

LESOTHO HIGHLANDS DEVELOPMENT AUTHORITY



ANNUAL FLOW RELEASES INSTREAM FLOW REQUIREMENT (IFR) IMPLEMENTATION AND MONITORING *(October 2006 to September 2007)*



REPORT NO.8

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STRATEGIC AND CORPORATE SERVICES DIVISION
MONITORING AND EVALUATION BRANCH

Aquatic Systems Section
HYDROLOGY

EXECUTIVE SUMMARY

The Annual Flow Releases for IFR Policy Implementation and Monitoring report provides information on the performance of the determined HYC for LHWP structures and its compliance with the IFR Policy and Procedures of the Lesotho Highlands Water Project for the period October 2006 to September 2007. It covers the release of water for IFR purposes from the Katse Dam, Mohale Dam, Muela Dam and the Matsoku diversion Weir.

KATSE RESERVOIR

The 2006/2007 hydrological year was characterized by wetter climatic conditions, with the aggregate of a Plus 1 HYC for the Katse catchment.

The rainfall patterns that are observed within this catchment area contributed and enabled Katse to attain a Plus 1 HYC; hence this catchment has received the average rainfall of 856.94 mm. The rainfall station at Mafika - Lisiu (Mphosong) has received the highest rainfall of 1, 285.60 mm during October 2006 to September 2007.

The total recorded reservoir inflow volume for the 2006/2007 hydrological year is 910.91 MCM. This inflow volume is inclusive of the transfers of 21.74 MCM from Matsoku Diversion Weir and Tunnel and 288.03 MCM from Mohale Dam. When these transfers are deducted, the net inflow from the Katse Catchment is 601.14 MCM, which falls within the wet Plus 1 classification range for Katse reservoir.

The total actual flow volume of 247.94 MCM was released downstream from the Katse Dam during October 2006 to September 2007, which was far more than the target flow amount of 97.71 MCM specified within the IFR Policy and Procedures. 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.

The actual flow volume recorded at the Katse Bridge Hydrometric Station, a reference point for the flows through IFR river reach 2 downstream of the Katse Dam, amounted to 293.02 MCM against the target IFR volume for this IFR site 2 of 127.63 MCM.

The total flow volume of 92.41 MCM was recorded as spillage from the Katse dam during this reporting period.

MOHALE RESERVOIR

The Mohale catchment experienced dry weather conditions with the overall aggregate of 'average' HYC conditions for the 2006/2007 hydrological year. Actual quarterly hydrological classification conditions varied from Minus 2 to Plus 2.

There was also not enough rainfall occurrences within the Mohale catchment. This catchment received the average rainfall of 809.20 mm with the rainfall station at Thaba – Putsoa registering the highest rainfall of 876.70 mm.

The total recorded inflow volume for 2006/2007 hydrological year was only 279.17 MCM, which falls within the dry average range for Mohale.

A total flow volume of 69.36 MCM was released from the Mohale dam. This flow volume is higher by 30.02 MCM from the target of 39.34 MCM. The released flow volume includes the effects of seepage through the dam wall.

The flow volume recorded at IFR site 7 amounted to 89.35 MCM. The target IFR flow volume was 100.59 MCM. There is therefore a deficit of 11.24 MCM that has occurred at IFR Site 7 during this reporting period.

‘MUELA DAM

‘Muela Dam released 3.44 MCM. This flow volume combines the flood release of 2.55 MCM to offset drought and provide water resources for domestic use in Maseru capital city. No spill occurred at ‘Muela Dam.

MATSOKU DIVERSION WEIR AND TUNNEL

The actual flow volume recorded at the Matsoku hydrometric station downstream of Matsoku weir was 39.27 MCM. The estimated Matsoku weir inflows based on this figure amounted to 35.34 MCM. Actual inflow volumes could not be definitively established due to faulty recording equipment at the weir. Based on the design capacity of the weir, it is estimated that 13.60 MCM was released downstream while 21.74 MCM was transferred to Katse.

In general there was drought being experienced in all LHWP catchments except for the Katse catchment that has attained the Plus 1 HYC during the 2006/2007 Hydrological Year.

Lack of and/or faulty measuring equipment at key points raises questions of the accuracy of the records.

Compliance with the IFR Policy and Procedures, especially with the flood releases at Mohale dam is still not up to standard and this continues to attract deficit at the IFR site 7 reach.

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BACKGROUND

The governments of the Mountain Kingdom of Lesotho and the Republic of South Africa signed the Treaty that established The Lesotho Highlands Water Project (LHWP) in October 1986. The LHWP is a multiphase project that comprises five (5) phases. The implementation of Phase 1 of the LHWP project began in 1988 with the construction of the Katse Dam and the 'Muela Hydropower generation Plant.

Phase 1 of the LHWP project is subdivided into two (2) phases, namely Phase 1A and 1B. Phase 1A, the Katse Dam, was first impounded on the 20th October 1995. The first water delivery to the Republic of South Africa took place on the 8th January 1998. Phase 1B, the Mohale Dam, was impounded in November 2002. These achievements marked the important milestones in the history of LHWP.

The signed Treaty specifies the required predetermined flows that must be released from the LHWP structures in order to sustain the aquatic lives within the river courses, the environment and the social activities downstream. The specified Treaty amounts were implemented from October 1995 for the Katse Dam. The Washington agreement that specified the amount of water that was required to be released when specified water levels in the Mohale reservoir were reached during its filling and impoundment was effected from November 2002.

The LHDA then observed that the Treaty required flows were not fully satisfying the requirements of the downstream river reaches and the expectations of the downstream environment. Therefore the LHDA respectively undertook the LHDA 648 and LHDA 678 studies to determine the Instream Flow Requirements (IFR) that would ensure appropriate fulfillment of downstream needs.

The study resulted in the production of the IFR Policy that was approved on the 13th December 2002. The associated IFR Procedures that stipulates the required monthly flows to be released at dam sites were later approved in July 2003.

The IFR Policy and Procedures' implementation was duly effected from August 2003. The procedures specify the monthly low flows and floods that are required to be released downstream. The importance of the IFR downstream flow releases to sustain downstream river systems calls for monthly flow monitoring programmes to be established to ensure that compliance to the required flows at the designated IFR sites is attained.

Hydrological data that is continuously recorded at flow measuring stations is therefore collected on monthly basis from LHWP structures, meteorological and hydrometric stations. The data is processed and analyzed to determine hydrological classifications for required flow releases, whilst also verifying compliance to the previously forecasted flow amounts.

1 INTRODUCTION

The Instream Flow Requirement (IFR) implementation and monitoring is driven, on a larger scale, by the prevailing Hydrology of the LHWP dam catchments.

The Lesotho Highlands Development Authority (LHDA) is mandated to implement and monitor the IFR Policy and Procedures that prescribe the amounts of water that must be released from dam structures to meet target flows at designated IFR sites.

The IFR requirements are determined by the computation of Evaporation from dam structures, the resultant Inflows into these structures through water balance modeling and the change in water level storages within the LHWP dam structures.

The parameters required for the computations of inflows are indirectly derived from the collected meteorological and hydrological data, through usage of the models that are developed and calibrated in the Hydrology section specifically for the LHWP dams.

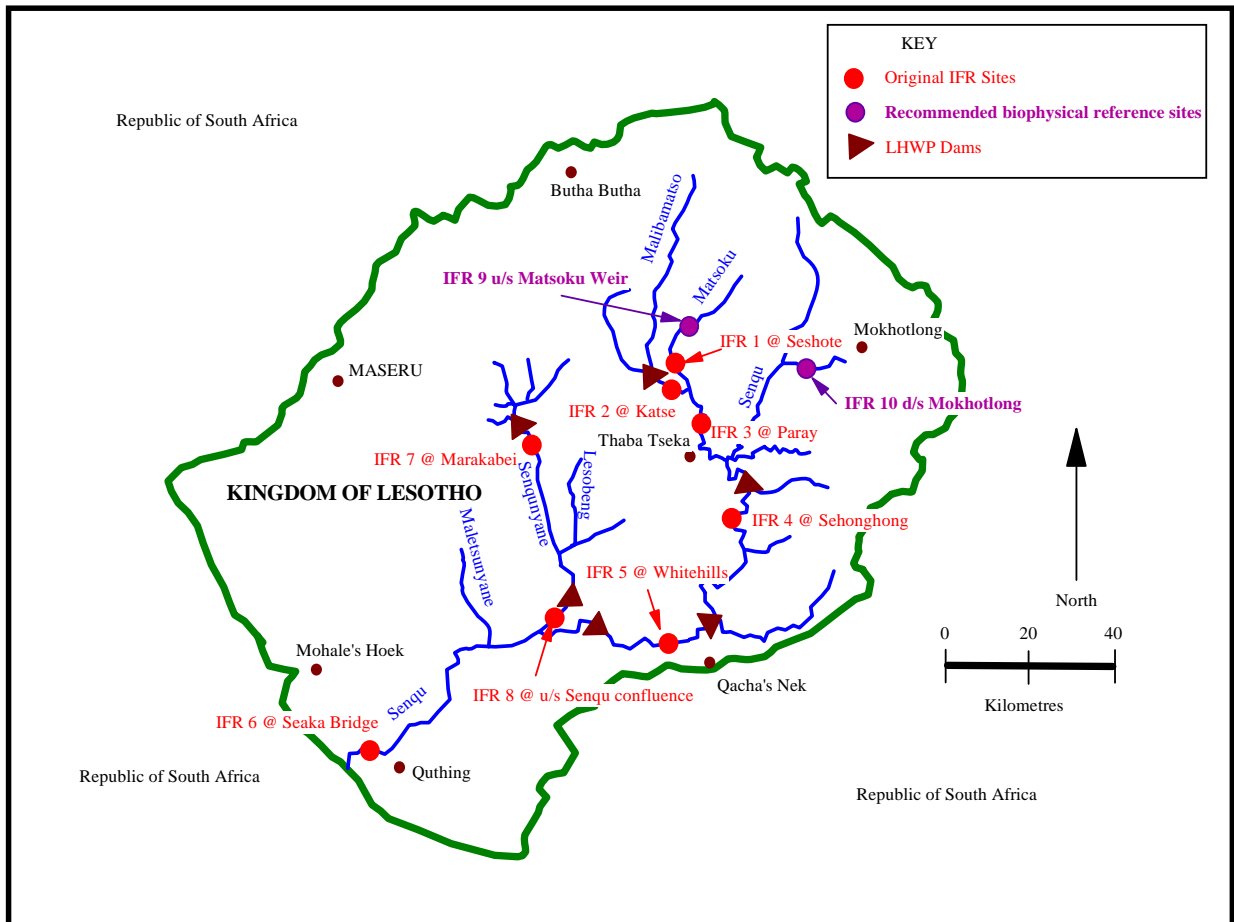
The collected IFR data informs on the responses of the IFR releases towards fulfilling the IFR Policy requirements. This report provides an account of compliance with the said IFR Policy and Procedures for flow releases downstream of the LHWP structures. Compliance to the IFR Policy is measured at the designated IFR sites where flow measurements are recorded daily.

