LESOTHO HIGHLANDS DEVELOPMENT AUTHORITY

ANNUAL FLOW RELEASES

INSTREAM FLOW REQUIREMENT (IFR)

IMPLEMENTATION AND MONITORING

(October 2007 to September 2008)

REPORT N0.9

November 2009

STRATEGIC AND CORPORATE SERVICES DIVISION

MONITORING AND EVALUATION BRANCH

Aquatic Systems Section
HYDROLOGY

EXECUTIVE SUMMARY

The Annual Flow Releases report for IFR Policy Implementation and Monitoring 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. This report covers the period October 2007 to September 2008. It provides the release of water for IFR purposes from the Katse Dam, Mohale Dam, Muela Dam and the Matsoku diversion Weir.

KATSE RESERVOIR

The 2007/2008 hydrological year was characterized by extremely wet weather conditions, with the aggregate of a Plus 2 HYC for the Katse catchment.

The rainfall patterns that are observed within this catchment area contributed and enabled the Katse region to attain a Plus 2 HYC; hence this catchment has received the average rainfall of 1, 131.16 mm. The rainfall station at Rampai has received the highest rainfall amount of 1, 876.30 mm during October 2007 to September 2008.

The total recorded reservoir inflow volume for the 2007/2008 hydrological year was 1, 231.00 MCM. This inflow volume is inclusive of the transfers of 37.41 MCM from Matsoku Diversion Weir and Tunnel and 139.63 MCM from Mohale Dam. When these transfers are deducted, the net inflow from the Katse Catchment was 1, 053.96 MCM, which falls within the very wet Plus 2 classification range for Katse reservoir.

The total flow volume of 279.77 MCM was released downstream of the Katse Dam during October 2007 to September 2008. This released flow volume was more than the target flow volume of 78.66 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 111.21 MCM against the target IFR flow volume of 107.19 MCM for this IFR site 2.

The total flow volume of 2.20 MCM was recorded as spillage from the Katse dam during this reporting period.

MOHALE RESERVOIR

The Mohale catchment experienced relatively wet weather conditions with the overall aggregate of 'Plus 1' HYC conditions for the 2007/2008 hydrological year.

This catchment received the average rainfall of 1048.90 mm with the rainfall station at Thaba – Putsoa registering the highest rainfall amount of 1, 201.60 mm.

The total recorded inflow volume for 2007/2008 hydrological year was only 421.36 MCM, which falls within the wet Plus 1 range for Mohale.

A total flow volume of 28.69 MCM was released from the Mohale dam. This flow volume was lower by 8.27 MCM from the target of 36.96 MCM. The released flow volume includes the effects of seepage through the dam wall.

The flow volume recorded at IFR site 7 amounted to 57.49 MCM. The target IFR flow volume was 91.94 MCM. There is therefore a deficit of 34.45 MCM that has occurred at IFR Site 7 during this reporting period.

‘MUELA DAM

‘Muela Dam released 0.89 MCM. This flow volume has been released according to the provided release schedule developed to enhance flow variability within the Nqoe River system downstream of the ‘Muela dam. No spill occurred at ‘Muela Dam.

MATSOKU DIVERSION WEIR AND TUNNEL

The actual flow volume recorded at Matsoku hydrometric station downstream of the Matsoku weir was 62.30 MCM. The Matsoku weir inflows, as computed based on flow records of this flow measuring station, amounted to 56.07 MCM. It is therefore estimated, based on the design capacity of the weir, that 18.66 MCM was released downstream while 37.41 MCM was transferred to Katse.

CONCLUSIONS

In general the weather conditions experienced in all LHWP catchments had improved to higher HYC conditions during the 2007/2008 Hydrological Year compared to the 2006/2007 hydrological year.

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

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BACKGROUND

The governments of the Mountain Kingdom of Lesotho and the Republic of South Africa (RSA) signed the Treaty that established The Lesotho Highlands Water Project (LHWP) in October 1986. The LHWP is a multiphase water development 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. These predetermined Treaty flow releases 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 impoundment, was effected from November 2002.

The LHDA then observed that the Treaty required flows were not satisfying the requirements of the downstream river reaches and the expectations of the downstream environment. Therefore the LHDA concurrently undertook the LHDA 648 and LHDA 678 studies to determine the Instream Flow Requirements (IFR) that would ensure appropriate mitigation of environmental impacts on the downstream aquatic ecosystems.

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 from dam sites were later approved in July 2003.

The IFR Policy and Procedures' implementation was duly effected from August 2003 since the procedures that specify the monthly low flows and flood releases were available then. The procedures specify required flows to be released at dam sites in order to satisfy the required flows at the designated IFR sites. Proper IFR implementation calls for the establishment of monthly flow monitoring programmes to ensure that compliance to the required flows is attained at all IFR sites.

1 INTRODUCTION

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

The Lesotho Highlands Development Authority 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 prevailing hydrological water circle; the computation of Evaporation from dam structures, the resultant Inflows into these structures, the water balance modeling and the change in water level storage within these LHWP dam structures.

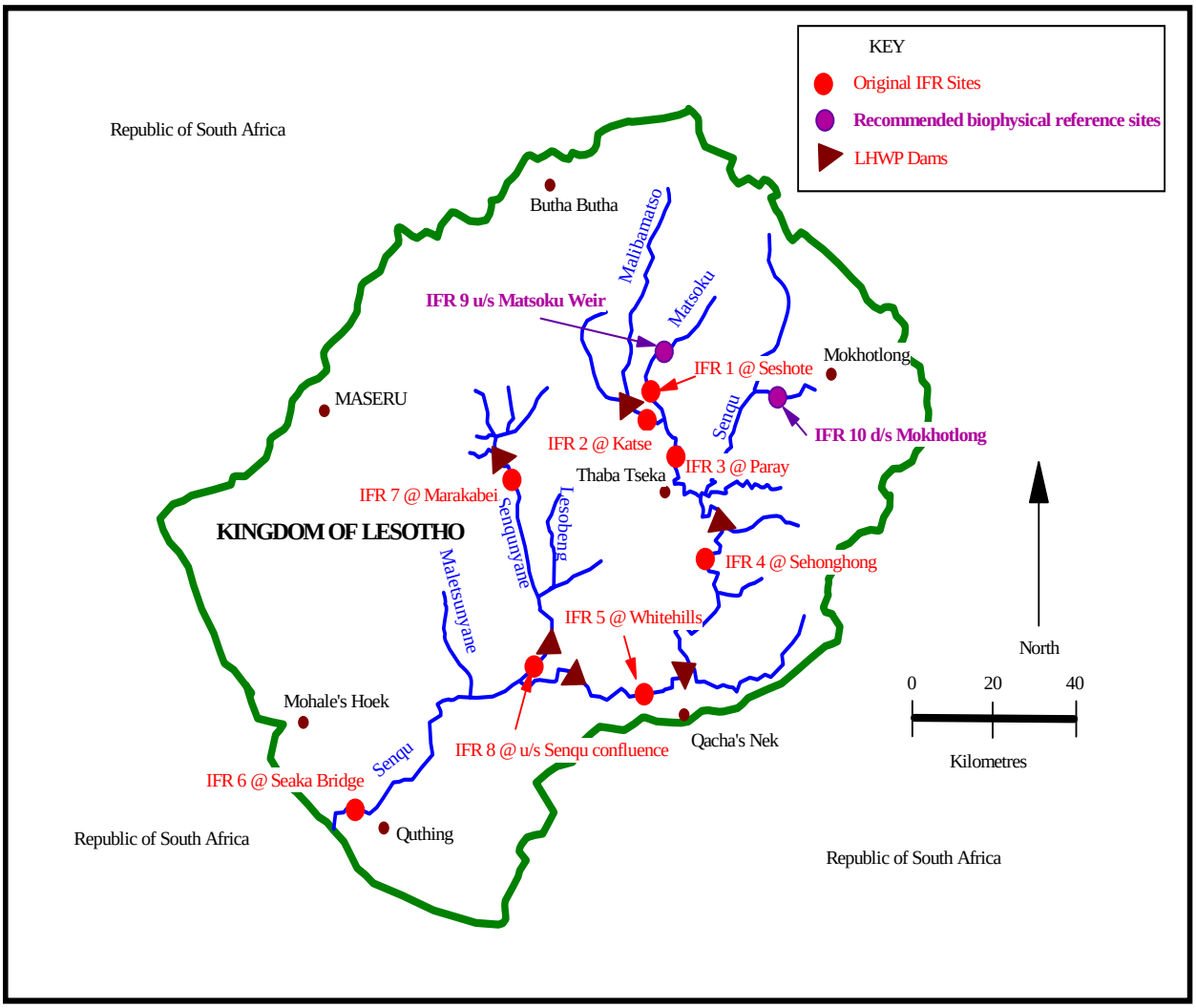
The hydrological data that is continuously recorded at flow measuring stations is therefore collected on monthly basis from LHWP structures, meteorological and hydrometric stations. The data is processed and analyzed to determine hydrological classifications for required flow releases, whist also verifying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

