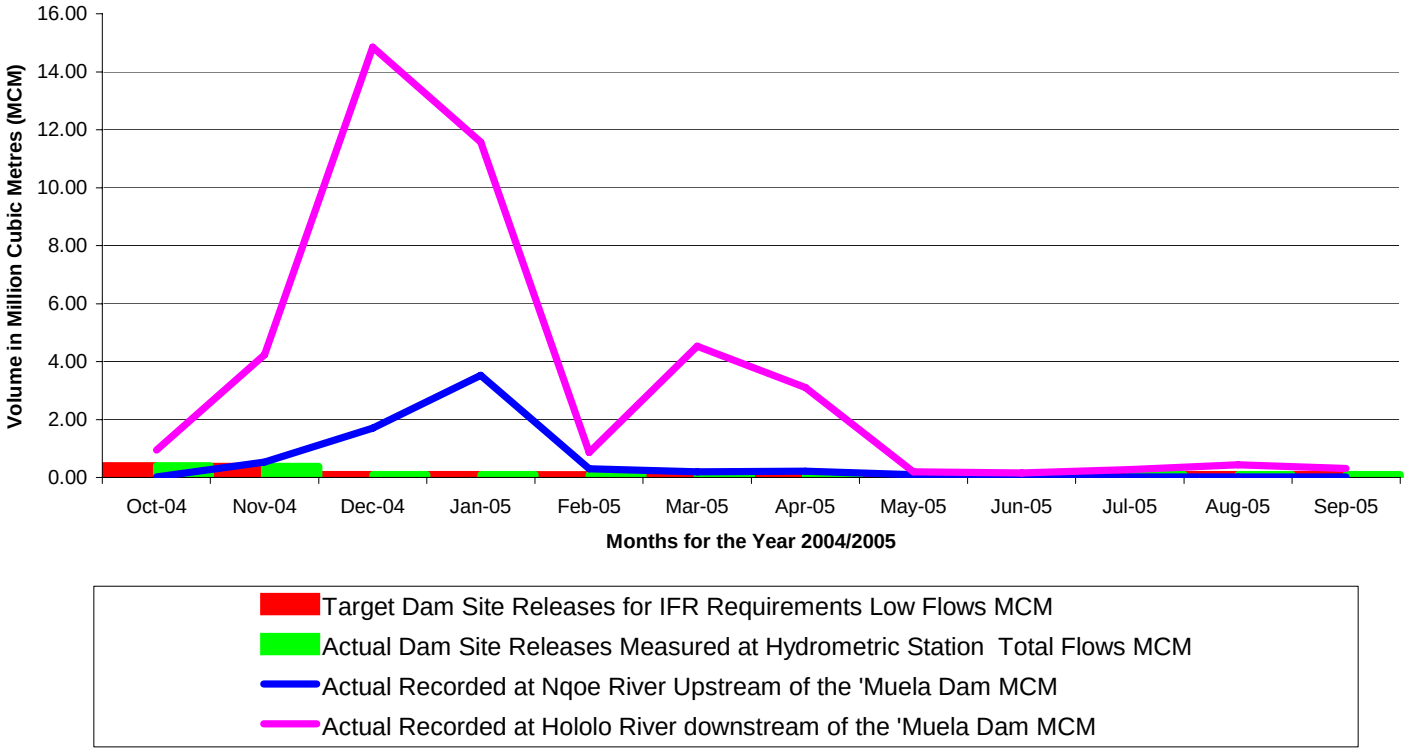
The total volume of water recorded at the Hololo River System is **41.47** MCM. This amount of water recorded at Hololo River System far exceeds the target flow released from the 'Muela Dam as it includes inflow from the larger Hololo river catchment.

Figure 6:

The Monthly Flow Releases and the target IFR releases from the 'Muela Dam.

Figure 6 on page 23 shows the flows from the 'Muela Dam outlets as compared with those from the Nqoe River Hydrometric Station. The Hololo River flows are also shown on this figure. It is observed that the Nqoe Inflows are much higher than the 'Muela Dam Outflows. The Nqoe flows however, decreased in magnitude to the minimum of 0.02 MCM for most part of the year. Thus the October 2004 to September 2005 period was a severely dry year for the Nqoe catchment area.