This report also discusses in detail the events and variations experienced during the implementation of the IFR Policy and Procedures influenced by the prevailing weather conditions and other operational requirements, challenges and/or limitations during the 2006/2007 hydrological year.

Figure 1 on page 4 depicts All IFR sites. Major rivers that are mostly affected by the LHWP project are shown on this figure. Figure 2 on page 7 shows the Katse Dam, the Downstream Hydrometric Station at the Katse Bridge, the Khohlontšo

Stream and the IFR site 2 reach. Figure 3 on page 17 provides the locations along the Senqunyane River where IFR site 7 is situated 28 km downstream of the Mohale Dam wall.

Figure 1: Hydrological map showing location of all IFR sites and reference sites



- IFR Site 1* Matsoku near Seshote
- IFR Site 2* Malibamatšo 3 km downstream of the Katse dam
- IFR Site 3* Malibamatšo at Paray 31 km downstream of the Katse dam
- IFR Site 4 Senqu at Sehong-hong 115 km downstream of the Katse dam
- IFR Site 5 Senqu at Whitehills 75 km downstream of the Katse dam

- IFR Site 6 Senqu at Seaka
- IFR Site 7* Senqunyane at Marakabei 28 km downstream of the Mohale dam
- IFR Site 8* Senqunyane upstream of the Senqu confluence.

2 FLOW RESULTS

2.1 KATSE CATCHMENT

The Katse catchment area is characterized by wet weather conditions with satisfactory inflows into the Katse dam. This catchment receives high amounts of rainfall that contribute substantial inflows into the Katse dam structure every year. And the strategic rainfall station at Mphosong recorded the cumulative rainfall amount of 1,285.60 mm during the October 2006 to September 2007 hydrological year.

The total recorded volume of inflow into the Katse dam during this period is 910.91 MCM and the volume of 780.93 MCM of water has been delivered to RSA. This abundant water resource enables the LHWP project to successfully continue to meet its water delivery obligations to the Republic of South Africa. See Table 3 on page 11.

Figure 2 on page 4 shows the locations of key focus areas along the Malibamatšo River downstream of the Katse dam. These are:

- a) The Katse bridge hydrometric station at 1.06 km downstream of the Katse dam.
- b) The Khohlontšo River, a tributary of the Malibamatšo main River, which is situated 2 km from the dam and providing additional flows to IFR Site 2 and
- c) IFR Site 2 at 3.06 km downstream of the Katse dam.

2.1.1 RAINFALL PATTERNS

Rainfall amounts within the Katse catchment area are illustrated in Table 1 on page 6. Rainfall provides part of the necessary runoff and the required inflows into LHWP structures to drive the implementation of IFRs.

The available flow records indicate that incremental catchment flows largely depend on rainfall events occurring within the Katse catchment area. The incremental catchment is the catchment that is found between the IFR site

and the Dam site and therefore rainfall is essential to provide the anticipated incremental catchment flows to fill up for the IFR required flows.

Table 1: Rainfall patterns within the Katse Catchment

Month	Mphosong	Rampai	Ha-Poli	Makopela	Katse Village
Oct - 06	70.20	122.50	112.10	105.10	106.10
Nov - 06	476.10	314.50	194.70	121.50	72.00
Dec - 06	222.80	154.00	157.50	130.80	132.00
Jan - 07	114.70	101.50	113.70	92.60	61.70
Feb - 07	84.40	56.00	51.10	31.10	40.70
Mar - 07	59.50	71.50	63.50	32.00	44.00
Apr - 07	85.80	102.00	85.60	41.10	43.10
May - 07	28.50	0.00	0.00	2.50	0.10
Jun - 07	13.1	35.40	23.60	22.00	4.50
Jul - 07	56.30	0.00	0.00	0.50	0.00
Aug - 07	6.50	0.00	5.00	3.70	0.00
Sep - 07	67.70	48.50	42.40	23.30	33.60
Total	1,285.60	1,005.90	849.20	606.20	537.80

Rainfall events varied from the maximum of 1, 285.60 mm occurring at Mphosong to 537.80 mm occurring at the Katse Village.

Rainfall figures in Table 1 above were considerably high during November 2006 to January 2007 for the 2006/2007 hydrological year, indicating that this half has been a wet year for the Katse catchment. The relatively high rainfall occurrences recorded at Mphosong and Rampai rainfall stations have significantly contributed to the high volume of recorded inflows into the Katse dam.

Figure 2: Katse Dam and the IFR site 2 reach

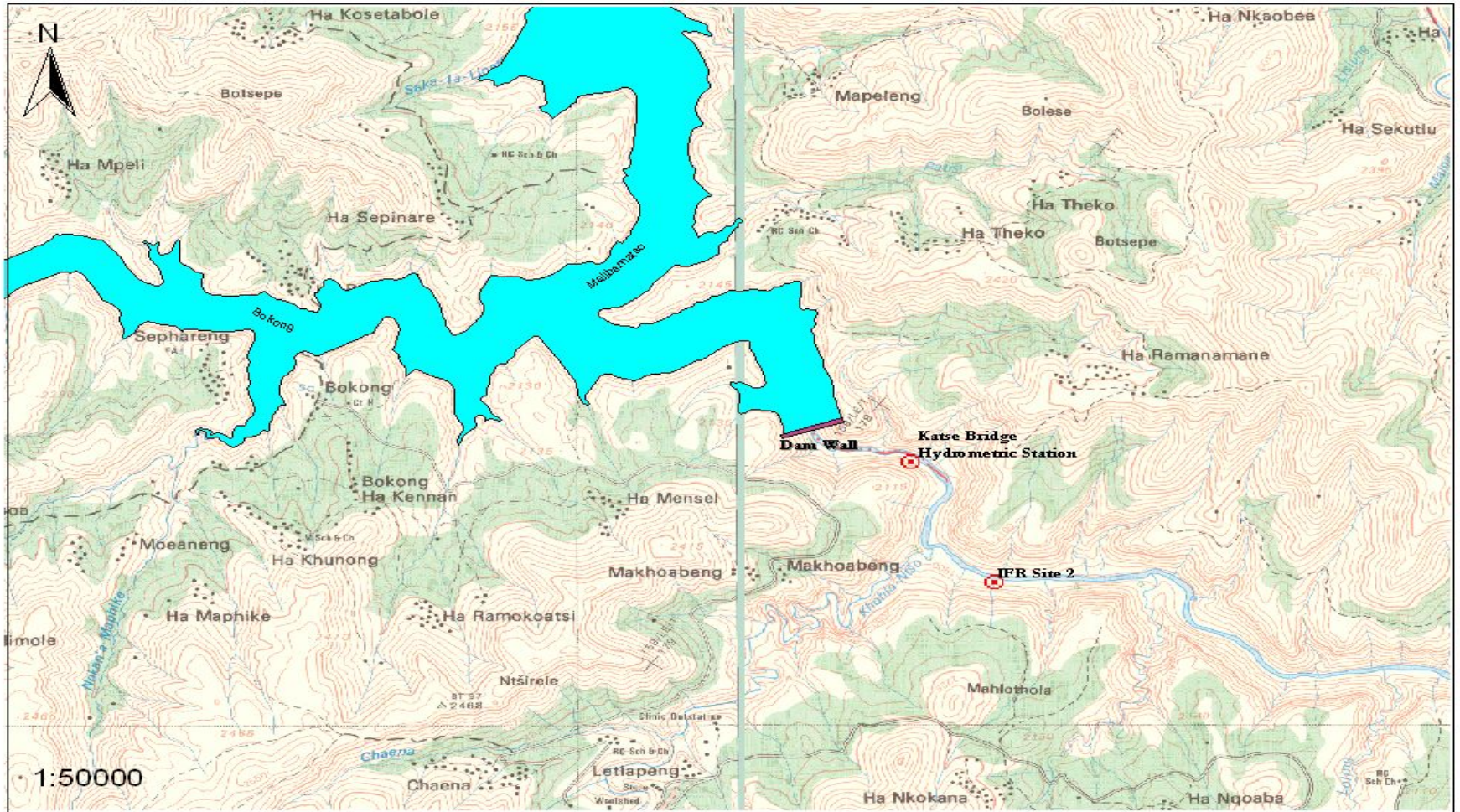
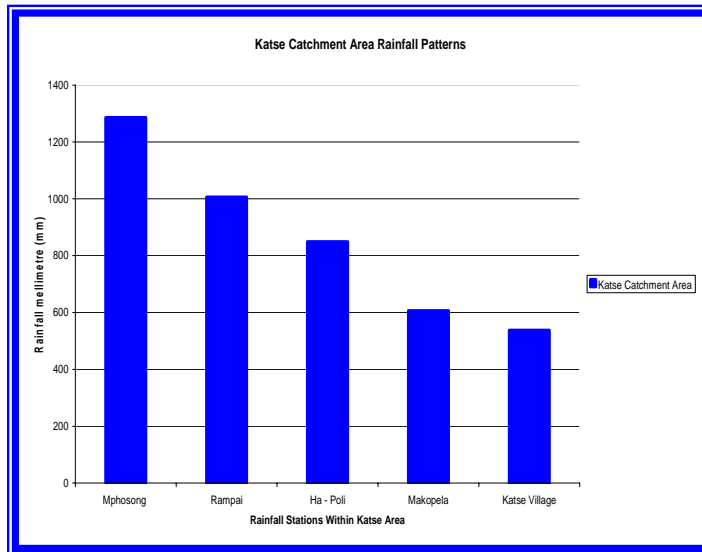