The collected IFR data informs on the impacts 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 details, 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 2007/2008 hydrological year.

Figure 1 below depicts All IFR sites. Major rivers that are mostly affected by the LHWP project are shown on this figure.

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 generally characterized by wet weather conditions. It receives high amounts of rainfall that contribute substantial inflows into the Katse dam structure every year.

Figure 2 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 2 km from the Katse 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. Rainfall provides part of the much needed runoff and the required inflows into LHWP structures to drive the implementation of IFRs and the water delivery obligations.

The relationship between the available flow records and rainfall indicate that incremental catchment flows largely depend on rainfall 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 at the IFR site.

Table 1: Rainfall patterns within the Katse Catchment

Month	Mphosong	Rampai	Ha-Poli	Makopela	Katse Village
Oct – 07	186.20	277.00	173.80	191.60	138.30
Nov – 07	220.80	217.00	117.00	94.80	61.40
Dec – 07	252.50	257.50	152.60	97.00	59.90
Jan – 08	277.10	374.30	119.40	89.70	74.30
Feb – 08	85.50	154.50	60.60	63.90	52.00
Mar – 08	185.70	227.00	147.10	102.80	84.90
Apr – 08	91.80	114.50	56.00	38.20	35.80
May – 08	62.30	147.50	22.90	33.70	26.20
Jun – 08	21.90	73.00	40.90	62.00	38.70
Jul – 08	59.50	0.00	1.60	0.00	0.00
Aug – 08	19.10	22.00	8.70	4.20	6.00
Sep – 08	1.50	12.00	17.90	27.20	14.50
Total	**1,463.90**	**1,876.30**	**918.50**	**805.10**	**592.00**

Rainfall events varied from the maximum of 1, 876.30 mm occurring at Rampai to 592.00 mm occurring at the Katse Village.

Rainfall figures in Table 1 were considerably high during the first half of the 2007/2008 hydrological year, indicating that this half was very wet 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 over leave shows the Katse dam, the Katse Bridge flow measuring station, the Khohlontšo Stream and the IFR site 2 reach.

