EXECUTIVE SUMMARY

Introduction

The Lesotho Highlands Development Authority's (LHDA) Instream Flow Requirements (IFR) Policy was approved by the Lesotho Highlands Water Commission (LHWC) on 13 December, 2003. Seven months later, on 30 July 2003, the IFR Procedures, which provide the operational framework for implementation of the Policy, were also agreed and approved.

IFR is a management system for dam releases for environmental maintenance of downstream river reaches impacted by the dams. IFR management is still in its infancy in Southern Africa. The Lesotho Highlands Water Project therefore provides a valuable case study in understanding the associated management of environmental ecosystems in downstream river reaches within the Southern African context.

This report records progress in LHDA's efforts to fulfil the IFR Policy requirements for the period from approval of the IFR Policy until September 2004. It also provides information on the implementation of mitigation and compensation measures undertaken for flow related impacts on the resources, ecosystems and communities in downstream areas, and other secondary or indirect losses. In addition, it addresses lessons learned and presents recommendations for improved implementation.

Compliance against release targets

The setting of IFR bulk-water allocations for the period under reporting was not without difficulties as a result of inexperience and significant fluctuations in the monthly rainfall. The year was projected to be a Plus 1 hydrological year class (HYC) for the Katse locality and an Average hydrological year for the Mohale area.

Releases from Katse for the period Jan to September 2003 totalled 256.61 MCM, which considerably exceeded IFR policy requirements due to various flood test releases, and spilling from the reservoir. Releases during the period October 2003 to September 2004 were frequently, and in aggregate, below the target releases that were set to achieve desired flows at IFR Site 2. Flows at Site 2 itself could not be measured as the measuring station is only about 1060 metres downstream of the Katse dam structure and is upstream of the Khohlonts'o tributary inflow. The Khohlonts'o stream, which is unmonitored, directly contributes to the flow at IFR site 2, which is some 3060 metres downstream of the dam and 2000 metres below the Katse bridge hydrometric station. It is therefore not possible to determine with accuracy whether actual IFR site 2 flows matched the target flows.

Releases from Mohale from the time of impoundment in October 2002 until the end of July 2003 were subject to the Washington Agreement. For the period October 2003 to September 2004, the water volume of flow recorded at IFR site 7 was 49.31 MCM against a target of 70.12 MCM, a 30% total deficit over the year. This was despite the fact that releases from Mohale dam of 37.56 MCM considerably exceeded the target release of 27.36 MCM. The explanation is that inflows from the incremental catchment between Mohale dam and IFR site 7 were consistently less than had been assumed.

Major adjustments to the release schedules were effected because of the prevailing conditions experienced. Incident Reports detail these changes. Adjustments resulted in the IFR releases varying from those for a Plus 1 to a Minus 2 hydrological year. The spring flood in August 2004 could not be released due to the absence of suitable natural climatic conditions at the time. Scheduled flood releases are intended to supplement naturally occurring floods as and when they occur. Spring freshets and small floods are significant cues for fish and invertebrate breeding cycles that cannot be ignored.

Overall, flood releases could not be effected as scheduled because of the prevailing dry condition throughout winter, early spring and summer 2003 and because of the absence of naturally occurring flood events. It was only in April 2004, at the onset of a high rainfall, that a flood was released.

The decision was also taken to increase releases from Mohale dam in an effort to compensate for the accumulating deficit in target flows at IFR site. The deficit appears to have been the result of inflows from the incremental catchment between Mohale Dam and IFR site 7 being less than calculated. The manipulation of releases in the short term had the effect of evening out the low flow releases to being nearly constant. On the other hand, releases from Katse for the October ’03 to September ’04 period have also shown absence of variability of flow.

Although the IFR Procedures provide for the full spectrum of climatic conditions – as reflected by river flows – it was found that annual adjustment of the hydrological year was inadequately responsive to changing climatic conditions.

Resolution reached relating to flood releases

The LHDA has now accepted that the release of certain floods under all hydrological year classes is a critical aspect of water management. Various options for dealing with such extreme dry events will be explored. This will include:

- Re-scheduling the flood within a particular season as the case might be,
- Releasing it as a set of smaller freshets over a period of two months,
- Reducing the size and duration of the flood.

Verification of river condition status

Water quality monitoring information was not effectively evaluated to enable credible and conclusive statements about river condition status. In addition, the biophysical monitoring exercise was substantially delayed and could not provide useful information. There were also significant problems in the characterization of the environmental quality objectives being monitored; namely, the criteria laid down in the river condition classification. The lack of precision in the criteria meant that interpretation of conditions was dependent on extensive experience in this very complex field, a depth of experience which the LHDA has not yet been able to build. Specialist guidance has not been available to the organization on an ongoing basis, but this is about to change with the imminent appointment of a consultant to manage the implementation of the full biophysical monitoring programme.

Related challenges include:

- ➢ In-house monitoring emphasis has focused on IFR sites 2 and 7, on a pilot basis. But, given the critical relationship between monitoring and compensation for resource losses, the LHDA acknowledges that all the sites have to be monitored and is putting in place a strategy to address this.

- No direct comparison can be made between baseline studies conducted in the IFR Study (Contracts 648 and 678) and the LHDA monitoring exercises. Again, the appointment of the monitoring consultant should see this situation improving.

Compensation and socio-economic monitoring

The implementation of IFR procedures in determining compensation mitigation measures was undertaken effectively. It was a participatory process where appropriate and relevant key stakeholders were involved to discuss issues of preparation, implementation and monitoring. To this effect, communities in IFR Reaches 1, 2 and 3 were mobilized into twenty-three (23) formal structures (Local Legal Entities (LLEs)) in preparation for receipt of the first 10-year tranche of the cash compensation payment, which was disbursed to these LLEs in May, 2004. An interim, in-house team is providing technical assistance to the LLEs who have received communal cash compensation.

On the other hand, preparation of affected communities in IFR Reaches 7 and 8 to receive their compensation was not scheduled to commence until April 2005. A first round of consultation with communities in reaches 7 and 8 was undertaken during 2003, but the detailed preparation for the establishment of LLEs and payment remains to be completed.

The LHDA is currently in the process of procuring the services of a Consultant to develop and implement the monitoring protocol for measuring and evaluating the socio-economic status of affected communities in downstream river reaches, as required by the IFR Policy.