FIGURE 3: Katse Catchment Rainfall Patterns



Mphosong rainfall station received the highest amount of rainfall. The rainfall magnitude seems to reduce as it progresses further, from Mafika – Lisiu all the way to Katse. This is because the warm and moist North Westerly winds are forced to rise over the

Mafika – Lisiu mountain plateau and cool adiabatically to form precipitation. Thus part of the moisture content gets lost and the dry winds progress further into the highlands with reduced moisture and magnitude of rainfall occurrences.

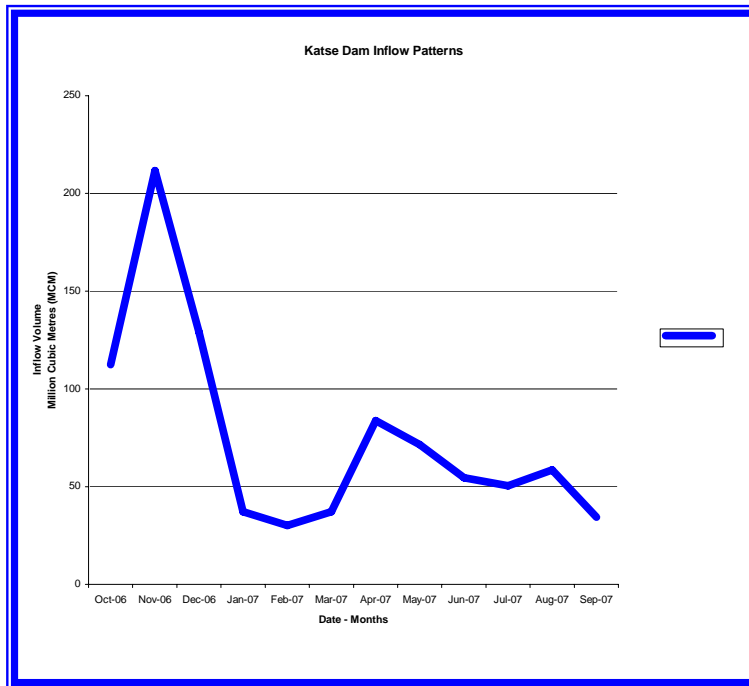
2.1.2 KATSE DAM INFLOWS

The Katse reservoir received the total inflow volume of 910.91 MCM for the 2006/2007 hydrological year. This amount of inflow into the Katse Dam comprises of:

- The rainfall occurring within the Katse catchment area
- The transfers of 288.03 MCM from Mohale Dam and
- The estimated transfers of 21.76 MCM from the Matsoku Diversion Weir and Tunnel.

The actual inflow volume into the Katse reservoir, after deductions of all the transfers is therefore 601.14 MCM. See Table 3 on page 12, which presents the monthly inflow volume and releases data for the Katse Reservoir.

FIGURE 4: Katse Dam Inflow Patterns



The volume of Inflows into the Katse reservoir was very high during October to December 2006. The inflow volume was 112.38 MCM in October 2006. It increased drastically to 211.61 MCM in November 2006. And it again went down to

129.06 MCM in December 2006. Thus this flow variation patterns show that naturally occurring floods were taking place and they were raging around the 1:50 (1 in 50) years flood during November 2006. That is a flood with the return period of 50 years.

The Inflow patterns thereafter reduced dramatically to very dry weather conditions during January to March 2007 and throughout the rest of the 2006/2007 hydrological year. See inflow patterns shown in Table 2 on page 10 and in figure 4 above.

2.1.3 HYDROLOGICAL YEAR CLASSES (HYC) AT IFR SITE 2

The HYC is determined through monthly computation of reservoir inflows. These monthly volumes of water are added at the end of each quarter to find inflow volume into the Katse dam for the considered quarter. It is upon these actual inflow figures that the following quarter is derived on and the IFR releases are determined.

The actual quarterly HYC conditions for IFR site 2 are presented in Table 2 on page 10 overleaf. The quarter October to December 2006 obtained a

Plus 2 HYC. The quarter January to March 2007 obtained a Minus 2 HYC. The quarter April to June 2007 attained a Minus 1 HYC and the quarter July to September 2007 obtained the “Average” HYC.

Table 2: Actual inflows into the Katse Reservoir (in MCM)

Quarter	Total Inflow into Katse Dam	Less Transfers from Mohale Dam	Less Transfer from Matsoku	Add Incremental Catchment Flows	Net Actual Inflows at IFR Site 2	Actual Hydrological Class
Oct 2006 To Dec 2006	453.05	31.00	13.53	41.58	450.10	Plus 2
Jan 2007 To Mar 2007	104.65	16.15	1.87	2.50	89.13	Minus 2
Apr 2007 To Jun 2007	209.84	146.21	3.92	5.56	65.27	Minus 1
July 2007 To Sept 2007	143.37	94.67	2.44	-4.55	41.71	Average
Total	910.91	288.03	21.76	45.09	646.21	Plus 1

The HYC at IFR site 2 is determined through considering both the net inflow volume into the Katse dam and the incremental catchment flows at IFR site 2. The sum of the inflow volume of 601.14 MCM into the Katse dam and the incremental catchment contribution of 45.09 MCM give the total flow volume of 646.21 MCM. The incremental catchment contribution of 45.09 MCM is computed as the difference between the recorded flow volume at IFR site 2 and the released flow volume from the Katse dam.

Thus the flow volume used for the determination of the aggregate HYC for IFR site 2 is 646.21 MCM. This inflow volume falls within the determined flow range of the Plus 1 HYC, which is 603.70 MCM to 757.20 MCM as given in Table 2.2-A of the IFR Procedures. Therefore the 2006/2007 hydrological

year has generally obtained a Plus 1 HYC conditions for IFR site 2 reach. Table 2 on page 10 provides the details.

2.1.4 DAM RELEASES

The actual total volume of water released from the Katse Dam Outlets during October 2006 to September 2007 is 247.94 MCM. This outflow volume far exceeds the target flow volume of 97.71 MCM by 150.23 MCM. This flow variance is attributed to the occurrence of good rains that also yielded the November 2006 floods and the spill flow that took place during October, November and December 2006.

There are, however incidences where the required flows could not be achieved. The discharge released downstream of the Katse Dam is hydraulically driven by the reservoir level (that is the Head of water in the reservoir). 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 and the IFR would not be fulfilled.

2.1.5 DISCHARGES THROUGH THE LOW LEVEL OUTLETS (LLOs)

The LLO gates facilitate releases of floods and freshets from the Katse dam. The total volume of water released through the Low Level Outlet gates (LLOs), both as floods and freshets, amounts to 215.36 MCM for this period. The target flood release of 52.00 MCM and the target freshet release of 10.50 MCM were partly released and they form part of the total volume released through the LLO gates.

The total target freshet volume of 10.50 MCM that was scheduled to be released during 2006/2007 hydrological year is not shown in column 9 of Table 3 on page 12. All the effected LLO releases are shown in the floods column because those were released as a measure of safety during heavy rains that also influenced the spill to occur repeatedly at the Katse dam due to the November 2006 floods.