Figure 2: Katse Dam and the IFR site 2 reach

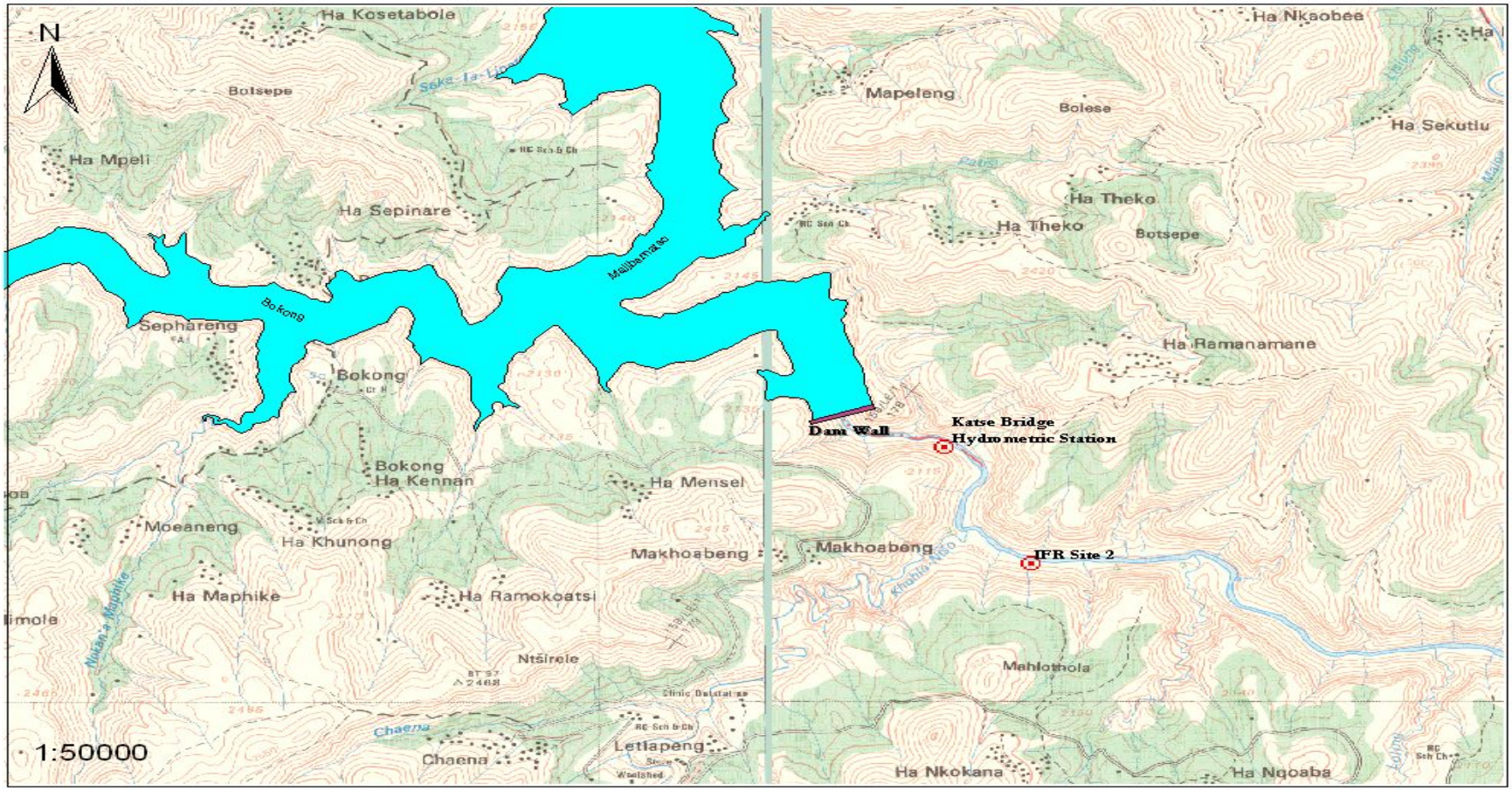


FIGURE 3: Katse Catchment Rainfall Patterns for 06/07 versus 07/08 Hydrological Years:

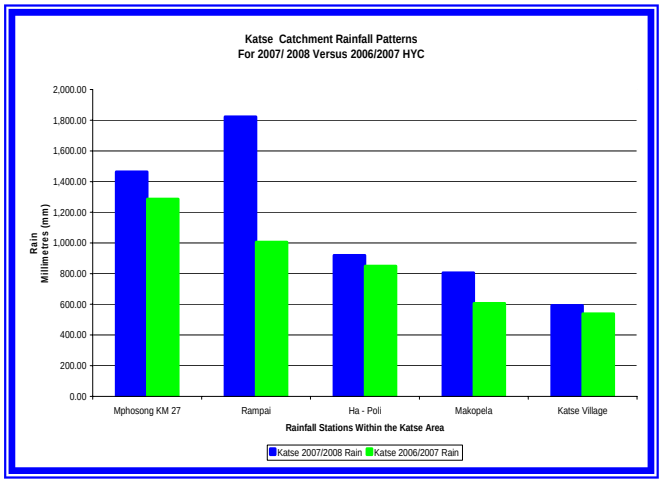


Figure 3 shows that Rampai and Mphosong rainfall stations received the highest amount of rainfall compared to other stations in downstream catchment areas. The rainfall magnitude seems to reduce as it progresses further downstream, from Mphosong (Mafika – Lisiu) all the way to Katse. This is because 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 leave the dry winds to progress further downstream with reduced magnitude of rainfall occurrences.

This figure also compares rainfall events within the Katse catchment area for the 2006/2007 and 2007/2008 hydrological years. It shows that the rainfall patterns within the Katse catchment seem to follow the similar behavioral trend with the highest rainfall amount occurring at Mphosong and Rampai rainfall stations and it reduces as it progresses to downstream catchments. Therefore Figure 3 clearly shows that there were more rainfall occurrences during October 2007 to September 2008 than there were in 2006/2007 hydrological year.

2.1.2 KATSE DAM INFLOWS

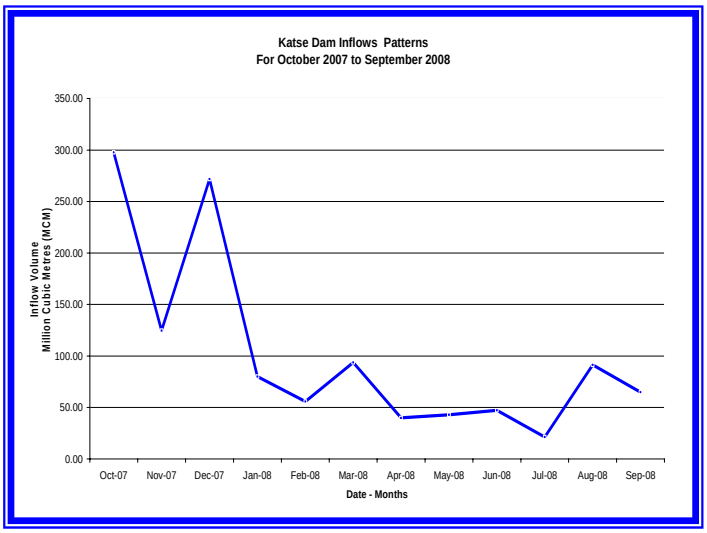
The Katse reservoir received the total inflow volume of 1, 231.00 MCM for the 2007/2008 hydrological year. This amount of recorded inflow into the Katse Dam comprises:

a. The rainfall occurring within the Katse catchment area

b. The transfers of 139.63 MCM from Mohale Dam and
c. The estimated transfers of 37.41 MCM from the Matsoku Diversion Weir and Tunnel.

The net inflow volume into the Katse reservoir, after deductions of all the transfers is therefore 1, 053.96 MCM. See Table 3 which presents the monthly inflow volume and releases data for the Katse Reservoir.

FIGURE 4: Katse Dam Inflow Patterns



The holistic patterns for monthly inflow volume into the Katse reservoir, as portrayed on figure 4, indicate that the inflow volume was dramatically high during October, November and December 2007. There was however a drop from the inflow volume of 300 MCM occurring in October 2007 to 120 MCM occurring in November 2007. The inflow volume decreased below 100 MCM in January 2008 and it was sustained there with normal sinusoidal fluctuations for different months. Thus the provided flow variation patterns show that naturally occurring floods were taking place from October to December 2007 and this was followed by very dry weather conditions during January to March 2008 and throughout the rest of the 2007/2008 hydrological year.

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 the total quarterly inflow volume into the Katse dam. It is upon these actual

inflow values that the following quarter is derived and the IFR releases are determined.

The Actual quarterly HYC conditions for IFR site 2 are presented in Table 2 below. The quarter October to December 2007 obtained a Plus 2 HYC.

Table 2: Inflows into Katse Reservoir (in MCM): October 2007 to September 2008

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 2007 To Dec 2007	694.02	12.71	26.53	52.47	707.25	Plus 2
Jan 2008 To Mar 2008	229.40	0.00	5.79	0.25	223.86	Minus 1
Apr 2008 To Jun 2008	130.04	0.00	4.21	0.41	126.24	Plus 2
July 2008 To Sept 2008	177.53	126.92	0.88	3.98	53.71	Plus 1
Total	**1,230.99**	**139.63**	**37.41**	**57.11**	**1,111.06**	**Plus 2**

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 net inflow volume of 1, 053.96 MCM into the Katse dam and the incremental catchment contribution of 57.11 MCM at IFR site 2 make up the total flow volume of 1, 111.06 MCM at IFR site 2. The incremental catchment contribution of 57.11 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 1, 111.06 MCM. This inflow volume falls within the determined flow range of the Plus 2 HYC, which is 757.20 MCM to 1, 183.40 MCM, see the appended Table 2.2-A of the IFR Procedures. The IFR site 2 reach has therefore obtained, on aggregate, a Plus 2 HYC conditions for the 2007/2008 hydrological year.