Way forward

- Further revision of the Procedures, under the guidance of an IFR specialist, is required. This revision will consider the revised approach of setting IFR release targets on a quarterly basis, as well as examining the feasibility of using the Water Balance model projection of yields for the following year to set the IFR annual flow schedule.
- Scheduled floods will not to be cancelled but may be rescheduled as necessary to coincide with naturally elevated river flow.
- Training LHDA technical staff in the use of the DRIFT database, and linking this to the results of biophysical monitoring, will be undertaken.
- LHDA will endeavour to reduce delays in internal approval procedures.
- The initiation of the IFR biophysical monitoring Contract 1237 will be fast-tracked. The focus will be on the following aspects:
  - Revision of the river condition classification and refinement of the measuring criteria.
  - Development of very specific protocols and methods for monitoring against these criteria.
  - Rigorous training in monitoring purpose, field methodologies and analytical techniques.
  - Development of a template for reporting each monitored component.

1 INTRODUCTION

1.1 Background

Environmental and social issues were incorporated as legally binding articles in the founding Lesotho Highlands Water Project (LHWP) Treaty signed by the governments of the Kingdom of Lesotho and the Republic of South Africa for Phase I of the Project in October, 1986. In particular, Articles 7(18) and 15 of the Treaty enjoin the Lesotho Highlands Development Authority (LHDA), the agency established to implement the part of the Project in Lesotho with responsibility for:

- operations and maintenance of dam and hydropower structures
- instituting mitigation measures for the protection and preservation of the natural and socio-economic environment.

Initially, environmental management efforts were focused on the upstream areas of the LHWP reservoirs. However, in keeping with emerging experience in the development of large dams worldwide, LHDA appointed consultants to undertake an assessment of the instream flow requirements of river reaches in Lesotho downstream of the Project dams and to predict the impacts of reduced flows on downstream ecosystems and human communities. This was effected during 1996-2002 through LHDA Consulting Contracts No. 648 and 678. The information would establish the extent of deterioration suffered by the downstream ecosystems and impacts on communities as a result of modified river morphology.

The study area covered about 600km of river reaches; namely Senqu, lower Senqunyane, lower Malibamats'o and Matsoku rivers. This study was groundbreaking with respect to the importance that was attached to the level of socio-economic impacts of flow modifications in the receiving environment downstream. In addition, realising that increasing downstream releases above the "Treaty minima" for IFR purposes would have impacts on the project yield, hence on project benefits, an additional study was commissioned to model the impacts of IFR flows on project economics.

1.2 Development of the IFR Policy and Procedures

The completion of IFR studies in 2002 led to a process of formulating an IFR Policy that would guide the management of releases from the LHWP dams for the maintenance of downstream river health[1]. It was approved by the Lesotho Highlands Water Commission (LHWC) in December 2002. Further changes were effected that resulted in the issue of a Second Edition of July 2003 Incorporating Corrigenda of July 2003.

In developing the IFR policy and procedures, the Project Authorities had to:

- Attain an optimal balance between water resources development goals and effective maintenance of river the health
- Assess and evaluate the trade-offs between river condition, community needs, and the implications of the different release options *vis a vis* probable financial and economic losses for the two countries

[1] The IFR Policy can be found on the LHWP website (www.lhwp.org.ls).

- Assess and evaluate "reasonable measures" for maintaining the welfare and livelihoods of affected persons and communities, and for ensuring the protection of the quality of the environment in line with the Treaty stipulations.

The IFR operational procedures took quite some time to finalize. They were only approved in July 2003. The IFR Policy however became effective from its approval in Dec 2002 and this report covers the period from January 2003 to September 2004. Releases from Mohale for the period January to July 2003 were in accordance with the Washington Agreement for Impoundment of Mohale Dam.

1.3 The Purpose of the IFR Policy

The overall purpose of the IFR Policy of the LHDA is to provide guidance for the management of flow releases for the maintenance of riverine ecosystems downstream of Phase 1 dams. It will also provide guidance for the mitigation measures aimed at addressing flow related impacts on resources, ecosystems and communities downstream of the dams for both direct and indirect or secondary losses.

1.4 Objectives of the Report

The purpose of this report is to describe Policy implementation activities and evaluate LHDA's performance against IFR Policy objectives, and report these matters to stakeholders. An annual report on the hydrological year is a commitment of the IFR Policy.

The report examines implementation performance and compliance with the three main aspects of the IFR Policy and Procedures, namely:

- Target IFR releases and dam operating procedures. That is, to what extent did the actual flow releases comply with the target set under the IFR Policy?
- River condition targets. That is, to what extent did the flows released permit the achievement of the downstream "river condition" targets? This is to be done by means of the IFR monitoring programme i.e., biophysical and socio-economic monitoring; and
- Compensation and mitigation procedures related to impacts on affected communities. That is:
  - To what extent were the compensation and mitigation measures provided for under the IFR Policy implemented?
  - To what extent did the compensation and mitigation measures achieve LHDA's Treaty obligation to ensure that no one is worse off as a result of the project?

1.5 The Report Structure

The report will present

- Operations or tasks undertaken under each of the three aspects under 1.4 above
- Lessons learned from the LHDA's performance
- Recommendations for effective and efficient management of IFR releases.

2 COMPLIANCE WITH IFR FLOW TARGETS

2.1 Adaptive Management System

The Policy specifies the core components of a system to manage releases from dams in order to:

i. Guarantee that water will be reserved for riverine ecosystems and communities downstream of control structures
ii. Ensure that the reserved water is made available to the ecosystems at the appropriate quality, quantity and time, including responses to any emergency environmental events;
iii. Maintain target river conditions in the affected river reaches, as specified in the Policy;
iv. Provide information towards an appropriate IFR management amenable to a periodic review and performance audit of the policy and its implementation.

These management procedures are described as the Adaptive Management System. They are designed to meet the IFR policy objectives. The IFR Adaptive Management System is based on the model known as the Downstream Response to Imposed Flow Transformations (DRIFT) and entails operational procedures, monitoring compensation, mitigation evaluation review and audit as well as mechanisms for public engagement.

It is important also to note that IFR releases are especially targeted to achieving specified river conditions states as depicted in Tables 2-1 and 2-2.

2.1.1 River condition classification

The Policy committed the Project to delivering a specified percentage of the Mean Annual Runoff (MAR) or target flow at each of the IFR sites downstream of Katse, Matsoku and Mohale dams. (Policy clause 5.1.1 and Table 5.1). The target flows at these sites are not the same as the releases from the dams. Dam releases were calculated so that incremental flow contributions from the catchment area between the dam wall and applicable IFR site would result in the target flows at the IFR site.