Table 3: Monthly Flow Releases and the Target IFR flows from the Katse Dam

Month	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				
Oct-06	Plus 2	112.38	0.00	0.00	3.21	3.21	3.53	0.00	2.81	6.34	7.10	10.57	13.01	59.56
Nov-06	Plus 2	211.61	16.00	3.50	3.24	22.74	151.00	0.00	2.73	153.73	27.50	179.20	215.26	57.09
Dec-06	Plus 2	129.06	9.00	0.00	3.26	12.26	49.31	0.00	2.92	52.23	16.30	64.11	52.18	54.85
Jan-07	Plus 2	37.19	4.50	3.50	3.48	11.48	0.00	0.00	2.53	2.53	16.50	7.33	18.03	55.52
Feb-07	Plus 2	30.19	9.00	0.00	3.14	12.14	0.00	0.00	2.53	2.53	15.90	0.00	5.00	50.85
Mar-07	Plus 2	37.27	4.50	3.50	3.48	11.48	0.00	0.00	2.78	2.78	15.20	3.01	4.45	56.44
Apr-07	Average	83.77	4.50	0.00	3.24	7.74	3.93	0.00	2.69	6.62	9.90	8.81	9.37	59.67
May-07	Average	71.42	0.00	0.00	3.21	3.21	0.00	0.00	2.78	2.78	3.98	3.78	4.29	73.76
Jun-07	Average	54.65	0.00	0.00	2.85	2.85	0.00	0.00	2.69	2.69	3.44	5.06	5.85	78.62
Jul-07	Minus 1	50.45	0.00	0.00	1.61	1.61	0.00	0.00	2.76	2.76	1.85	3.58	4.12	82.35
Aug-07	Minus 1	58.51	4.50	0.00	2.14	6.64	7.60	0.00	2.72	10.31	7.17	4.37	4.43	85.73
Sep-07	Minus 1	34.41	0.00	0.00	2.33	2.33	0.00	0.00	2.64	2.64	2.79	3.21	3.43	66.50
Total for Year 2006/2007		910.91	52.00	10.50	35.21	97.71	215.36	0.00	32.58	247.94	127.63	293.02	339.43	780.93

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

The released flood volume far exceeds the targeted floods by 152.86 MCM. This implies that the IFR requirements were fully satisfied both at dam site and at the IFR site 2.

The inflow volume in Table 3 on page 12, present flow data that shows that there was more flooding during October to December 2006 and enough flows were experienced throughout the reporting period. The required number of floods were naturally satisfied and even exceeded.

2.1.6 SPILLAGE

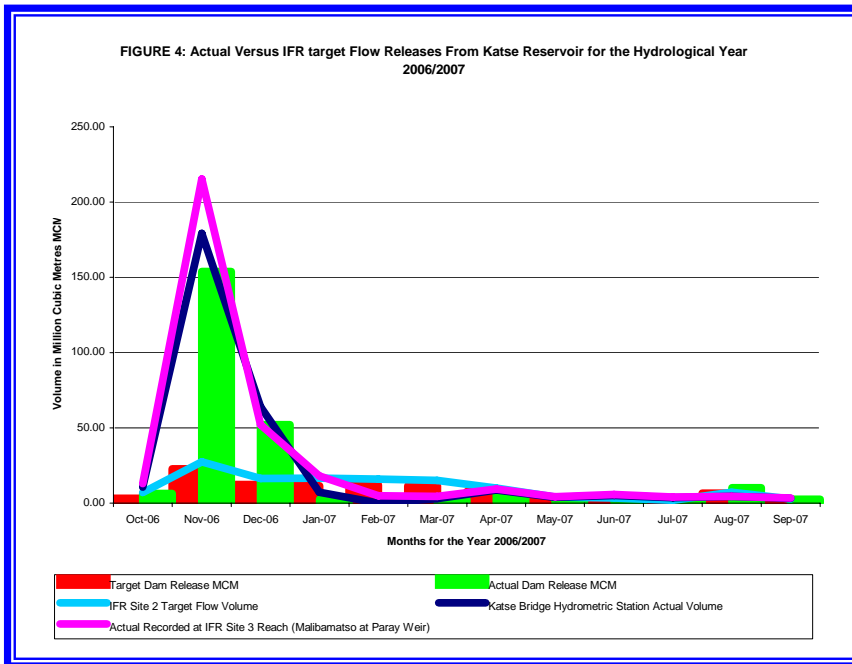
The spillway facility on the Katse dam wall enables the excess water that is brought about by naturally occurring floods to overflow and propagates downstream. The Katse dam was full and the reservoir level rose above its full supply level of 2053 masl. The water was therefore activated to overflow through the spillway despite releases effected through the LLO gates to drawdown the reservoir level.

The total volume of water released through the spillway amounts to 92.41 MCM for this period. This total spill amount comprises of 1.21 MCM occurred in October 2006, 81.50 MCM occurred in November 2006 and 9.70 MCM occurred in December 2006.

2.1.7 RECORDED FLOWS AT THE KATSE BRIDGE HYDROMETRIC STATION

IFR site 2 is located 3.06 km downstream of the Katse dam. There is currently no flow measuring station at this site. The flow measuring station that is closer to IFR site 2 is situated 2 km upstream of this IFR site, and it is about 1.06 km downstream of the Katse dam. The Katse Bridge flow measuring station is being used to assess IFR site 2 flows for IFR requirements confirmation and monitoring. It however leaves out part of the most valuable incremental catchment flow volume between the flow measuring station and the actual IFR site.

Figure 5: The actual Monthly flow releases versus the Target IFR flow releases from Katse Dam.



The total volume of water recorded at the Katse Bridge Hydrometric Station was 293.02 MCM. The required target flow volume of 97.71 MCM from the Katse dam site was calculated to be transformed to achieve the target river flow of 127.63 MCM at IFR site 2 downstream of the Katse

Bridge Hydrometric Station.

The actual flow volume of 293.02 MCM recorded at the Katse Bridge Hydrometric Station was therefore 165.39 MCM more than the stipulated IFR target flow volume of 127.63 MCM at the IFR site 2. See Table 3 on page 12 for recorded flows.

Table 3 indicates that dam releases, especially during November 2006 far exceeded the target IFR flows. The flow trend on figure 5 above clearly shows the flow patterns from dam site to IFR site 3 at Paray. Flow variations within respective months could not be explicitly shown because only monthly total volumes are considered. Thus the IFR requirements were fully satisfied at all IFR sites. The environment was able to provide the most crucial and needed incremental catchment flows at the IFR reaches.

Figure 5 above presents graphical records for Monthly Flow Releases from the Katse Dam, the recorded flows at the Hydrometric station on Malibatso River at Paray Weir (IFR site 3 reach), the Hydrometric Station at Katse Bridge just downstream of the Katse Dam Wall (labeled IFR Site 2 Reach) and the target IFR releases at both the Katse Dam site and IFR site 2.

2.2 MOHALE CATCHMENT

The Mohale catchment area is characterized by drier weather conditions. This catchment receives moderate to high amount of rainfall every year, enough to contribute substantial inflow into the Mohale dam structure. The collected water resources in Mohale dam is then transferred via a tunnel to the Katse dam. This catchment therefore recorded considerably high amount of rainfall (876.70 mm) at its strategic rainfall station at Thaba – Putsoa during the 2006/2007 hydrological year.

The total recorded inflow volume into Mohale dam during this period is 279.17 MCM. The flow volume transferred to the Katse dam is 288.03 MCM. See Table 6 on page 21.

Figure 6 on page 17 provides the locations for key focus areas along the Senqunyane River where IFR site 7 is situated 28 km downstream of the Mohale Dam wall.

2.2.1 RAINFALL PATTERNS

Rainfall records are being collected from three rainfall stations within the Mohale catchment area and these stations are Thaba – Putsoa, Rapokolane and Cheche. Table 4 shows the rainfall occurrences within the Mohale catchment area during October 2006 to September 2007.

The available flow records indicate that IFR site 7 is completely dependent on rainfall events occurring within the Mohale catchment area. There are no immediate Tributaries to this site whereby flow from other upstream sources can serve to step up the incremental catchment flows. Therefore if there is insufficient rainfall occurrence within this catchment then there is deficit accruing at the IFR site 7 reach. Rainfall is therefore crucially required to provide the incremental catchment flows.

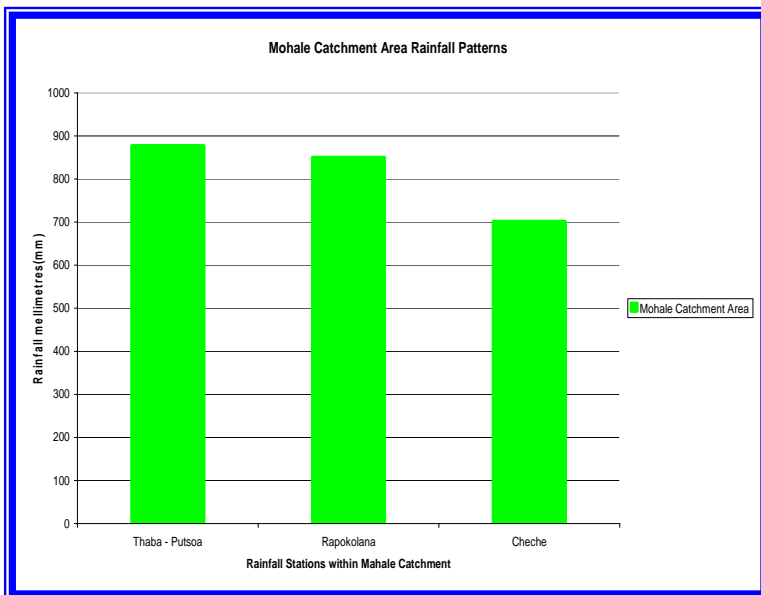
Rainfall events varied from the maximum of 876.70 mm occurring at Thaba – Putsoa mountain plateau to the minimum of 701.20 mm occurring at the Cheche rainfall station.

There is no rainfall data records for May, June and July 2006 at the Thaba – Putsoa rainfall station. The Hydrometric Field based Observer to this station passed away and there was no observer for three consecutive months.