2.1.4 DAM RELEASES

The total volume of water released from the Katse Dam Outlets during October 2007 to September 2008 is 279.77 MCM. This outflow volume far exceeds the target outflow volume of 78.66 MCM by 201.11 MCM. This variance is attributed to the occurrence of good rains that also influenced releases through the Low Level Outlets and the spill.

2.1.5 DISCHARGES THROUGH THE LOW LEVEL OUTLETS (LLOs)

The LLO gates facilitate the 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 228.64 MCM and 8.62 MCM respectively. There were five (5) scheduled flood releases that constitute the total flood volume of 31.50 MCM and there were also six (6) schedule freshet releases constituting 13.00 MCM.

The flood and freshet releases were scheduled during periods when the environment could not yield natural floods thus only two (2) floods and two (2) freshets were released. The larger volume of floods was released through the LLOs in December 2007. The Katse catchment was saturated with water due to good rains that were taking place and the Katse reservoir was full to its full supply capacity. The inflow volume into Katse dam also shows that there were more flooding during October to December 2007.

Therefore the scheduled floods and freshet releases needed to be aligned to the naturally prevailing weather conditions that were providing natural floods.

This is required to enable river reaches to enhance their functionality and responsiveness to the natural conditions as provided by the environment.

The released flood volume therefore far exceeds the targeted flood volume by 197.14 MCM.

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 LLOs to drawdown the reservoir level.

The total volume of water released through the spillway only amounts to 2.20 MCM for this period. The spill occurred during December 2007.

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

Months Since October 2007 to September 2008	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-07	Plus 1	297.70	0.00	0.00	2.95	2.95	0.00	0.00	2.77	2.77	5.10	4.22	27.47	75.01
Nov-07	Plus 1	124.58	9.00	1.50	3.11	13.61	0.00	0.00	2.71	2.71	16.80	4.05	8.65	60.73
Dec-07	Plus 1	271.74	0.00	0.00	3.21	3.21	223.97	0.00	2.81	226.78	7.00	56.67	146.22	58.20
Jan-08	Plus 2	79.99	4.50	3.50	3.48	11.48	0.00	0.00	3.42	3.42	16.50	3.41	10.02	61.32
Feb-08	Plus 2	55.74	9.00	0.00	3.26	12.26	0.00	0.00	4.79	4.79	15.90	4.93	6.17	57.71
Mar-08	Plus 2	93.68	4.50	3.50	3.48	11.48	0.00	0.00	5.28	5.28	15.20	5.41	10.95	64.51
Apr-08	Minus 1	39.89	0.00	1.50	2.59	4.09	0.00	7.47	5.09	12.56	6.43	5.50	8.14	68.06
May-08	Minus 1	42.83	0.00	0.00	2.41	2.41	0.00	0.00	4.00	4.00	2.94	4.10	6.04	76.18
Jun-08	Minus 1	47.32	0.00	0.00	1.45	1.45	0.00	0.00	3.16	3.16	1.62	4.63	6.99	77.75
Jul-08	Plus 2	21.39	0.00	1.50	2.95	4.45	0.00	1.14	3.07	4.21	5.40	6.05	6.98	82.36
Aug-08	Plus 2	91.41	4.50	0.00	2.68	7.18	4.67	0.00	2.77	7.44	7.90	9.42	9.05	77.53
Sep-08	Plus 2	64.73	0.00	1.50	2.59	4.09	0.00	0.00	2.65	2.65	6.40	2.81	3.04	72.68
Total for Year 2007/2008		**1231.00**	**31.50**	**13.00**	**34.16**	**78.66**	**228.64**	**8.62**	**42.52**	**279.77**	**107.19**	**111.21**	**249.72**	**832.03**

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

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 assessment of flow records at this station shows that part of the most valuable incremental catchment flow volume between the flow measuring station and the actual IFR site 2 is left unmonitored. More specifically the Khohlontšo stream flows are not assessed.

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

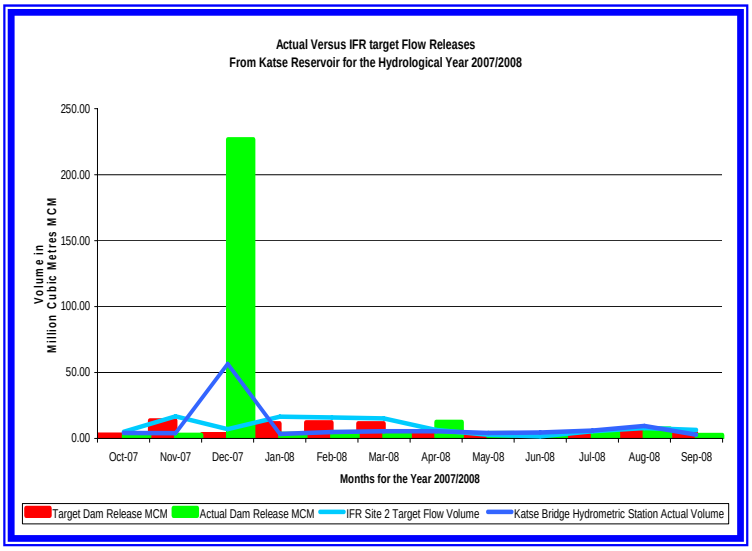


Figure 5 presents graphical records for Monthly Flow Release volumes from the Katse Dam, the recorded flows at the Hydrometric station on Malibamatšo River at Katse Bridge just downstream of the Katse Dam Wall (labeled IFR Site 2 Reach) and the target IFR releases at both the Katse Dam site and IFR site 2.

The actual total volume of water recorded at the Katse Bridge Hydrometric Station was 111.21 MCM. The required target flow release of 78.66 MCM from the Katse dam site was calculated to be transformed to achieve the target river flow of 107.19 MCM at IFR site 2 downstream of the Katse Bridge Hydrometric Station.

The actual flow volume of 111.21 MCM recorded at the Katse Bridge Hydrometric Station was therefore slightly more than the stipulated IFR target flow volume of 107.19 MCM.

Table 3 indicates that dam releases, especially during December 2007 far exceeded the target IFR flows. The flow trend on figure 5 above clearly shows the flow patterns from dam site to IFR site 2. Flow variations within respective months could not be explicitly shown because only monthly total volumes are considered. Hence 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.

The required number of floods at the designated IFR site 2 and IFR site 3 were also satisfied and even exceeded.

2.2 MOHALE CATCHMENT

The Mohale catchment area is characterized by moderately wet weather conditions. This catchment receives normal to high amount of rainfall every year, enough to contribute substantial inflow into the Mohale dam structure.

The water resources collected in Mohale dam is then transferred via a tunnel to the Katse dam.

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 data within the Mohale catchment area during October 2007 to September 2008.

Rainfall events varied from the maximum of 1, 201.60 mm recorded at the rainfall station that is situated at the Thaba – Putsoa mountain plateau to the minimum of 842.80 mm occurring at the Cheche rainfall station.

Figure 6 over leave 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.