River condition classification is described as a condition brought about by the effect of the target flows and existing environmental condition to meeting the desired environmental quality objectives for the indicated river reach. Table 2-1 provides information on the extent of the river reach and related river condition class. Table 2-2 gives a description of river condition classes for Lesotho rivers in accordance with Tables 4.1 and 4.2 in the Policy.

Table 2-1: Target River Condition Classes for river reaches affected by LHWP

Reach	Description	Targeted river condition class or 'state'
Reach 1	Matsoku River, from Matsoku Weir to confluence with Malibamats'o River (30 km)	3
Reach 2	Malibamats'o River, from Katse Dam to confluence with Matsoku River (18 km)	4
Reach 3	Malibamats'o River, from confluence with Matsoku R to confluence with Senqu R (35 km)	4
Reach 4	Senqu River between confluences with Malibamats'o and Tsoelike rivers (115 km)	3
Reach 5	Senqu River between confluences with Tsoelike and Senqunyane rivers (90 km)	2
Reach 6	Senqu River, from confluence with Senqunyane River to South African border (150 km)	2
Reach 7	Senqunyane River from Mohale Dam to confluence with Lesobeng River (90 km)	4
Reach 8	Senqunyane River, from confluence with Lesobeng River to confluence with Senqu River (40 km).	3
Reach 11	Nqoe and Hololo Rivers, from Muela Tailpond to confluence with the Caledon River (13 km)	2

Source: Table 4.2 of IFR Policy

2.1.2 Determination of Release Schedules

Every year, in the month of October, the LHDA sets about determining the yield targets for Katse and Mohale dams for the following calendar year. The level for each dam is factored into the Water-Balance model for the system and programmed to generate expected yield for the following year. The yield schedule is approved by the Commission for implementation at the beginning of January of each year.

The procedure for setting the annual IFR release schedule is such that its implementation is synchronized with natural cycles so that the 'IFR' year would be the hydrological year starting in spring in the month of October. Both the natural cycles and the IFR release schedules are subject to approval by the LHWC.

IFR release management is based on the Downstream Response to Imposed Flow Transformations (DRIFT) hydrological Model. The steps involved in determining the scheduled releases are outlined in Figure 2-1. The model links changes in the flow regime to environmental impacts.

The concept of classifying the next hydrological years through a projected rainfall model to predict the next 'hydrological year class' (HYC) was developed. A decision was reached to have such HYCs sub-divided into 5 such classes, namely:

- + 2 representing - Very Wet Year
- +1 representing - Moderately wet year
- 0 representing - Average
- - 1 representing - Dry year
- - 2 representing - Severe drought.

Annex A sets out the release schedules for Katse and Mohale for each HYC.

Table 2-2: Definitions of the River Condition Classes for Lesotho rivers using key indicators / descriptors

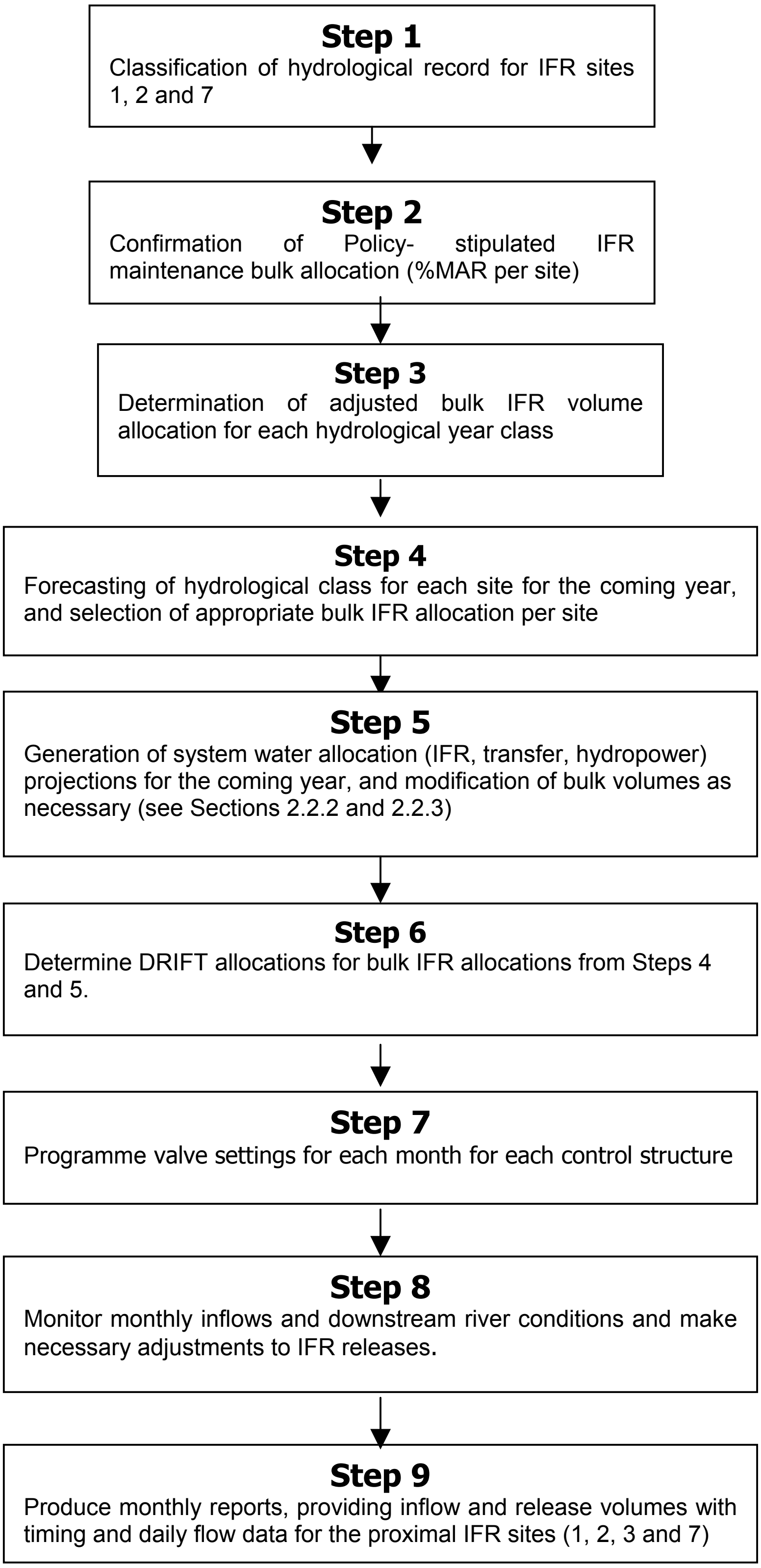
Indicator	Class/State 1	Class/State 2	Class/State 3	Class/State 4	Class/State 5
	Pristine	**Near natural**	**Moderately modified**	**Significantly modified**	**Severely modified**
GEOMORPHOLOGY/HYDRAULICS					
Instream Habitat Diversity	Full natural diversity	5-15% loss in diversity	15-40% loss in diversity	40-70% loss in diversity	>70% loss in diversity
Pool depth	Natural	5-15% loss in depth	15-40% loss in depth	40-70% loss in depth	>70% loss in depth
Bank erosion or collapse	<5% of bank area	5-10% of bank area	10-20% of bank area	20-40% of bank area	>40% of bank area
WATER QUALITY					
Mean monthly temperature[1]	Natural	< 3^{O}C	< 4^{O}C	< 5^{O}C	< 6^{O}C
pH annual range* change	Natural	< 0.5 pH units	< 1.0 pH units	< 1.5 pH units	< 2 pH units
Rapid Biological Assessment Score	Total Score: Unknown	Total Score: ≥ 95	Total Score: 94-70	Total Score: 69-45	Total Score: < 45
VEGETATION					
Zone definition[2]	All present and distinct	All present and distinct	Loss of ≤ 2 zones and/or zone definition less distinct	Loss of ≤ 3 zones and/or zone definition indistinct	No definition
Species composition of riparian vegetation	Full complement	Change in ratios of indigenous species	Dominated by hardy indigenous species and/or exotic species	Dominated by exotics and/or weedy indigenous species	Dominated by one or two species, often > 80% exotics OR no plants
Structure	Full array of growth forms	5-10% reduction in growth forms	11-25% reduction in growth forms	26-50% reduction in growth forms	> 50% reduction in growth forms
FISH					
Community composition	Full complement of indigenous species in natural proportions. No exotic species.	Full complement of indigenous species, plus very low numbers of exotic species	Noticeable shifts in natural community structure, moderate numbers of exotic species	Very few natural fish and/or exotic fish dominate	Very few fish dominated by exotic species