Table 4: Rainfall patterns within the Mohale Catchment

Month	Thaba - Putsoa	Rapokolana	Cheche
05-Oct	160.00	128.30	134.60
05-Nov	215.10	208.30	108.80
05-Dec	65.40	123.80	60.10
06-Jan	156.60	110.60	168.40
06-Feb	28.60	35.10	54.60
06-Mar	66.60	65.00	33.90
06-Apr	98.60	84.70	83.30
06-May	0.00	4.70	3.00
06-Jun	0.00	45.80	22.80
06-Jul	0.00	0.30	0.00
06-Aug	7.30	4.20	3.50
06-Sep	78.50	38.90	28.20
Total	876.70	849.70	701.20

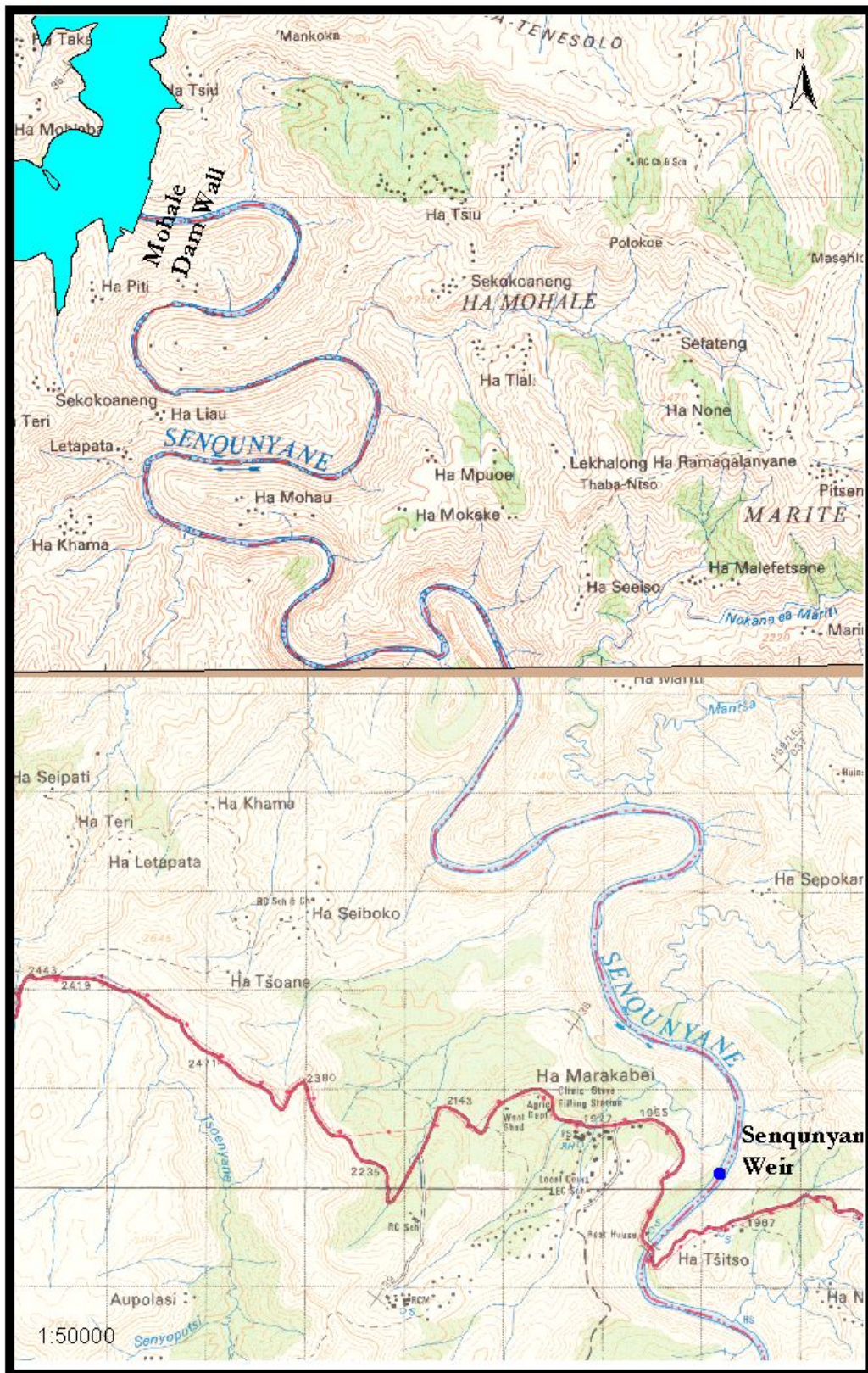
FIGURE 7: Mohale Catchment Rainfall Patterns



Despite the three months without rainfall data records, the Thaba – Putsoa rainfall station still shows that it received the highest amount of rainfall. The rainfall magnitude seems to reduce as it progresses further into the Mohale catchment. This is because the warm and moist North Westerly winds, in a

similar manner to Mphosong, form precipitation over the plateau of the Thaba – Putsoa ranges and losses most of its moisture content. So the rainfall magnitude reduces as the winds progress further.

Figure 6: Mohale Dam and the IFR site 7 reach



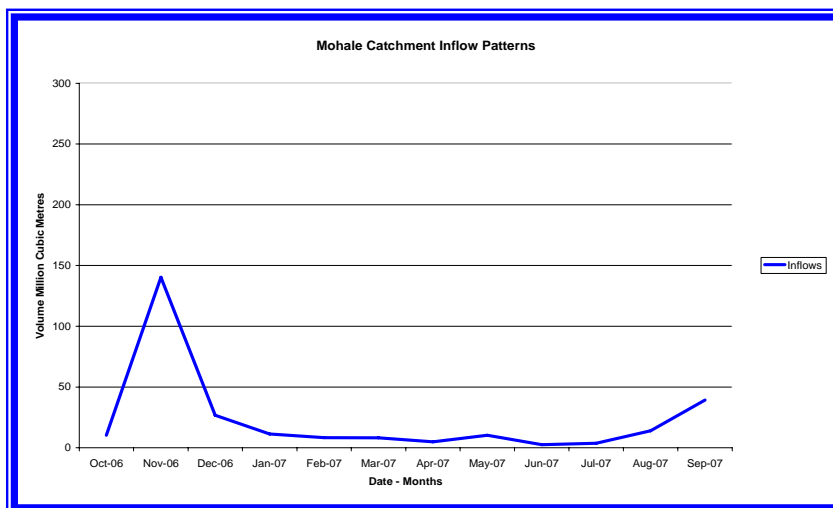
2.2.2 MOHALE DAM INFLOWS

The Mohale Dam received the total reservoir inflow volume of 279.17 MCM for the 2006/2007 hydrological year. The total volume of 288.03 MCM was transferred to the Katse Dam during this period.

The delivered volume of water from Mohale to Katse dam is slightly more than the inflow volume into Mohale dam by 8.86 MCM.

Inflows into Mohale reservoir increased drastically in volume from 10.20 MCM in October 2006 to 140.29 MCM in November 2006. Naturally occurring floods that include the 1:50 years flood were realized during this period when the IFR Policy and Procedures do not specify any floods for IFR implementation in the Mohale catchment. The IFR Policy and Procedures specify flood releases during the months of August and February every year depending on the determined HYC.

FIGURE 8: Mohale Dam Inflow Patterns



The scheduled flood releases from Mohale dam for the month of November are only for a Plus 2 HYC.

Therefore there were no floods released from Mohale dam through the

LLO gates during October 2006 to September 2007 hydrological year.

Despite the high inflows into Mohale dam during the month of November 2006, The Mohale catchment was experiencing severely dry weather conditions. The inflow volume reduced drastically to below 20 MCM during January 2007 and thereafter the

inflows remained very low for the rest of the 2006/2007 hydrological year. The inflow volume of 279.17 MCM is very low for the whole year and indicates dry weather conditions. See inflow patterns shown in Table 5 below and in figure 8 on page 18.

2.2.3 HYDROLOGICAL YEAR CLASSES (HYC) AT IFR SITE 7

The HYC at IFR site 7 is determined the same way as the IFR site 2 HYC. The sum of the inflow volume of 279.17 MCM into the Mohale dam and the incremental catchment contribution volume of 19.97 MCM give the total flow volume of 299.14 MCM.

The flow volume used for the determination of the HYC at IFR site 7 for 2006/2007 hydrological year is therefore 299.14 MCM. This inflow volume falls with the determined flow range of the Average HYC, which is 299.10 MCM to 376.60 MCM as given in Table 2.2-B of the IFR Procedures. Hence the 2006/2007 hydrological year has, on aggregate obtained an Average HYC conditions for Mohale catchment.

The actual quarterly HYC conditions for IFR site 7 are presented in Table 5 below. The quarter October to December 2006 obtained a 'Plus 2' HYC. The quarters January to March 2007 obtained a Minus 2 HYC. The quarter April to June 2007 got a 'Minus 2' HYC and the quarter July to September 2007 received a 'Plus1' HYC. Thus the aggregate of an Average HYC conditions had been achieved in Mohale catchment for the 2006/2007 hydrological year.

Table 5: Actual Inflows into Mohale Reservoir

Quarter	Inflow into Katse Dam	Incremental Catchment Flows	Actual Inflows at IFR Site 7	Actual Hydrological Class
Oct 2006 To Dec 2006	177.16	15.27	192.43	Plus 2

Annual Flow Releases for Instream Flow Requirement (IFR) Implementation – October 2006 to September 2007

Quarter	Inflow into Katse Dam	Incremental Catchment Flows	Actual Inflows at IFR Site 7	Actual Hydrological Class
Jan 2007 To Mar 2007	27.71	4.64	32.35	Minus 2
Apr 2007 To Jun 2007	17.54	0.55	18.09	Minus 2
July 2007 To Sept 2007	56.76	-0.49	56.27	Plus 1
Total	279.17	19.97	299.14	Average

2.2.4 DAM RELEASES

The actual total volume of water released from the Mohale Dam Outlets, including seepage flow is 69.36 MCM. This outflow volume is 30.02 MCM higher than the targeted dam releases for IFR requirements. The required target release at dam site was 39.34 MCM. This flow volume has been calculated to be transformed to achieve the target river flow volume of 100.59 MCM at IFR site 7 downstream of the Mohale Dam. See details in Table 6 on page 21.