Figure 6:Mohale Dam and the IFR site 7 reach

Table 4: Rainfall patterns within the Mohale Catchment

Month	Thaba - Putsoa	Rapokolana	Cheche
Oct – 07	184.90	194.60	131.20
Nov – 07	118.00	101.90	112.70
Dec – 07	179.00	150.10	98.80
Jan – 08	147.30	159.00	139.60
Feb – 08	153.80	136.70	84.90
Mar – 08	142.50	109.10	112.20
Apr – 08	82.60	59.30	45.50
May – 08	74.10	96.80	37.40
Jun – 08	85.60	59.60	49.50
Jul – 08	0.00	0.00	0.00
Aug – 08	18.20	19.90	8.00
Sep – 08	15.60	15.30	23.00
Total	**1,201.60**	**1,102.30**	**842.80**

Rainfall figures in Table 4 were considerably high during the first half of the 2007/2008 hydrological year, indicating that this half was wet for the Mohale catchment.

FIGURE 7: Mohale Catchment Rainfall Patterns for 06/07 versus 07/08 Hydrological year:

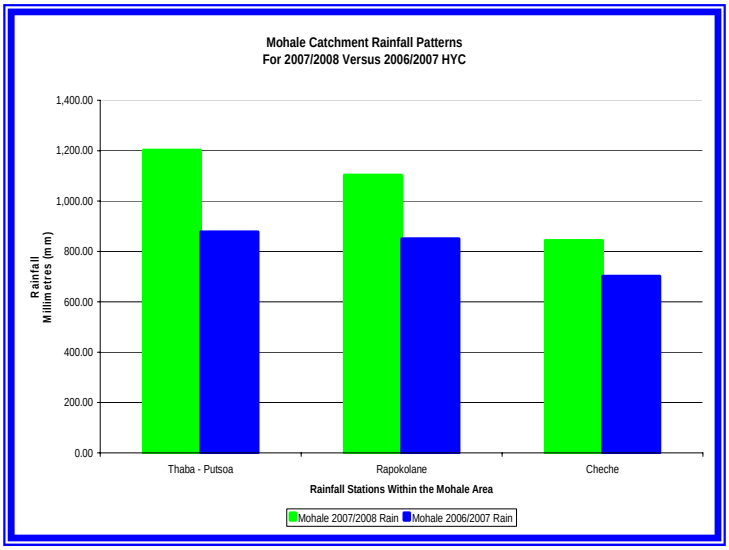


Figure 7 portrays the total rainfall figures for rainfall stations within the Mohale catchment and it shows that the Thaba – Putsoa rainfall station received the highest amount of rainfall compared to other downstream stations. The rainfall magnitude seems to reduce as it progresses further downstream of 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 winds progressing further downstream are drier with reduced amount of moisture content to influence the occurrence of rainfall.

Figure 7 also compares rainfall events within the Mohale catchment area for the 2006/2007 and 2007/2008 hydrological years. The rainfall patterns within the Mohale catchment also seem to follow the similar pattern of behavior with the highest rainfall amount occurring at Thaba – Putsoa rainfall station. This figure clearly shows that there were more rainfall occurrences during October 2007 to September 2008 than there was in 2006/2007 hydrological year. Thus the rainfall patterns for different years in figure 6 show the similar pattern of rainfall occurrences with the Cheche rainfall station receiving the lowest rainfall amount.

2.2.2 MOHALE DAM INFLOWS

The Mohale Dam received a total reservoir inflow volume of 421.36 MCM for the 2007/2008 hydrological year. The total volume of 139.63 MCM, which is part of this inflow volume, was transferred to the Katse Dam during this period.

The transferred volume of water from Mohale to Katse dam is appropriately less than the inflow volume into Mohale dam compared to the previous hydrological year where the transferred volume of water was more than the inflow volume by 8.86 MCM.

Inflows into Mohale reservoir were dramatically high during October to December 2007. Naturally occurring floods took place during this period.

FIGURE 8: Mohale Dam Inflow Patterns

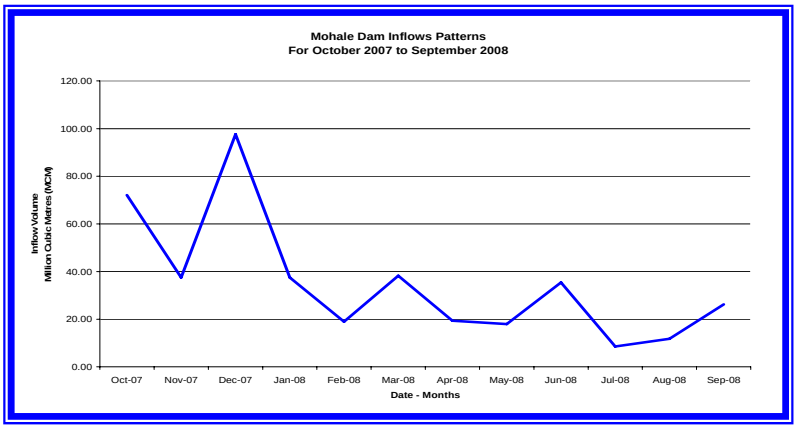


Figure 8 portrays monthly inflow patterns for Mohale dam. This figure shows that the highest inflow volume of 100 MCM occurred in December 2007. The inflow volume then dropped below 40 MCM during January 2008.

The Mohale catchment was experiencing severely dry weather conditions with the inflow volume remaining very low for the rest of the 2007/2008 hydrological year. This inflow time series portrays the sinusoidal oscillatory behaviour which ranges between 40 and 20 MCM from January to June 2008. Thereafter the inflow volume reduced as low as 8 MCM during July 2008.

2.2.3 HYDROLOGICAL YEAR CLASSES (HYC) AT IFR SITE 7

The HYC at IFR site 7 is determined the same way as the HYC at IFR site 2. The sum of the inflow value of 421.36 MCM into the Mohale dam and the incremental catchment contribution of 28.80 MCM give the total flow volume of 450.16 MCM.

The inflow volume used for the determination of the HYC at IFR site 7 for 2007/2008 hydrological year is therefore 450.16 MCM. This inflow volume falls within the determined flow range of the Plus 1 HYC, which is 376.60 MCM to 485.80 MCM as given in Table 2.2-B of the Appendices. Hence the 2007/2008 hydrological year has, on aggregate achieved the Plus 1 HYC conditions for Mohale catchment.

The quarterly HYC conditions for IFR site 7 are presented in Table 5 over leave.

Table 5: Inflows into Mohale Reservoir

Quarter	Inflow into Katse Dam	Incremental Catchment Flows	Actual Inflows at IFR Site 7	Actual Hydrological Class
Oct 2007 To Dec 2007	207.20	15.27	222.47	Plus 2
Jan 2008 To Mar 2008	94.77	7.36	102.13	Minus 1
Apr 2008 To Jun 2008	72.74	6.18	78.92	Plus 1
July 2008 To Sept 2008	46.65	-0.01	46.64	Average
Total	**421.36**	**28.80**	**450.16**	**Plus 1**

2.2.4 DAM RELEASES

The total volume of water released from the Mohale Dam Outlets, including seepage flow is 28.69 MCM. This outflow volume is 8.27 MCM less than the targeted dam releases for IFR requirements. The required target release at dam site was 36.96 MCM. This flow volume has been calculated to achieve the target river flow of 91.94 MCM at IFR site 7 downstream of the Mohale Dam.