1 After South African DWAF Guidelines (1999); values given represent degrees Centigrade change from the natural mean monthly temperature
2 Zones include: Aquatic Zone, Lower Wetbank Zone, Upper Wetbank Zone, Lower Dynamic Zone, Tree/Shrub Zone, Back Dynamic Zone (Report LHDA 648-F-16)
* pH Annual Range refers to the change in pH units, not levels

Source: Table 4.1 of IFR Policy

The hydrological year, October 2003 to September 2004 was not a typical rainfall year for Lesotho. The country experienced severe drought conditions. However rainfall in the Mohale and Katse catchments was not as adversely affected and runoff was only slightly below average in aggregate. It was evident, however, that annual adjustment of the hydrological year classification was insufficiently responsive to actual climatic variability and a modification of the IFR Procedures is proposed.

Figure 2-1: Procedure for determination of the IFR releases at Katse and Mohale dams



2.1.3 Difficulties in the implementation of the IFR Policy

Implementing the IFR Policy has met with a number of challenges, including

- The effective commencement of the Policy coincided with the first dry cycle since the impoundment of Katse Dam in October 1995. The provision in the Procedures allowing for annual adjustment of the predicted hydrological year classification was too slow to respond to natural fluctuations in climatic conditions,
- The IFR Policy set bulk water (annual volume of flow) targets to be met at the proximal IFR sites, which are downstream of the dams, and worked back from these to projected water releases from the dams. In other words, there is a difference in bulk allocation between the dam release and the IFR site, the difference to be made up by the calculated runoff generated from the intervening catchment[2].
- The use of Instream Flow Requirement concepts as an operating framework for large dam releases is still in its infancy in Southern Africa. There are numerous challenges in operationalizing the theory.

The following sections provide information on the actual releases for IFR purposes from Phase 1 structures for the period January 2003 to September 2004.

2.2 IFR Releases from Dams and Recorded Flows at IFR Sites

2.2.1 Katse Dam releases and downstream Malibamats'o River

Katse Dam releases - January to September 2003

Katse was first described as experiencing a Plus 1 Hydrological Year, i.e. a wetter than average year (*see Table 2-4*). By late winter/spring 2003, it was apparent that climatic conditions were more towards being characteristic of drought conditions. A spring within-year flood release, scheduled for August, could therefore not be effected.
The discussion around implementing the August flood was thoroughly reviewed with the decision undertaken to cancel the flood occurrence during the month, because it would have additional stress on the system. The cancellation was based more on ecological consequences. The hydraulic character of the river during drought periods was not taken into consideration for it would have demonstrated other management options such as:

- releasing the flood in a later spring month
- reducing the size and duration of the flood
- splitting the flood into small 'freshets' released over a two or three month period.

- [2] This assumption had also been made in the IFR study hydrological modelling of the system. However, the consultants at the time warned that this was a modelled system, based on sparse real data, and that the assumption would have to be tested, proven and verified empirically. Flow measurements on the Malibamats'o and Senqunyane systems downstream of the dams since implementation of IFR release regimes have suggested that the assumption was not accurate.

During incidences of drought cycles, there may be events of high rainfall resulting in elevated river flows, which must be taken into account in the management of the river downstream.

A constant release of water from the compensation valve was effected at the rate of 0.75 m^3/s during the above period. This translated into a monthly low flow release of approximately 2 million cubic metres (MCM) (see Target Release column in Table 2-3) which was in accordance with Treaty requirements of a minimum rate of flow at all times of 0.5 m^3/s but not with the IFR Policy which had been approved but not yet implemented.

However, a number of tests were also performed during this period:

- Assessment of the integrity of the compensation release valve to perform under higher flow volumes was also undertaken.
- A flood of 11.24 MCM was released in April 2003 to investigate downstream thermal impacts of flood releases.

No IFR flows were released for the remaining period May- September 2003, because of the tests being undertaken.

The actual downstream flows at Katse constituted 62.3% of the MAR for the period as a result of the flooding exercise and spilling of the dam.

The IFR Policy commitment for releases from Katse dam are 12.1% MAR.