FIGURE 6: Actual versus Target Flow Releases from the 'Muela Dam since October 2004 to September 2005



4. MATSOKU DIVERSION WEIR AND TUNNEL

Table 4 on page 25 shows the Matsoku Diversion Weir and Tunnel estimated flows against the Matsoku River at Seshote Hydrometric Station for the period October 2004 to September 2005.

The Matsoku Diversion Weir is actually a non – storage facility and therefore there are also no IFR requirements implied for this Weir. However, the targeted flow volume, if the flow rate of **0.6** m^3/s was constantly released downstream, amounts to **18.92** MCM for the period October 2004 to September 2005.

The Matsoku River Hydrometric station at Seshote was used to evaluate the performance of the Matsoku Weir. This station recorded the volume amounting to **48.45** MCM for the same period.

Table 4:

Estimated Monthly Flow Releases from Matsoku Weir.

Months Since October 2004 to September 2005	Estimated Volume Downstream Release	Actual Matsoku Weir Downstream Releases	Target Matsoku Weir Downstream Releases for IFR Requirements	Measured Transfers to Katse Dam	Estimated Transfers to Katse Dam	Actual Recorded at Matsoku River downstream of the Diversion Weir and Tunnel	Estimated Matsoku Weir Inflows
	MCM	MCM	MCM	MCM	MCM	MCM	MCM
Oct-04	1.61	0.00	1.61	0.00	1.46	3.41	3.07
Nov-04	1.56	0.00	1.56	0.00	1.46	3.36	3.02
Dec-04	1.60	0.00	1.61	0.00	1.76	3.74	3.37
Jan-05	1.61	32.67	1.61	24.72	6.57	9.08	8.17
Feb-05	1.45	1.66	1.45	11.40	2.91	4.84	4.36
Mar-05	1.61	1.94	1.61	21.82	3.07	5.19	4.67
Apr-05	1.56	32.61	1.56	24.18	3.46	5.58	5.02
May-05	1.61	0.00	1.61	0.00	1.65	3.62	3.26
Jun-05	1.55	0.00	1.56	0.00	0.38	2.14	1.93
Jul-05	1.34	0.00	1.61	0.00	0.00	1.49	1.34
Aug-05	1.40	0.00	1.61	0.00	1.09	2.76	2.49
Sep-05	1.56	0.00	1.56	0.00	1.35	3.23	2.91
Total for Year 2004/2005	**18.44**	**68.87**	**18.92**	**82.11**	**25.16**	**48.45**	**43.60**

4.1. Summary of Flow Volumes Released from the Matsoku Diversion Weir and Tunnel

4.1.1. Spillage

Matsoku Diversion Weir and Tunnel did not spill since October 2004 to September 2005.

4.1.2. Discharges through the Tunnel Outlet to Katse Dam

The flow measuring metres/devices were not functional at the Matsoku Diversion Weir and Tunnel and as a result the estimated figures had been used to evaluate the transfers to the Katse Reservoir as well as flow releases downstream. Thus the total estimated volume of **25.16** MCM was transferred into Katse reservoir for the period October 2004 to September 2005.

4.1.3. Estimated Matsoku Weir Releases

The estimated total volume of water released from the Matsoku Diversion Weir and Tunnel Outlets is **18.44** MCM.