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 2007/2008 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.

These floods were scheduled during periods when the environment could not yield natural floods, coupled with the existing problem on the operation of LLO gates that the valves were not designed to be regularly operated.

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

Months Since October 2007 to September 2008	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	MCM
Oct-07	Average	72.09	0.00	2.01	2.01	0.00	0.00	0.00	0.79	0.79	6.88	4.89	12.71
Nov-07	Average	37.49	0.00	3.27	3.27	0.79	0.00	0.00	0.67	1.45	11.26	3.67	0.00
Dec-07	Average	97.63	0.00	1.45	1.45	2.26	0.00	0.00	0.47	2.73	4.95	11.68	0.00
Jan-08	Plus 2	37.50	0.00	4.47	4.47	2.30	0.00	0.00	0.70	3.00	17.55	4.81	0.00
Feb-08	Plus 2	19.02	11.30	3.18	14.48	2.15	0.00	0.00	0.65	2.81	23.38	4.81	0.00
Mar-08	Plus 2	38.25	0.00	3.51	3.51	3.29	0.00	0.00	0.12	3.42	13.73	6.96	0.00
Apr-08	Minus 2	19.40	0.00	0.62	0.62	3.37	0.00	0.00	0.01	3.38	2.03	4.85	0.00
May-08	Minus 2	17.90	0.00	0.91	0.91	3.48	0.00	0.00	0.01	3.50	2.75	5.03	0.00
Jun-08	Minus 2	35.44	0.00	0.78	0.78	2.81	0.00	0.00	0.23	3.04	1.90	6.22	0.00
Jul-08	Average	8.59	0.00	0.40	0.40	0.00	0.00	0.00	1.37	1.37	0.91	1.65	12.85
Aug-08	Average	11.80	3.90	0.67	4.57	0.00	0.00	0.00	1.26	1.26	5.45	1.20	61.77
Sep-08	Average	26.25	0.00	0.49	0.49	0.00	0.00	0.00	1.95	1.95	1.15	1.71	52.30
Total for Year 2007/2008		**421.36**	**15.20**	**21.76**	**36.96**	**20.46**	**0.00**	**0.00**	**8.23**	**28.69**	**91.94**	**57.49**	**139.63**

The inflows into Mohale dam were only 19.02 MCM during February 2008 and 11.80 MCM during August 2008. 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.

The scheduled flood releases needed to be aligned with naturally prevailing weather conditions that are providing good flooding.

The operational problems on the LLO valves due to design limitations were also reported as hindering complete implementation of IFR requirements. The valves could be easily damaged if operated quite often. This causes reluctance to dam operators to implement required IFR floods.

The Plus 1 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 at the rate of approximately 0.50 m^3/s.

Data records, as given in Table 6, show that seepage from the Mohale dam is rapidly increasing in magnitude, irrespective of dry prevailing weather conditions. The recorded total seepage volume is 8.23 MCM for the 2007/2008 hydrological year.

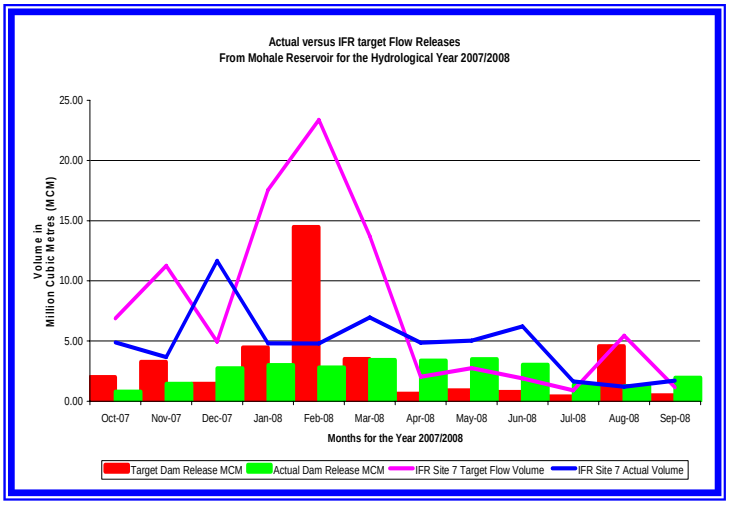
2.2.7 SPILLAGE

There was no spill flow during October 2007 to September 2008. 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 57.49 MCM. This flow is 34.45 MCM less than the stipulated IFR target flow volume of 91.94 MCM for the considered period, October 2007 to September 2008.

Figure 9: The Monthly flows versus the Target IFR flows from Mohale Dam.



The IFR flows were completely not met, both at dam site and at IFR site 7. The intervening catchment downstream of Mohale dam could not adequately contribute flow to satisfy IFR requirements at IFR site 7. 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. Thus the available flow records indicate that IFR site 7 is completely dependent on rainfall occurrences within the Mohale catchment area.

The observed variance of 34.45 MCM is basically due to the floods that were not released and it is adding on to the already accumulated deficit at IFR site 7.

The target river flow at IFR site 7 has therefore not been attained in terms of magnitude during October 2007 to September 2008. Flow patterns shown in Figure 9, however exhibits required monthly flow variations at IFR site 7, even though time series variations within respective months could not be shown.

DEFICIT AT IFR SITES

2.3.1 IFR site 2

The Katse Bridge flow measuring station which is located 2 km upstream of both the IFR site 2 and the Khohlontšo tributary is being used for the assessment of IFR site 2 flows. This station does not capture all incremental flows and it therefore under estimates the actual IFR flows. It thus fails to show the impact of the tributary between IFR site 2 and this flow measuring station. This tributary contributes considerable amounts of flow that could not be quantified or even be 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 4.02 MCM measured at the Katse Bridge Hydrometric station. The target IFR flow was 107.19 MCM for the period October 2007 to September 2008 and this target IFR flow volume is lower than the measured flow volume of 111.21 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, 28 km downstream of the Mohale dam. This weir accurately measures Senqunyane River flow, which combines Mohale dam releases and the incremental catchment flows.

Deficit at IFR site 7 has been accumulating since the impoundment of the Mohale dam.

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.

The deficit value of -8.76 MCM in Table 7 below shows that there was no deficit accrued at IFR site 7 during October 2005 to September 2006 due to good rains that occurred during February 2006. This Table also presents the deficits that have been accrued at IFR site 7 since October 2005 to September 2008.

Table 7: IFR site 7 deficit

Date – Years	Target IFR Flow	Actual IFR Flow	Deficit
Oct 05 To Sept 06	89.10	97.86	-8.76
Oct 06 To Sept 07	100.59	89.35	11.24
Oct 07 To Sept 08	91.94	57.49	34.45
Total	**281.63**	**244.7**	**36.93**

The deficit computed for the 2007/2008 hydrological year is 34.45 MCM and the deficit computed to September 2008 is 36.93 MCM. The total deficit at IFR site 7 takes into considerations the World Bank deficit volume of 52.68 MCM, which lifts the IFR site 7 deficits to 89.61 MCM.