Table 2-3: Katse Dam releases January 2003 to September 2003

Month*	Hydrological Year Classification	Katse Release Target Volume MCM	Katse Release Actual MCM	Hydrometric Station Flow Volume MCM	Monthly Ave Inflow (Rainfall-Runoff Model) MCM	Katse Inflow[2] (Water Balance Model) MCM
Jan-03	*Not classified: IFR Procedures implemented for Katse in October 2003 due to running of various tests of release structures*	2.01	[1]38.18	32.79	78.8	62.40
Feb-03		1.81	59.32	29.96	83.5	18.19
Mar-03		2.01	[1]143.36	70.00	71.7	126.24
Apr-03		1.94	13.39	13.55	47.1	21.81
May-03		2.01	2.21	3.62	22.3	13.99
Jun-03		1.94	2.19	3.48	12.0	10.52
Jul-03		2.01	2.17	4.06	10.1	4.98
Aug-03		2.01	2.43	4.03	13.1	8.80
Sep-03		1.94	2.36	3.83	21.3	8.09
Oct	*Reported in Table 2.4 for year 2003-2004*				55.0	7.74
Nov					72.1	15.08
Dec					61.8	20.72
Total		**17.68**	**256.61**	**165.32**	**359.9**	**275.02**

Source: Data supplied by OM& E Group, LHDA, February 2005

1 Katse spilled. In addition, in Jan 35.98 MCM, in Feb 57.52 MCM and in March 133.68 MCM flood releases were made through the Low Level Outlets

* Data derived from long-term hydrological model used for the IFR studies. They are included simply to illustrate the long-term *average* expected runoff in the system, as a comparison against the calculated actual inflows. The table also shows

- Monthly inflows to Katse dam calculated by the system Water Balance Model, (= correlates dam water level with inflow)

- The long-term average monthly runoff estimated by the Rainfall-Runoff long-term hydrological model. The purpose is to demonstrate the comparison between long-term average runoff against variations in inflow which may be experienced in a single annual cycle. These figures also serve to illustrate reasoning behind pronounced adjustments of IFR releases to be effected in the following hydrological year, October 2003 - September 2004, when the IFR Policy and Procedures would be engaged implemented fully for the first time.
  The figures represent Malibamats'o catchment flows into Katse, the transfers from Matsoku weir having been subtracted.

Katse Dam releases - October 2003 to September 2004

In September 2003, the LHDA requested that the remaining months of the year be re-classified to Average due to the dry conditions. It was in September that the low flow rates were increased. This was because of the successful testing of the integrity of the compensation valve under higher flow rates (Katse Incident Report September 2003). The low-flow rates were increased by taking some volume from the scheduled November flood.

The approval for HY re-classification was received much later. Releases for October, November and December 2003 were confirmed under Plus 1 river target conditions. A subsequent request was submitted to downgrade the next three months; January-March 2004 to Minus 1 HYC due to the prevailing dry conditions experienced of the past three months.

The February flood was missed but was later compensated for through a release of two small floods with a magnitude of 31m^3 from 30th April to 2nd May 2004.

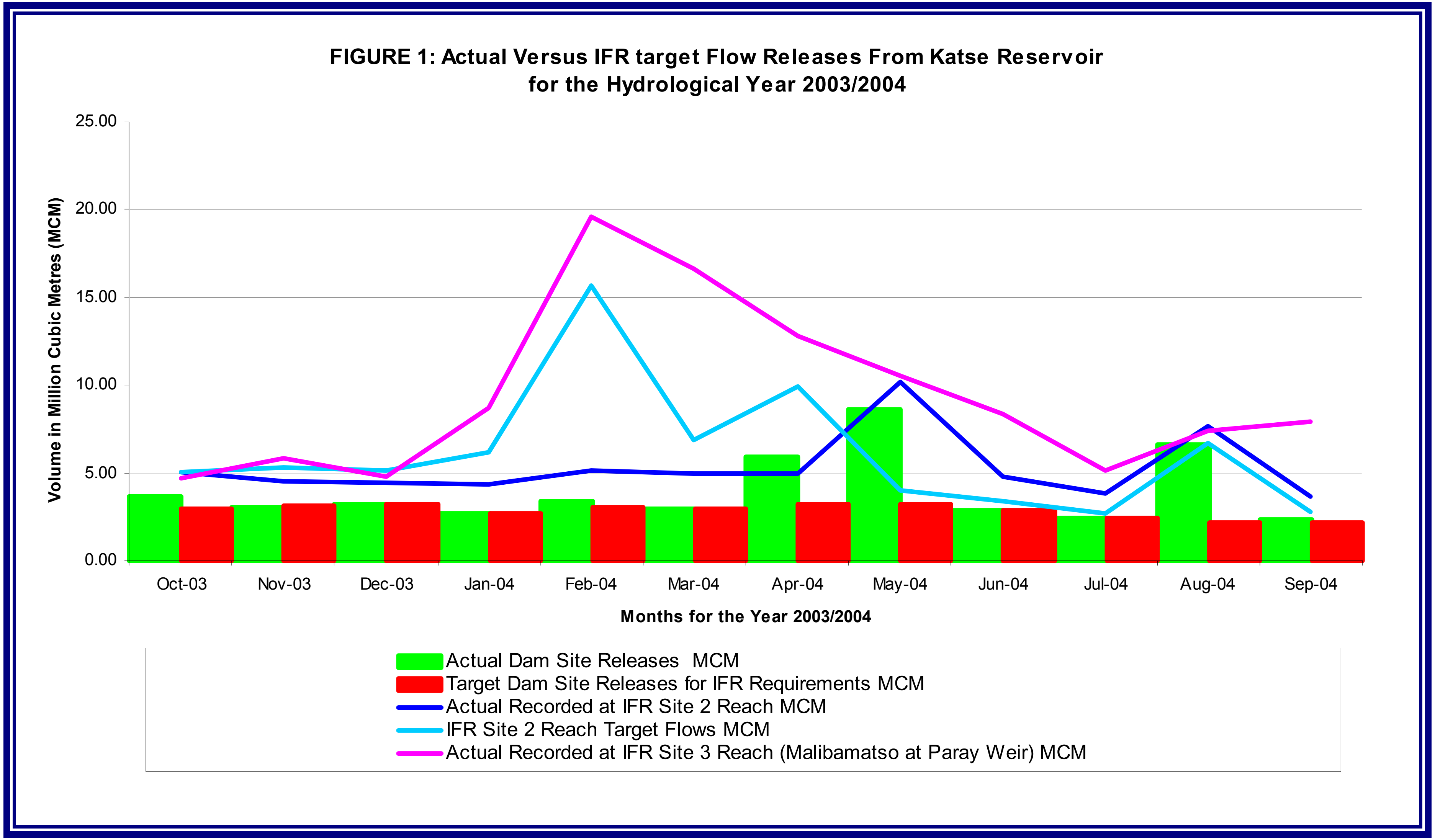
Figure 2-2 illustrates that the targeted flood release for April arrived in the system late, in May. Practically only one out of a potential four scheduled within-year floods for any of the hydrological year classes applied, was effected, albeit, it was delayed. However, the scheduled January flood for a Minus 1 year was not released and the low flow released characterises to a Minus 2 HYC. At the same time, the first three months experienced exceptionally high monthly rainfall. The new situation prompted for a decision to re-adjust to an Average HYC from April 2004 for the remainder of the reporting period. Another flood of magnitude 25.39 m^3/s (4.43 MCM) was released for two days from 18-20 August 2004.