The target river flow at IFR site 7 has, however not been attained during October 2006 to September 2007. There is a deficit of 11.24 MCM accrued as a result of the non – achievement of the required flows at IFR site 7.

Table 6: Monthly Flow Releases and the target IFR Flows from Mohale Dam

Months Since October 2006 to September 2007	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	Low Flow	Floods	Spill	Seepage	Total	MCM	MCM
Oct-06	Average	10.20	0.00	2.01	2.01	1.66	0.00	0.00	0.03	1.69	6.88	3.50	31.00
Nov-06	Average	140.29	0.00	3.27	3.27	10.51	0.00	0.00	1.68	12.19	11.26	23.83	0.00
Dec-06	Average	26.67	0.00	1.45	1.45	11.52	0.00	0.00	1.44	12.96	4.95	14.78	0.00
Jan-07	Plus 2	11.28	0.00	4.47	4.47	11.52	0.00	0.00	1.44	12.96	17.55	14.87	0.00
Feb-07	Plus 2	8.30	11.30	3.07	14.37	10.40	0.00	0.00	1.30	11.71	23.38	13.66	0.00
Mar-07	Plus 2	8.13	0.00	3.51	3.51	8.40	0.00	0.00	0.97	9.37	13.73	10.15	16.15
Apr-07	Average	4.85	0.00	2.41	2.41	3.16	0.00	0.00	0.23	3.40	8.24	3.78	55.53
May-07	Average	10.26	0.00	1.58	1.58	1.02	0.00	0.00	0.56	1.58	3.70	1.60	49.39
Jun-07	Average	2.43	0.00	0.73	0.73	0.03	0.00	0.00	0.95	0.98	1.68	1.13	41.29
Jul-07	Minus 1	3.62	0.00	0.54	0.54	0.00	0.00	0.00	0.92	0.92	1.59	0.91	36.82
Aug-07	Minus 1	13.85	3.90	0.70	4.60	0.00	0.00	0.00	0.86	0.86	6.24	0.62	31.84
Sep-07	Minus 1	39.29	0.00	0.41	0.41	0.00	0.00	0.00	0.76	0.76	1.39	0.52	26.01
Total for Year 2006/2007		279.17	15.20	24.14	39.34	58.22	0.00	0.00	11.14	69.36	100.59	89.35	288.03

2.2.5 DISCHARGES THROUGH THE LOW LEVEL OUTLET (LLOs)

No flood releases were made through the LLO gates from the Mohale dam during the 2006/2007 hydrological year. The scheduled within – year flood releases of **11.30** MCM for February 2008 and **3.90** MCM for August 2008 were not released due to poor weather conditions that were prevailing during these periods when the IFR Policy and Procedures scheduled some floods for the Mohale catchment area.

The inflows into Mohale dam were only 8.30 MCM and 13.85 MCM in February and August 2007 respectively. These inflow magnitudes indicate that the environment was not providing the required additional flows to enable releases of floods from Mohale dam. See Table 6 on page 21.

The LLO gates are, however not designed to be regularly operated and the operational problems on the LLO valves were also reported as hindering complete implementation of IFR requirements. The valves are easily damaged if operated quite often. This causes reluctance to dam operators to implement required IFR floods.

The average HYC conditions for the Mohale catchment indicate that Mohale experienced dry weather conditions and naturally occurring floods were not realized, especially during February and August 2007 when the IFR Policy and Procedures schedule some floods. Rainfall occurrence was very low in February 2007. The average rainfall occurred within the Mohale catchment was approximately 39.43 mm. The corresponding inflow volume of water into Mohale reservoir in February 2007 was only 8.30 MCM.

The IFR Policy and Procedures also undertakes, through the Adaptive Management procedure, that scheduled flood releases should be aligned to the naturally prevailing weather conditions that are providing natural floods.

The aggregate of an Average HYC conditions for the Mohale catchment also indicate that Mohale experienced drier weather conditions compared with the wet Katse catchment.

2.2.6 SEEPAGE

Consequent to the development of a crack on the dam wall in February 2006, water had been increasingly seeping downstream of the Mohale dam.

Data records, as given in Table 6 on page 21, show that seepage from the Mohale dam is rapidly increasing in magnitude, irrespective of dry prevailing weather conditions. The recorded total seepage volume is 11.14 MCM for the 2006/2007 hydrological year.

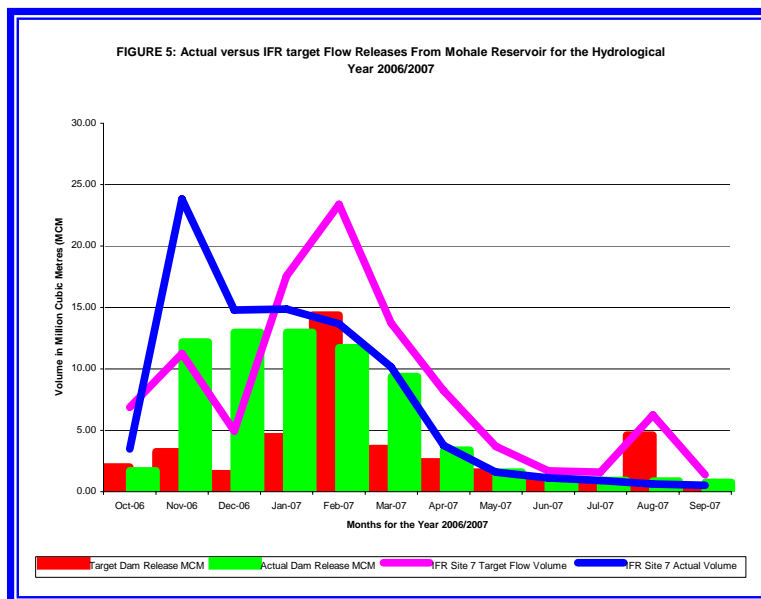
2.2.7 SPILLAGE

There was no spill flow during October 2006 to September 2007. Dry prevailing weather conditions were dominating the Mohale catchment area and inflows into the Mohale Dam were minimal.

2.2.8 FLOW RECORDED AT IFR SITE 7 REACH

The total volume of water recorded at IFR Site 7 was 89.35 MCM. This flow is 11.24 MCM less than the stipulated IFR target flow volume of 100.59 MCM for the considered period, October 2006 to September 2007.

Figure 9: The actual Monthly flow releases versus the Target IFR flow releases from Mohale Dam.



The flow volume recorded at IFR site 7 indicates that despite the higher flow volume released downstream of the Mohale dam, the IFR requirements could still not be met at IFR site 7. The intervening catchment downstream of Mohale dam could not

contribute adequate flow to satisfy IFR requirements at IFR site 7. The higher release of 69.36 MCM at Mohale dam site only yielded 89.35 MCM at the required IFR site.

The observed variance of 11.24 MCM is adding on the already accumulated deficit. See Table 6 on page 21 for details on recorded flows.

Table 6 also provides the volumes of water as stipulated in the IFR Policy and Procedures, the actual released amounts from the Mohale Dam and the actual recorded flows at IFR site 7. It also provides the overall total at the end of the period, October 2006 to September 2007.

2.3 DEFICIT AT IFR SITES

2.3.1 IFR site 2

It has been deduced that the Katse Bridge flow measuring station is not useful for the assessment of IFR flows and the deficits for IFR site 2. This station does not capture all incremental flows during rainy seasons, and it therefore under estimates the actual IFR flows. It thus fails to show the impact of the Khohlontšo tributary between IFR site 2 and this flow measuring station. This tributary contributes considerable amounts of flow that could not be quantified or even assessed at IFR site 2.

It has, therefore not been ease to compute the IFR deficit or excess IFR flows at IFR site 2. There was, however, excess IFR flow of 150.23 MCM measured at the Katse Bridge Hydrometric station. The target IFR flow was 97.71 MCM for the period October 2006 to September 2007 and this target IFR value is lower than the measured volume of 247.94 MCM at the Katse Bridge. Thus there is no value to be displayed as the deficit figure for IFR site 2.

2.3.2 IFR site 7

The river flow at IFR site 7 is being measured and assessed at the Crump Weir that is situated near Marakabei Village. This weir accurately measures

Senqunyane River flow, which combines Mohale dam releases and the incremental catchment flows.

Deficit at IFR site 7 is a persistent problem that was encountered since the impoundment of the Mohale dam.

Downstream flow releases from Mohale dam were specified according to the water levels that were reached during the reservoir impoundment from November 2002 to July 2003. This release scenario was referred to as Washington Agreement. The LHDA did not fully honour the obligations of the Washington Agreement.

After the approval of the IFR procedures in July 2003, the LHDA appropriately implemented the procedures according to the specified required IFR releases at the Mohale dam site to meet the required flows at IFR site 7. However the deficit continued to accumulate.

The deficit figure of 52.68 MCM, as given by the World Bank, was accumulated from November 2002 to December 2005 due to noncompliance to the Washington Agreement and the non responsive of the IFR site 7 flows to dam releases.

There was no deficit accrued at IFR site 7 during October 2005 to September 2006 due to good rains that occurred during February 2006. Thus the deficit figure given by the World Bank reduced from 52.68 MCM to 43.92 MCM. See Table 7 below.