2.3 '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. There is no IFR implied for 'Muela dam.

It was decided in December 2004 to bank 75% of the 'Muela Mean Annual Runoff (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 0.89 MCM was therefore estimated as the low flow volume released in accordance with the developed schedule. No flood releases to offset drought in Maseru were requested during October 2007 to September 2008.

The 'Muela dam release schedule demands that a flood of 0.75 m^3/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 15.00 MCM at the end of September 2008.

2.4.1 DAM RELEASES

The estimated total volume of water released from the 'Muela dam outlets was 0.89 MCM. This outflow volume is 0.32 MCM less than the targeted total dam release of 1.21 MCM. The total target flow volume, which is 25% MAR, comprises of the low flow volume of 0.89 MCM and the flood volume of 0.32 MCM.

The variance is due to the flood volume of 0.32 MCM that was not released as required and specified in the schedule to enhance flow variability downstream of the 'Muela dam.

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 or Automatic recorder at this station. The new flow measuring station to facilitate precise quantification of the 'Muela downstream flows is under construction.

2.4.2 DISCHARGES THROUGH THE LOW LEVEL OUTLET (LLO)

The 'Muela dam release schedule demands that a flood of 0.75 m^3/s must be released for one day during November to March of the following year. This requirement was established due to the need to enhance flow variability within the Nqoe River downstream of the 'Muela dam.

The total volume of 0.32 MCM was therefore required to have been released downstream of the 'Muela Dam. However no releases were effected through the LLOs. The release schedule was not implemented effectively during October 2007 to September 2008.

2.4.3 SPILLAGE

'Muela Dam did not spill during October 2007 to September 2008. 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 delivered to RSA other than to overflow through the spillway. Hence the water resources delivered to RSA was 832.03 MCM against the targeted delivery of 780 MCM.

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

The flow measuring station on Hololo River became nonfunctional since July 2006. There is serious sediment deposition taking place at the station. This 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 being constructed on Nqoe River downstream of the 'Muela dam. This station will verify downstream releases as well as incremental catchment flows. Hence Hololo will be taken out completely.

No emergency flow releases volume was requested during October 2007 to September 2008.

Table 8: Monthly Flow Releases from the 'Muela Dam

Months Since October 2007 to September 2008	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	MCM	MCM
Oct-07	0.05	0.00	0.00	0.00	0.05	0.05	1.30	0.00
Nov-07	0.10	0.06	0.00	0.00	0.10	0.10	0.86	0.00
Dec-07	0.11	0.06	0.00	0.00	0.11	0.11	1.16	0.00
Jan-08	0.11	0.06	0.00	0.00	0.11	0.11	0.46	0.00
Feb-08	0.10	0.06	0.00	0.00	0.10	0.10	0.21	0.00
Mar-08	0.11	0.06	0.00	0.00	0.11	0.11	0.27	0.00
Apr-08	0.05	0.00	0.00	0.00	0.05	0.05	0.06	0.00
May-08	0.05	0.00	0.00	0.00	0.05	0.05	0.06	0.00
Jun-08	0.05	0.00	0.00	0.00	0.05	0.05	0.12	0.00
Jul-08	0.05	0.00	0.00	0.00	0.05	0.05	0.03	0.00
Aug-08	0.05	0.00	0.00	0.00	0.05	0.05	0.01	0.00
Sep-08	0.05	0.00	0.00	0.00	0.05	0.05	0.00	0.00
Total for Year 2007/2008	**0.89**	**0.32**	**0.00**	**0.00**	**0.89**	**0.89**	**4.55**	**0.00**

The total volume recorded at the Nqoe flow measuring station upstream of the 'Muela dam amounts to 4.55 MCM. This inflow volume is 3.66 MCM higher than the estimated released volume of 0.89 MCM.

Figure 10: The Monthly flows and releases versus the Target flows from the 'Muela Dam.

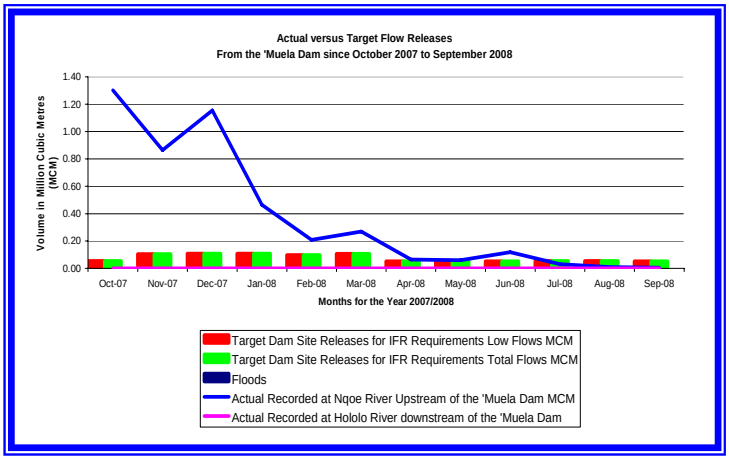


Figure 10 shows the flow patterns from the 'Muela Dam outlets as well as those from the Nqoe River Hydrometric Station upstream of 'Muela dam. It is observed that the Nqoe Inflows are higher than the 'Muela Dam Outflows and indicating that the excess water was banked. The Nqoe flows however, decreased in magnitude to 0.00 MCM during September 2008.

2.4 MATSOKU DIVERSION WEIR AND TUNNEL

The Matsoku Diversion Weir and Tunnel has been constructed to divert the excess water of the Matsoku River catchment into the Katse dam. This weir has been designed to release all the inflows that are less than and/or equal to 0.8 m^3/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 m^3/s gets transferred to the Katse dam. The capacity of the Matsoku to Katse Transfer Tunnel is 47 m^3/s. Therefore all the flows in excess of 0.8 m^3/s up to 47 m^3/s are transferred into the Katse dam. The spill

flow from the Matsoku weir crest is expected to occur when the flow into the Transfer Tunnel to Katse dam is more than 47 m^3/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 m^3/s or the Matsoku to Katse transfer tunnel is closed.

2.5.1 MATSOKU WEIR RELEASES

All the flow measuring devices at the Matsoku Diversion Weir and Tunnel are currently 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 18.66 MCM. This outflow volume is 0.31 MCM less than the targeted flow volume of 18.97 MCM if the flow rate of 0.60 m^3/s was constantly flowing downstream.

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 2007 to September 2008 are presented in Table 9.