The IFR release target of 67.54 MCM for the period amounts to 12.17% of the 554.8 MCM long-term MAR at Katse dam. The actual volume released from Katse Dam was 47.67 MCM. This translates into a shortfall of 29.42% against target. The long-term target release of 67.13 MCM for Katse is 12.1% of the MAR. It is evident that the 2003/04 year fell 29% below that long-term target. The inflow to Katse in the same year was approximately 35% below average at 361.44 MCM. The actual release of 47.67 MCM therefore constituted 13.2% of the actual inflow.

The flow volume recorded at IFR site 2 amounted to 63.65 MCM. The target IFR volume was maintained at 91.41MCM, resulting in a deficit of 30.4%. This is misleading to some extent, however, since the target is the target for an Average hydrological year, the targets at site 2 having not been computed for the other scenarios.

The discrepancy would thus be lower if the target was pegged to each month's hydrological classification (*as per column 2 in Table 2-6*).

Figure 2-2: Actual vs. target releases from Katse Reservoir for the hydrological year 2003/04 (*Source:* LHDA-a, 2005)



NOTE: The target releases shown here do not include floods; they reflect only target low flows.

No spillage occurred at the Katse Dam for the reporting period. Floods at IFR site 2 were assumed to be coming from the dam and/or from incremental catchment flow, notably from the Khohlonts'o tributary which enters the Malibamats'o just above IFR site 2.

It is evident from Figure 2-2 that the February flood was not delivered to IFR site 2 by either the catchment inflow tributary or by a scheduled release from the dam as the recorded flow remains constant throughout the month.

The actual flow curve recorded downstream at IFR site 3 (Paray), which is below the confluence with the Matsoku River, shows that a flood came down the Matsoku River in February (*see column 7, Table 2-5*).

Also noteworthy is the fact that targeted and actual monthly dam low flow releases show very little variation, and are constant. This must be partially attributed to the limitations on the compensation valves and flood release mechanisms at Katse, which resulted in IFR schedules with limited variability in low flows.

Table 2.4: Katse Dam monthly releases - October 2003 to September 2004

Month	*Inflow MCM*/# Hydrological Year classification	Target Dam Releases* MCM	Actual Dam Releases** MCM	IFR Site 2 Target Volume MCM	IFR Site 2 Actual Volume MCM	IFR Site 3 Actual Volume MCM
Oct-03	*7.44* /Plus 1	2.95	@3.63	5.05	5.06	4.73
Nov-03	*15.08* /Plus 1	13.60	3.01	16.80	4.57	5.84
Dec-03	*20.72* /Plus 1	3.21	3.22	7.00	4.47	4.79
Jan-04	*60.56* /Minus 1	7.70	2.74	10.56	4.39	8.71
Feb-04	*82.88* /Minus 1	(3.08 + 9.0)$ 12.08	3.43	16.67	5.17	19.62
Mar-04	*105.14* /Minus 1	2.95	2.95	5.78	5.00	16.64
Apr-04	*54.29* /Average	7.74	5.94	9.90	4.93	12.79
May-04	*7.11* /Average	3.21	8.60	3.98	10.18	10.58
Jun-04	*5.24* /Average	2.85	2.84	3.44	4.76	8.35
Jul-04	*0.78* /Average	2.41	2.42	2.69	3.84	5.12
Aug-04	*1.17* /Average	(2.14 + 4.5)£ 6.64	6.58	6.75	7.65	7.37
Sep-04	*1.03* /Average	2.20	2.31	2.79	3.63	7.97
Total for Year	***361.44***	**67.54**	**47.67**	**91.41**	**63.65**	**112.51**

Source: "Instream Flow Requirement (IFR): October 2003 to September 2004", Hydrology Branch of the Operations Maintenance and Engineering Group (OM&E Group), LHDA, January 2005, hereafter cited as LHDA-a, 2005; and OM&E Group, miscellaneous data supplied directly, February 2005.

Monthly inflow to Katse Dam as calculated by the Water Balance Model (Mass Transfer Method), less transfers from Matsoku. (Long-term mean monthly inflows, derived from rainfall-runoff model applied to the long-term hydrological database, are shown in Table 2-1.) Inflows October-December 03 were below average; January to April 04 were above average, and May-September 04 were below average. Total inflow for the 12-month period was 361.44 MCM (*cf.* long-term mean of 554.8 MCM). Interestingly, if the year is taken from Jan 04 to Dec 04, then the total 12-month inflow approaches the average.

* Includes scheduled flood releases (Hydrology annual report excluded scheduled flood releases from this column) in November, January, February and April.

** Includes flood releases in April 04 and May 04 of 2.68 MCM and 5.36 MCM, respectively

$ The target volume for the low flow for Feb 04 is given in the Hydrology report as 3.08 MCM, which is neither the Minus 1 (3.14 MCM) nor the Minus 2 (2.30 MCM) target low flow given in the IFR Procedures (Table 2.11). However, it has been taken as the nearest, namely Minus 1, and the applicable scheduled flood for Minus 1 added to it.

@ The small discrepancy between the target volume and actual volume was due to a short flood release of 387 m^3/s made from a low level outlet for half an hour for purposes of filming an advertisement. The total volume thus released was 0.697 MCM.

£ Again, for August 2004 the target low flow figure given in the Hydrology report (2.14 MCM) does not fit the given figures in Table 2.11 for an Average (2.17 MCM) year. It is for a Minus 1 year, but a small flood was released as scheduled for an Average year, therefore the Average classification has been used.

2.2.2 Mohale dam releases and downstream Senqunyane River

Mohale Dam releases - January to September 2003

In the case of Mohale dam, IFR Policy and Procedures commenced from August 2003 as a result of satisfaction of the requirements of the Washington Agreement with the World Bank[3].