Table 7: IFR site 7 deficit

Date	Target IFR Flow	Actual IFR Flow	Deficit
Oct 05 To Sept 06	89.10	97.86	-8.76

Date	Target IFR Flow	Actual IFR Flow	Deficit
Oct 06 To Sept 07	100.59	89.35	11.24
Total	189.69	187.21	2.48

The deficit computed to September 2007 is 2.48 MCM. The total deficit at IFR site 7 takes into considerations the value of 52.68 MCM, which lifts the IFR site 7 deficits to 55.16 MCM.

2.4 ‘MUELA DAM

‘Muela dam is situated along the Nqoe River in ‘Muela Butha - Buthe. The main purpose of the ‘Muela dam is to balance flows from the Katse dam, through the transfer tunnel, to ‘Muela Hydropower plant.

The Hydropower generation water resources is then stored in ‘Muela dam for onward delivery to the Republic of South Africa (RSA), after having generated the required electricity for Lesotho. The ‘Muela reservoir level is kept constantly at 1760 masl and any additional water resources, above this level is transferred to RSA.

There is no IFR implied for ‘Muela dam. It was initially agreed to release the Mean Annual Runoff (MAR) from ‘Muela dam, which had then been computed as 0.15 m³/s, to sustain the aquatic ecosystems and social activities downstream of the dam. The recent study carried out by the Lesotho Highlands Water Commission (LHWC) in association with Ninham Shand, however presented the ‘Muela MAR of 0.16 m³/s.

Drought conditions repeatedly troubled the Maseru capital city and an intervention measure to release water from ‘Muela dam into Phuthi River to offset drought and meet the water demand in Maseru was considered.

It was therefore decided in December 2004 to bank 75% of the ‘Muela MAR as the Lesotho water in LHWP structures thus leaving 25% to be released downstream. The LHDA then decided to draw a release schedule on how to implement the 25% release of the MAR in order to enhance flow variability in Nqoe River downstream of the ‘Muela dam.

The total flow volume of 3.44 MCM is therefore estimated as the volume released in accordance with the developed schedule and releases to offset drought in Maseru during October 2006 to September 2007. See Table 8 on page 28.

The 'Muela dam release schedule demands that a flood of 0.75 m³/s must be released for one day during November, December, January, February and March every year. The flow release, over and above this flood, to offset drought and to meet water demand in Maseru may be requested through the office of the Commissioner of Water (COW) in periods of severe drought

The banked water for Lesotho amounted to the volume of 12.50 MCM at the end of September 2007.

Table 8 gives the monthly volumes of water released downstream of the 'Muela Dam during October 2006 to September 2007. It also provides the overall total at the end of the period.

2.4.1 DAM RELEASES

The estimated total volume of water released from the 'Muela dam outlets, including floods that were released to offset drought conditions in the Maseru capital city is 3.44 MCM. This outflow volume is 2.25 MCM higher than the targeted total dam release of 1.19 MCM. The total target volume is comprised of the low flow volume of 0.87 MCM and the flood volume of 0.32 MCM. See Table 8 on page 28 for details.

The higher variance is due to the flood volume of 2.55 MCM that was released to offset drought and provide water resources for domestic use in Maseru.

All the 'Muela dam downstream releases could not be precisely quantified due to the absence of flow measuring station. A V – notch weir exists downstream of the 'Muela Dam but lacks a continuous flow recording device to confirm downstream releases as there is no data logger and/or Automatic recorder at this station.

Table 8: Monthly Flow Releases from the 'Muela Dam

Months Since October 2006 to September 2007	Target Dam Site Releases for IFR Requirements	Volume Target 'Muela Dam Floods	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	Floods	Spill Flow	Low Flows	Total Flows		
	MCM	MCM	MCM	MCM	MCM	MCM		
Oct-06	0.05	0.00	0.00	0.00	0.05	0.05	0.27	0.00
Nov-06	0.10	0.06	0.00	0.00	0.10	0.10	2.38	0.00
Dec-06	0.11	0.06	0.00	0.00	0.11	0.11	0.37	0.00
Jan-07	0.10	0.06	0.00	0.00	0.11	0.11	0.18	0.00
Feb-07	0.09	0.06	0.00	0.00	0.10	0.10	0.19	0.00
Mar-07	0.10	0.06	1.33	0.00	0.11	1.43	0.07	0.00
Apr-07	0.05	0.00	0.00	0.00	0.05	0.05	0.07	0.00
May-07	0.05	0.00	0.00	0.00	0.05	0.05	0.04	0.00
Jun-07	0.05	0.00	0.64	0.00	0.05	0.69	0.02	0.00
Jul-07	0.05	0.00	0.00	0.00	0.05	0.05	0.02	0.00
Aug-07	0.05	0.00	0.00	0.00	0.05	0.05	0.01	0.00
Sep-07	0.05	0.00	0.58	0.00	0.05	0.64	0.00	0.00
Total for Year 2006/2007	0.87	0.32	2.55	0.00	0.89	3.44	3.62	0.00

2.4.2 DISCHARGES THROUGH THE LOW LEVEL OUTLET (LLO)

The 'Muela dam release schedule demands that a flood of 0.75 m³/s must be released for one day. This requirement was established due to the need to enhance flow variability within the Nqoe River system downstream of the 'Muela dam.

The total flow volume of 0.32 MCM was therefore required to have been released downstream of the 'Muela Dam. However this flood volume was not released. The evidenced flood volume of 2.55 MCM was requested through the office of the Commissioner of Water (COW) to be released to meet water demand and to offset drought conditions in Maseru. The release schedule was therefore not implemented effectively during October 2006 to September 2007.

2.4.3 SPILLAGE

'Muela Dam did not spill during October 2006 to September 2007. The design of the 'Muela dam structure is such that the reservoir level is kept constantly at 1760 masl. This feature encourages excess water to be transferred to RSA other than to overflow through the spillway.

2.4.4 FLOWS RECORDED AT HOLOLO RIVER DOWNSTREAM OF THE 'MUELA DAM

The Hololo River flow measuring station became malfunctional since July 2006. There is serious sediment deposition that encourages river flow to divert, change its course and drift away from the inlet pipes. It has also been discovered that the inlet pipes to the station are blocked and no flow is being recorded. Thus there is no data to be presented for Hololo.

A more reliable station is planned to be constructed on Nqoe River downstream of the 'Muela dam. This station will verify downstream releases as well as incremental catchment flows. The currently estimated 'Muela downstream release volume is 3.44 MCM. This flow volume comprises scheduled low flow volume of 0.89 MCM and the emergency release volume of 2.55 MCM.

The total volume recorded at the Nqoe flow measuring station upstream of the 'Muela dam amounts to 3.62 MCM. This inflow volume is 0.18 MCM higher than the estimated released volume of 3.44 MCM.

Figure 10: The actual Monthly flow releases versus the Target IFR flow releases from the 'Muela Dam.

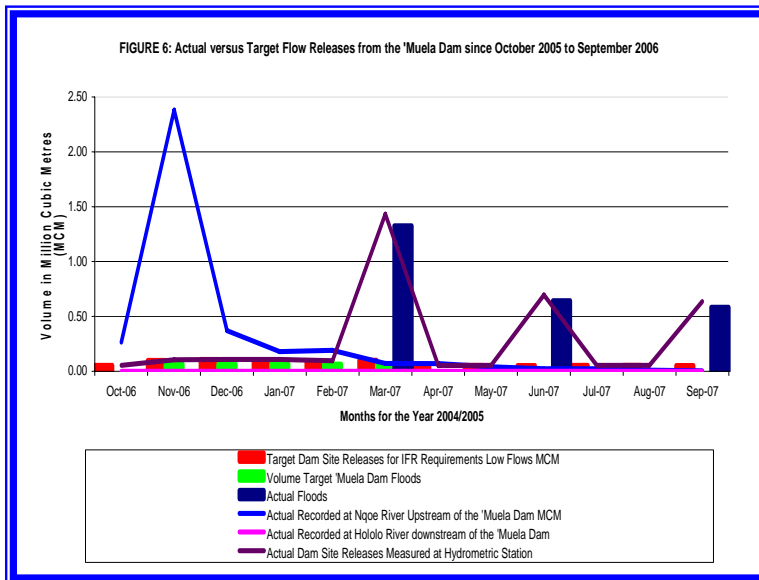


Figure 10 shows the flows patterns from the 'Muela Dam outlets as well as those from the Nqoe River Hydrometric Station upstream of 'Muela dam. It is observed that the Nqoe Inflows are higher than the 'Muela Dam Outflows and indicating

that the excess water was banked. The Nqoe flows however, decreased in magnitude to 0.00 MCM for most part of the year.

2.5 MATSOKU DIVERSION WEIR AND TUNNEL

The Matsoku Diversion Weir and Tunnel has been constructed to divert the excess water from the Matsoku River system into the Katse dam. This weir has been designed to release all the inflows that are less than and/or equal to 0.8 m³/s, which is the capacity of the weir downstream outlet. Hence Matsoku weir is a non – storage facility and it is expected to operate automatically and in accordance with the design capacities of the available outlets. Thus the IFR requirements at the Matsoku Diversion Weir and Tunnel are automatically fulfilled before any transfers could take place.

Any flow in excess of 0.8 m³/s gets transferred to the Katse dam. The capacity of the Matsoku to Katse Transfer Tunnel is 47 m³/s therefore all the flows in excess of 0.8 m³/s up to 47 m³/s are transferred into the Katse dam. The spill

flow from the Matsoku weir crest is expected to occur when the flow into the weir is more than 47 m³/s, which is the capacity of this Tunnel. That is, flow at the Matsoku weir could spill only if the inflow into this weir is in excess of 47 m³/s

The estimate of the transferred volume from Matsoku to Katse dam during October 2006 to September 2007 amounts to 21.74 MCM. This value has been estimated from the flow data that is collected from the hydrometric station downstream of the weir. The results obtained from the hydrometric station flow data are presented in Table 9 on page 32.