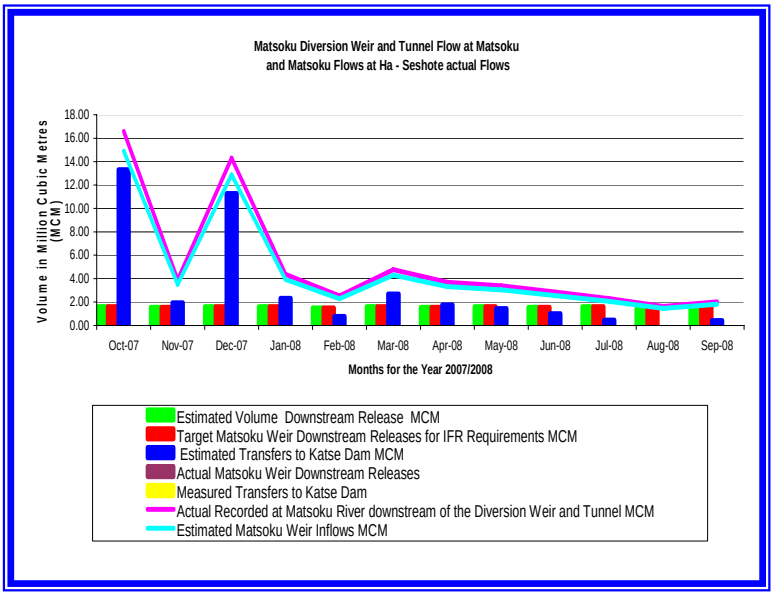
Table 9: Recorded and Estimated Monthly Flows at the Matsoku Weir.

Months Since October 2007 to September 2008	Estimated Volume Downstream Release (@ 0.6m3/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-07	1.61	0.00	1.61	0.00	13.32	16.58	14.93
Nov-07	1.56	0.00	1.56	0.00	1.95	3.89	3.50
Dec-07	1.61	0.00	1.61	0.00	11.27	14.31	12.88
Jan-08	1.61	0.00	1.61	0.00	2.32	4.36	3.93
Feb-08	1.50	0.00	1.50	0.00	0.77	2.53	2.27
Mar-08	1.61	0.00	1.61	0.00	2.69	4.78	4.30
Apr-08	1.56	0.00	1.56	0.00	1.76	3.68	3.31
May-08	1.61	0.00	1.61	0.00	1.44	3.39	3.05
Jun-08	1.55	0.00	1.56	0.00	1.01	2.85	2.56
Jul-08	1.61	0.00	1.61	0.00	0.45	2.29	2.06
Aug-08	1.46	0.00	1.61	0.00	0.00	1.62	1.46
Sep-08	1.39	0.00	1.56	0.00	0.43	2.02	1.82
Total for Year 2007/2008	**18.66**	**0.00**	**18.97**	**0.00**	**37.41**	**62.30**	**56.07**

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

The total volume of water recorded at the Matsoku River System at Seshote Hydrometric Station is 62.30 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 56.07 MCM.

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



The flow records at the Seshote flow measuring station indicates that Matsoku catchment was also experiencing relatively 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 62.30 MCM at the Seshote flow measuring station is acceptable considering that part of this flow volume has been diverted into the Katse dam. This flow volume falls within the Minus 1 HYC for the Matsoku catchment, which ranges from 59.90 MCM to 82.00 MCM. 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 m^3/s is released downstream.

2.5.3 DISCHARGES THROUGH THE TUNNEL OUTLET TO KATSE DAM

The estimate of the transferred volume from Matsoku to Katse dam during October 2007 to September 2008 amounts to 37.41 MCM. This value has been estimated

from the flow data that is collected from the hydrometric station downstream of the weir.

The environment and weather conditions could not supply enough flow volume for the Matsoku catchment to satisfy the Mean Annual Runoff (MAR) conditions.

2.5.4 SPILLAGE

Matsoku Diversion Weir and Tunnel did not spill during October 2007 to September 2008. 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.

3 CONCLUSIONS

The implementation of the IFR Policy and Procedures for the 2007/2008 Hydrological Year was effectively and efficiently carried out with a lot of improvements being executed with regard to low – flow implementation and flood releases for the Katse catchment.

The 2007/2008 Hydrological Year has been a particularly wet year for Mohale catchment area with the aggregate of Plus 1 HYC conditions whilst the Katse catchment was very wet with the aggregate of Plus 2 HYC conditions.

KATSE DAM

The actual HYC for the Katse catchment area for the Hydrological Year 2007/2008 was, on aggregate, a 'Plus 2' class with the total inflow volume of 1, 111.06 MCM at IFR site 2.

The actual total volume of 279.77 MCM was released from the Katse Dam during October 2007 to September 2008. The target flow release, as specified in the IFR Policy and Procedures, amounts to 78.66 MCM for the entire reporting period. The Dam releases therefore far exceeded the stipulated amounts by approximately 201.11 MCM, which is equivalent to 256% of target releases.

The volume recorded at the Katse Bridge Hydrometric Station amounts to 111.21 MCM whilst the targeted IFR volume at IFR site 2 stands at 107.19 MCM. The IFR required flow volume was therefore achieved 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 'Plus 1' HYC conditions, which has demonstrated to be drier than the Katse catchment. The total flow volume was 450.36 MCM at IFR Site 7 for the 2007/2008 Hydrological Year.

A total flow volume of 28.69 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 36.96 MCM. Therefore actual Dam releases were less than the target releases by 8.27 MCM.

The total flow volume recorded at IFR site 7 amounts to 57.49 MCM and the target IFR flow volume amounts to 91.94 MCM. This indicates that the IFR requirements were not satisfied at IFR site 7. The observed flow variance is 34.45 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 0.89 MCM. This flow volume has been released in accordance with the low flow release schedule developed to enhance flow variability in Nqoe River downstream of the 'Muela dam.

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 2007 to September 2008.

MATSOKU DIVERSION WEIR

The Hydrometric Station flow time series from the 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 **37.41** MCM whilst the volume of water released downstream equates to **18.66** 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 2007 to September 2008.

Appendices

Table 2.2-A: Runoff maxima and minima for hydrological year classes: IFR Site 2 – Katse Dam

MAR = 576 MCM

Classification	Maximum Annual Runoff (MCM)	Minimum Annual Runoff (MCM)
Plus 2	**1183.4**	**757.2**
Plus 1	**757.2**	**603.7**
Average	**603.7**	**491.2**
Minus 1	**491.2**	**378.9**
Minus 2	**378.9**	**180.8**

Table 2.2-B: Runoff maxima and minima for hydrological year classes: IFR Site 7 – Mohale Dam

MAR = 355 MCM

Classification	Maximum Annual Runoff (MCM)	Minimum Annual Runoff (MCM)
Plus 2	**893.6**	**485.8**
Plus 1	**485.8**	**376.6**
Average	**376.6**	**299.1**
Minus 1	**299.1**	**227.6**
Minus 2	**227.6**	**89.6**

Table 2.2-C: Runoff maxima and minima for hydrological year classes: IFR Site 1– Matsoku Diversion

MAR = 87 MCM

Classification	Maximum Annual Runoff (MCM)	Minimum Annual Runoff (MCM)
Plus 2	**236.4**	**140.0**
Plus 1	**140.0**	**97.4**
Average	**97.4**	**82.0**
Minus 1	**82.0**	**59.9**
Minus 2	**59.9**	**37.19**