Table 2-5: Mohale Dam releases - January 2003 to September 2003.

Month	Hydrological Year Classification	Mohale Release Target Volume MCM	Mohale Release Actual MCM	Marakabei (IFR site 7) Flow Volume MCM	Monthly Ave Inflow (Rainfall-Runoff Model)* MCM	Mohale Inflow (Water Balance Model) MCM
Jan-03	*Transitional to inundation: Releases were as per Washington Agreement*	6.56	8.82	8.40	39.9	33.44
Feb-03		5.93	4.87	4.18	44.9	25.99
Mar-03		6.56	4.89	8.03	41.4	87.23
Apr-03		6.35	4.62	6.26	33.0	21.04
May-03		6.56	7.61	8.16	15.3	3.76
Jun-03		6.35	7.91	9.16	8.4	0.65
Jul-03		6.56	6.14	6.94	7.6	1.04
Aug-03	Plus 1	5.37	2.10	2.85	9.7	3.69
Sep-03	Plus 1	1.94	1.43	2.11	11.2	3.34
TOTAL		52.18	48.39	56.09	211.40	180.18
Oct	*Reported in Table 2-6 for year 2003-2004*				27.4	6.97
Nov					37.3	12.76
Dec					30.1	8.77
Total					**306.2**	**201.71**

Source: Data supplied by OM& E Group, LHDA, February 2005

* Data derived from long-term hydrological model used for the IFR studies. They are included simply to illustrate the long-term *average* expected runoff in the system, as a comparison against the calculated actual inflows.

Mohale Dam releases - October 2003 to September 2004

[3] The Washington Agreement between LHDA and the World Bank governed releases from Mohale Dam for the period October 2002 until July 2003. It enabled a phased impoundment to proceed since all preconditions for impoundment had not been fully satisfied. It is not reported here in detail since releases were well in excess of IFR releases that would have been required under the IFR Policy.

Mohale Dam commenced the year under the Average hydrological year class conditions. However, for the period January - March 2004 the HYC was re-classified to Minus 1 in response to the dry conditions in the preceding months. These three months experienced high rainfall and the HYC was reclassified again to Average from April 2004.

The total released amount of 37.56 MCM for the period was effected through the operation of either a 500mm diameter sleeve valve or a 200mm diameter sleeve valve. The amount was 37% higher than the target release of 27.36 MCM. Higher releases were made from the dam to reduce the deficit that was accumulating in the flow past IFR site 7 (*see Table 2-6*), as per the IFR Policy.

It would appear that inflow that was expected to be contributed by the incremental catchment between the dam and IFR site 7 had been over-estimated. The estimate was based on the relative catchment areas. The IFR policy makes provision for scheduled dam releases to be adjusted in such circumstances and the authorities authorised increased releases from March 2004. They decided not to amend the IFR Procedures however until a longer record was available to analyze.

At the same time, only one of the two scheduled flood releases were effected as planned, that in August 2004. However, a lot of water was released in April and again in June to reduce the accumulating deficit at IFR site 7. No spilling was expected or occurred from Mohale Dam because it was still filling.

The water volume flow recorded at IFR site 7 for the period was 49.31 MCM against a target of 70.12 MCM, a 30% total deficit over the year, for the reasons explained above. Figure 2-3 reveals the patterns in target versus actual releases from the dam as well as target and actual flows at IFR site 7. The following observations can be made:

- Targeted releases show more pronounced variability, a demonstration of a healthy state of condition.
- Actual releases showed acceptable variability, except as regards the timing of flood flows;
- Recorded flows at site 7 closely follow the volume of releases from the dam, except for exceptionally high flows. This suggests that the incremental catchment contribution to base/ low flows was negligible, the major contribution being from the released floods.
- Late summer/ autumn rains raised flows at site 7 very substantially (blue line in Figure 2-3 in the months Feb, March) indicating the appropriateness of the April flood release.

The notable discrepancy in target versus actual at IFR sites 2 and 7 has focused attention on the need for a reappraisal of the flows from the incremental catchment to the IFR sites. The IFR Consultants have advanced the case for a review of this input based on empirical data. Their advice has been accepted and such verification is planned to occur in the coming year.

Table 2-6: Mohale Dam monthly releases - October 2003 to September 2004 (*Source:* LHDA-a, 2005; and OM&E Group, miscellaneous data supplied directly, February 2005)

Month	*Inflows to Mohale*/ Hydrological Year classification	Target Dam Releases** MCM	Actual Dam Releases MCM	IFR Site 7 Target Volume MCM	IFR Site 7 Actual Volume MCM
Oct-03	/Average	2.00	1.86	6.88	2.64
Nov-03	/Average	3.11	2.84	11.09	3.79
Dec-03	/Average	1.47	1.65	4.98	2.28
Jan-04	/Minus 1	1.61	0.91	5.73	2.42
Feb-04	/Minus 1	6.44	2.67	12.67	4.88
Mar-04	/Minus 1	2.54	3.52	7.62	7.58
Apr-04	/Average	2.33	6.58	8.17	7.85
May-04	/Average	1.61	2.55	3.72	2.10
Jun-04	/Average	0.78	7.29	1.73	5.57
Jul-04	/Average	0.39	1.22	0.91	1.08
Aug-04	/Average	4.56	4.88	5.45	5.82
Sep-04	/Average	0.52	1.59	1.17	3.30
Total		**27.36**	**37.56**	**70.12**	**49.31**

** Includes floods in February and August. Low flow targets are not as per the Hydrology report: they are as supplied directly by OM&E Group, February 2005.