Therefore there are no specified floods or even low flows for the Matsoku Weir due to its automatic design operation. It is anticipated that flow events at the Matsoku weir would be naturally driven.

The Matsoku Diversion Weir and Tunnel flows, the estimated inflows into the Matsoku Weir and the Matsoku River flows that are collected from the Seshote Hydrometric Station for the period October 2006 to September 2007 are presented in Table 9 on page 32.

2.5.1 MATSOKU WEIR RELEASES

All the flow measuring devices at the Matsoku Diversion Weir and Tunnel are not operational. They have all experienced breakdown, therefore the estimates derived from the records of the Seshote Flow Measuring Station are used to portray the flow contribution pattern of the Matsoku Weir to the Katse dam as well as downstream flow releases for IFR purposes.

The estimated downstream flow releases from the Matsoku Diversion Weir and Tunnel amounts to 13.60 MCM. This outflow volume is 5.32 MCM less than the targeted flow volume of 18.92 MCM if the flow rate of 0.60 m³/s was constantly flowing downstream.

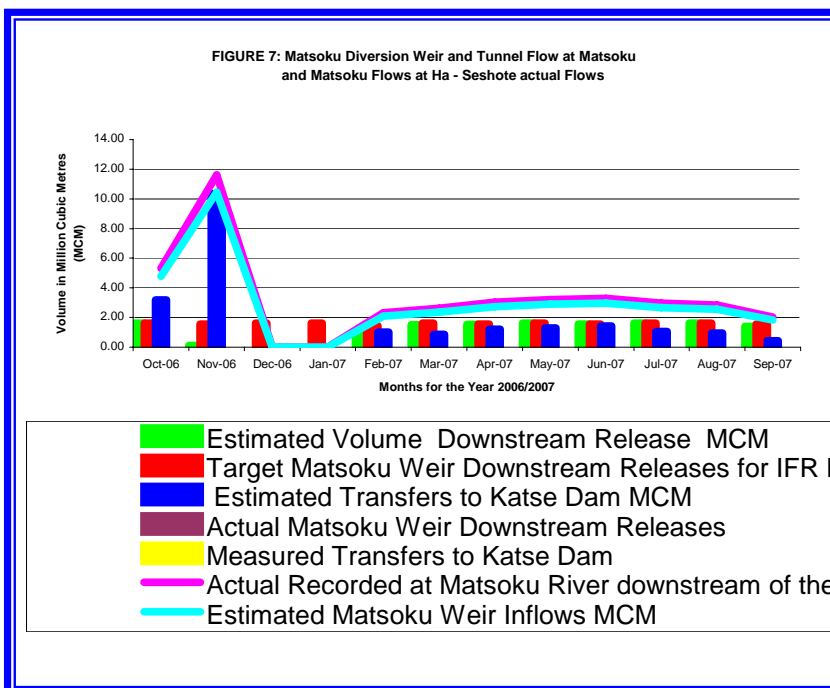
Table 9: Recorded and Estimated Monthly Flows at the Matsoku Weir.

Months Since October 2006 to September 2007	Estimated Volume Downstream Release (@ 0.6m ³ /s)	Actual recorded flow - 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-06	1.61	0.00	1.61	0.00	3.18	5.32	4.79
Nov-06	0.10	0.00	1.56	0.00	10.35	11.61	10.45
Dec-06	0.00	0.00	1.61	0.00	0.00	0.00	0.00
Jan-07	0.00	0.00	1.61	0.00	0.00	0.00	0.00
Feb-07	1.09	0.00	1.45	0.00	1.01	2.33	2.10
Mar-07	1.50	0.00	1.61	0.00	0.86	2.62	2.36
Apr-07	1.53	0.00	1.56	0.00	1.21	3.04	2.73
May-07	1.61	0.00	1.61	0.00	1.29	3.22	2.90
Jun-07	1.56	0.00	1.56	0.00	1.42	3.31	2.97
Jul-07	1.61	0.00	1.61	0.00	1.06	2.96	2.67
Aug-07	1.61	0.00	1.61	0.00	0.95	2.84	2.56
Sep-07	1.39	0.00	1.56	0.00	0.43	2.02	1.82
Total for Year 2006/2007	13.60	0.00	18.92	0.00	21.74	39.27	35.34

2.5.2 FLOWS RECORDED AT MATSOKU RIVER DOWNSTREAM OF THE DIVERSION WEIR AND TUNNEL

The actual total volume of water recorded at the Matsoku River System at Seshote Hydrometric Station is 39.27 MCM. All the estimated flow volumes at the Matsoku Diversion Weir and Tunnel are derived from the Seshote recorded flows. The computed inflow into the Matsoku Weir amounts to 35.34 MCM.

Figure 11: The estimated Monthly flow releases versus the Target release requirement from the Matsoku Diversion Weir and Tunnel



The flow records at the Seshote flow measuring station indicates that Matsoku catchment was also experiencing dry weather conditions.

Figure 11 shows all 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 recorded flow volume of 39.27 MCM is small and gives the flow releases that were below the targeted flow rate of 0.60 m³/s downstream of the weir. Estimated releases from the Weir are calculated based on the computed inflows, whereas the target releases are only based on the requirement that the flow rate of 0.60 m³/s is released downstream.

2.5.3 DISCHARGES THROUGH THE TUNNEL OUTLET TO KATSE DAM

The estimated transferred volume into the Katse dam is computed as 21.74 MCM during October 2006 to September 2007.

The environment and weather conditions could not supply enough flow volume for the Matsoku catchment.

2.5.4 SPILLAGE

Matsoku Diversion Weir and Tunnel did not spill during October 2006 to September 2007. The flow volume recorded at the Matsoku River Hydrometric Station at Seshote indicates that the recorded flows were below the mean annual runoff of 87.00 MCM for Matsoku River at Seshote. Hence the possibilities for the Matsoku Weir to spill were not foreseen. There is also no record at the Weir site to indicate spillage. See Table 9 for actual recorded figures.

3 CONCLUSIONS

The implementation of the IFR Policy and Procedures for the 2006/2007 Hydrological Year has been a challenging experience. This was not effectively and efficiently carried out as some of the required flow releases and floods were not adequately effected in accordance with the produced schedules.

The 2006/2007 Hydrological Year has been a particularly dry year for Mohale catchment areas with the aggregate of Average HYC conditions whilst the Katse catchment was wetter with the aggregate of Plus 1 HYC conditions.

KATSE DAM

The actual HYC for the Katse catchment area for the Hydrological Year 2006/2007 was, on aggregate, a 'Plus 1' class with the total inflow volume of 646.21 MCM at IFR site 2.

The actual total volume of 247.94 MCM was released from the Katse Dam during October 2006 to September 2007. The target flow release, as specified in the IFR Policy and Procedures, amounts to 97.71 MCM for the entire reporting period. The Dam releases therefore far exceeded the stipulated amounts by approximately 150.23 MCM, which is equivalent to 154% of target releases.

The volume recorded at the Katse Bridge Hydrometric Station amounts to 293.02 MCM whilst the target IFR volume at IFR site 2 stands at 127.63 MCM. The IFR required flow volume was therefore exceeded despite the fact that the Katse Bridge Hydrometric Station is situated 2 km upstream of IFR site 2 and it is not capturing flows at the IFR site 2 location.

The flood magnitude of the 1:50 (1 in 50) years that occurred in November 2006 demolished the structure that was constructed to accurately measure flow time series at IFR site 2. Preparations to reconstruct IFR site 2 flow measuring station are in progress.

MOHALE DAM

The Mohale Reservoir has experienced, on aggregate, the 'Average' HYC conditions throughout the year but actual conditions varied from Minus 2 to Plus 2. The total inflow volume was only 299.14 MCM at IFR Site 7 for the 2006/2007 Hydrological Year.

A total volume of 69.36 MCM was released from the Mohale Dam during the period through various 'outlets'. The target annual flow release as specified in the IFR Policy amounts to 39.34 MCM. Therefore actual Dam releases were greater than the target releases by 30.02 MCM.

The total volume recorded at IFR site 7 amounts to 89.35 MCM and the target IFR flow volume amounts to 100.59 MCM. This indicates that despite the higher volume released downstream of the Mohale Dam site, the IFR requirements could still not be satisfied at IFR site 7. The observed flow variance is 11.24 MCM and this is adding on to the already accumulated deficit.

'MUELA DAM

The flow volume released downstream of the 'Muela Dam has been computed as 3.44 MCM. This flow volume combines the floods of 2.55 MCM released to offset drought in Maseru and the low flow releases of 0.89 MCM.

There is no IFR implied for 'Muela Dam. However the schedule to implement the 25% 'Muela MAR to enhance flow variability in Nqoe River has been developed. This schedule was not adhered to during October 2006 to September 2007.

MATSOKU DIVERSION WEIR

The Hydrometric Station flows of Matsoku River at Ha – Seshote have been used to estimate the inflows into the Matsoku Diversion Weir and Tunnel. The downstream releases from Matsoku Weir and the tunnel transfers to Katse have been derived from these estimates. The volume of water transferred via the Diversion Tunnel into the Katse reservoir equates to **21.74** MCM whilst the volume of water released downstream equates to **13.60** MCM.

The assessment of quarterly classifications by predicting the next quarter on the bases of the actual prevailing conditions of the quarter under consideration has helped keep dam releases in line with IFR stipulated flows within the IFR Policy and Procedures. This is seen in the minimal deviations, as well as the level of compliance that were experienced for the period October 2006 to September 2007.