4.1.4. Flows Recorded at Matsoku River Downstream of the Diversion Weir and Tunnel

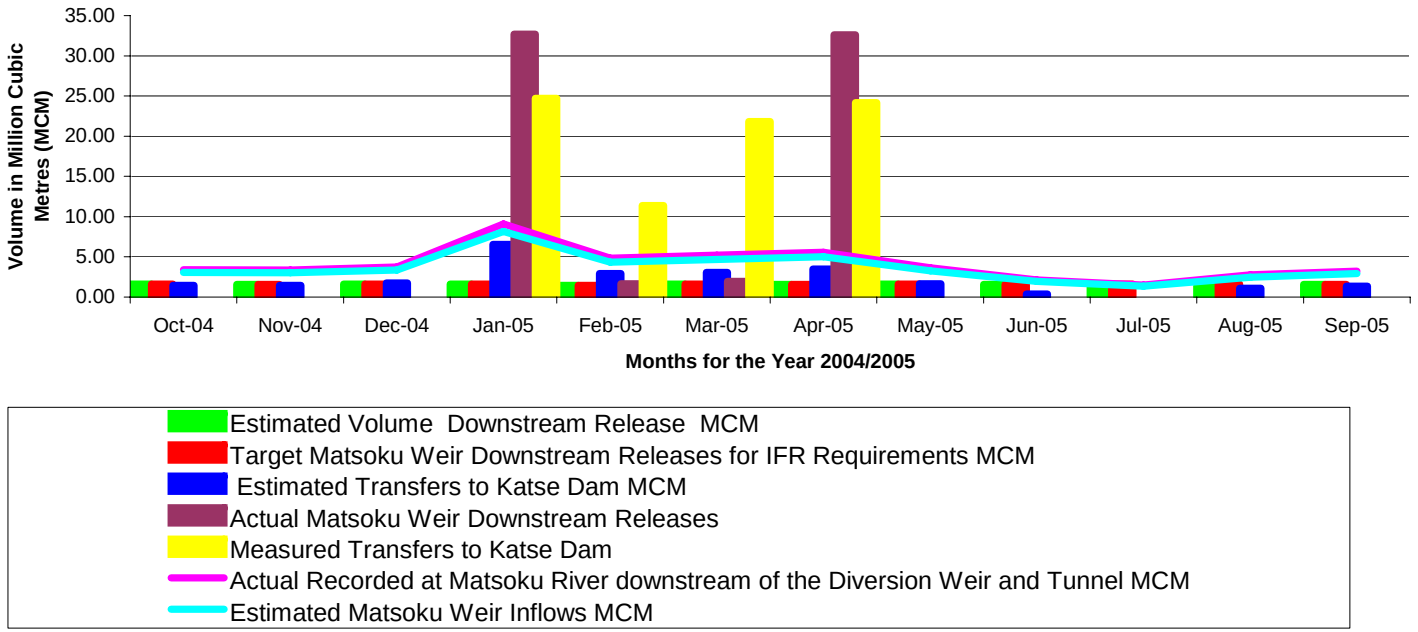
The total volume of water recorded at the Matsoku River System at Seshote Hydrometric Station is **48.45** MCM and the estimated Matsoku Diversion Weir and Tunnel Inflows, as computed, amounts to **43.60** MCM.

Figure 7:

The Monthly Estimated Flow Releases and the target releases requirement from the Matsoku Diversion Weir and Tunnel.

Figure 7 on page 28 shows the estimated downstream flows from the Matsoku Diversion Weir and Tunnel as compared with the Targeted releases and the Transfers into the Katse Dam. The estimated Matsoku Weir Inflow and the Matsoku Hydrometric Station at Seshote flows are also shown on this figure.

FIGURE 7: Matsoku Diversion Weir and Tunnel Flow at Matsoku and Matsoku Flows at Ha - Seshote actual Flows



5. CONCLUSIONS

The actual Hydrological Year Class for the Katse catchment area for the Hydrological Year 2004/2005 was, on average a 'Plus 1' class with the total inflow into the Katse Dam of **745.23** MCM.

The actual total volume of **74.34** MCM was released from the Katse Dam from October 2004 to September 2005. The target flow release, as specified in the IFR Policy, amounts to **77.40** MCM for the entire period, October 2004 to September 2005. The Dam has under delivered by approximately **4% (3.95%)**.

More importantly, the volume recorded at the Katse Bridge Hydrometric Station amounts to **80.34** MCM whilst the target IFR volume at IFR site 2 stands at **103.21** MCM. The Katse Bridge Hydrometric Station is situated 1 km upstream of the IFR site 2 and therefore this station is not capturing flows from the Khohlontšo Stream. Thus the difference between the flows measured at the Hydrometric station and the target IFR required flows stands at **22%.** Hence this difference would be somewhat less if the contributions from the Khohlontšo tributary were measured.

The Mohale Reservoir has experienced, on average, the 'Average' river classification conditions throughout the year but actual conditions varied from Minus 2 to Plus 2. The total inflow was **360.64** MCM for the Hydrological year 2004/2005.

A total volume of **44.32** MCM was released from the Mohale Dam through the alternate operation of a 500 mm diameter Sleeve Valve and a 200 mm diameter Sleeve Valve. The target flow release as specified in the IFR Policy amounts to **22.54** MCM from October 2004 to September 2005. The Dam has over delivered by **40%**.

However, the volume recorded at IFR site 7 amounts to **62.85** MCM and the target IFR volume stands at **67.82** MCM. This indicates that despite the over delivery of 40% at the dam site there is still a deficit of **7%** experienced at IFR site 7 for the period October 2004 to September 2005.

Generally releases from both the Katse Dam and the Mohale Dam have been insufficient to meet the stipulated flow quantities at the downstream IFR compliance sites. In the case of Mohale catchment, this is because the contributions from the intervening catchments were over estimated. Since flows at IFR site 2 cannot be measured, it is not possible to say with accuracy what the deficit is at that site. On the other hand the required within year floods were satisfactorily released from either dams.

The flow downstream of the 'Muela Dam has been reduced to 25% of the Mean Annual Runoff (MAR) of the Nqoe River Catchment. Therefore the Compensation valve at 'Muela Dam is constantly set to release 25% of the long – term mean annual runoff of Nqoe River system, which is estimated to be **0.04** m^3/s. There is no IFR implied for 'Muela Dam. Thus the total volume released from the 'Muela Dam from October 2004 to September 2005 is **1.84** MCM.

The Hydrometric Station flows of Matsoku River at Seshote have been used to estimate the Inflows into the Matsoku Diversion Weir and Tunnel and the Outflows that have been released downstream of Matsoku Weir whilst transferring excess water into the Katse reservoir. The estimated volume of water transferred via the Diversion Tunnel into the Katse reservoir equates to **25.16** MCM whilst the volume of water released downstream equates to **18.44** MCM.

It is observed from the Matsoku data set that measuring instruments were either not calibrated or faulty as the recorded values were only for a very short period and they were out of range, hence the estimates are

still used. The preparations to measure actual flows are, however, in an advanced stage therefore future flows will not be estimations.

The implementation of the IFR Policy and Procedures for 2004/2005 Hydrological Year was properly done through the assessment of quarterly classifications by predicting the next quarter on the bases of the actual prevailing conditions of the quarter under considerations. This is seen in the minimal deficits that were experienced for the period October 2004 to September 2005.

6. RECOMMENDATIONS

It is recommended that Hydrometric Stations be constructed at IFR Sites so that the targeted flows at IFR Sites could be compared with the actual recorded flows at those sites. That is downstream of Matsoku Weir (IFR Site 1) and at IFR Site 2 downstream of the Katse Bridge Hydrometric Station and Khohlontšo tributary.

There has been an improved implementation and monitoring of the IFR Policy and Procedures for the Hydrological Year 2004/2005 with regard to low flow releases and flood releases. It is however, recommended that LHDA management should take its time learning the importance of this task so that all the required resource could be made available to the team that handles the IFR tasks.

It is also recommended that Surveys for sediment monitoring be carried out periodically at gauging station cross sections.

The IFR Policy required the issue of corrigenda to correct detailed provisions and the IFR Procedures will also require a revision to be issued to correct inaccuracies, to reflect changes, and to clarify provisions. That should be done in a timely manner. In particular the ratio of flow contribution to flows at IFR site 7 from above and below Mohale Dam should be corrected based on the available data that shows a consistent pattern different to that assumed. This assumption requires that flows are over released by about 40% to compensate for the lower catchment flow contributions below the dam.

Although the implementation of the quarterly Hydrological classifications of the IFR Policy and Procedures has proven fruitful, it is recommended that this is critically, technically and professionally reviewed. It imposes flow targets that are representative of climatic conditions during the previous quarter that may be quite different to the actual climatic

conditions of the subsequent quarter. That is the Summer flows are translated into Autumn season target flows and Winter flows are translated into Spring season target flows, possibly imposing a different season that the environment is not expecting, and may have adverse impacts on the aquatic environment.