2.2.3 ‘Muela Dam and Matsoku Weir

Dam Releases January to September 2003

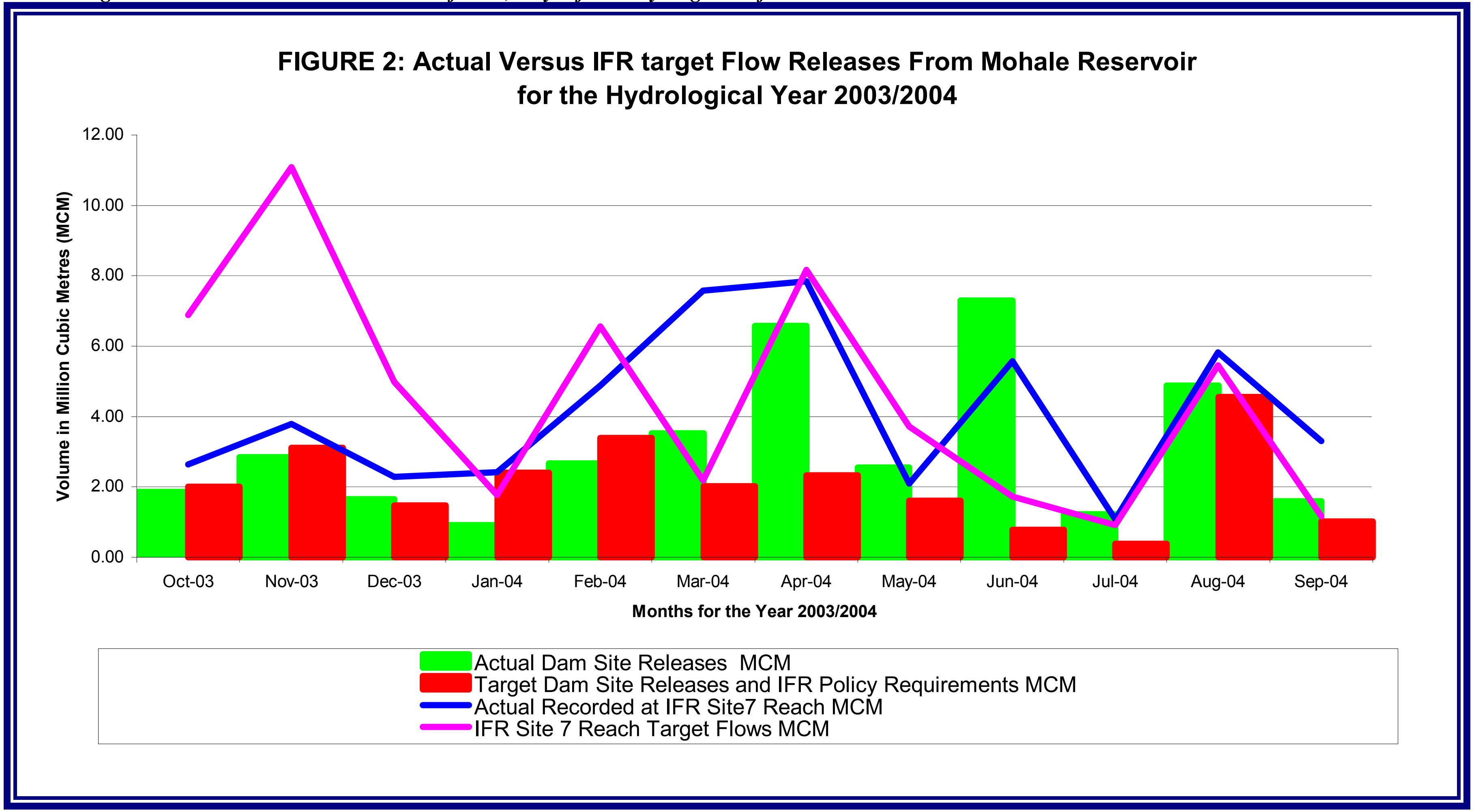
The IFR procedures did not take into consideration ‘Muela dam and Matsoku weir situations, due to the absence of flow controlling mechanisms in their release structures. 'Muela’s compensation outlet valve is designed to release the long-term average flow in the Nqoe River, and this cannot be adjusted. It should however, be acknowledged that not all flow from the upstream of the River will report downstream, as some flood flows are diverted into the delivery tunnel. Downstream flows are measured on the Hololo River.

In the case of Matsoku weir, the outlet valve is set to release flows of up to 0.6 m^3/s downstream. Flows above 0.6m3/s can neither be stored nor completely diverted and will pass over the weir. Downstream flows are thus a combination of variable base flow and partial flood flows. There is no flow measuring mechanism on the base flow valve, and the downstream flow gauge is some distance away at Ha Seshote. There was no accommodation for the Matsoku system in the IFR policy guidelines and accurate estimates of downstream ‘releases’ cannot be provided.

A flow recording mechanism for Matsoku is currently being investigated to improve the precision of the system.

Figure 2-3: Actual vs. IFR target flow releases from Mohale Reservoir for the hydrological year 2003/2004 (*Source:* LHDA-a, 2005)

NOTE: The target releases shown here do not include floods; they reflect only target low flows



Dam releases October 2003 - September 2004

Volumes of flow passed downstream through ‘Muela dam and Matsoku weir structures are detailed in Tables 2-7 and Table 2-8, respectively.

Table 2-7: Muela Dam releases September 2003 to October 2004 (*Source:* LHDA-a, 2005)

Months	Actual Dam Releases	Target Dam Releases	Actual Recorded at Nqoe River Upstream of Muela	Actual Recorded in Hololo River downstream of Muela
	MCM	MCM	MCM	MCM
Oct-03	0.40	0.40	0.00	4.44
Nov-03	0.39	0.39	0.15	3.64
Dec-03	0.40	0.40	0.08	0.90
Jan-04	0.40	0.40	0.49	2.95
Feb-04	0.38	0.38	0.43	3.99
Mar-04	0.40	0.40	0.45	2.35
Apr-04	0.39	0.39	0.11	0.62
May-04	0.40	0.40	0.01	0.04
Jun-04	0.39	0.39	0.00	0.52
Jul-04	0.40	0.40	0.00	0.99
Aug-04	0.40	0.40	0.00	1.09
Sep-04	0.39	0.39	0.01	0.77
Total for Year	**4.74**	**4.74**	**1.73**	**22.30**

Table 2-8: Matsoku Weir releases September 2003 to October 2004 (*Source:* LHDA-a, 2005)

Months	Actual Weir Releases	Target Releases	Actual Recorded at Matsoku River downstream	Estimated Matsoku Weir Inflows
	MCM	MCM	MCM	MCM
Oct-03	0.48	1.61	0.53	0.48
Nov-03	1.29	1.56	2.83	2.55
Dec-03	1.41	1.61	1.69	1.54
Jan-04	1.37	1.61	5.04	4.53
Feb-04	1.50	1.50	6.32	5.69
Mar-04	1.61	1.61	5.09	4.58
Apr-04	1.56	1.56	4.42	3.98
May-04	1.36	1.61	1.67	1.51
Jun-04	0.79	1.56	0.88	0.79
Jul-04	1.09	1.61	1.21	1.09
Aug-04	0.94	1.61	1.20	1.08
Sep-04	1.39	1.56	3.00	2.70
Total for Year	**14.79**	**19.01**	**33.88**	**30.52**

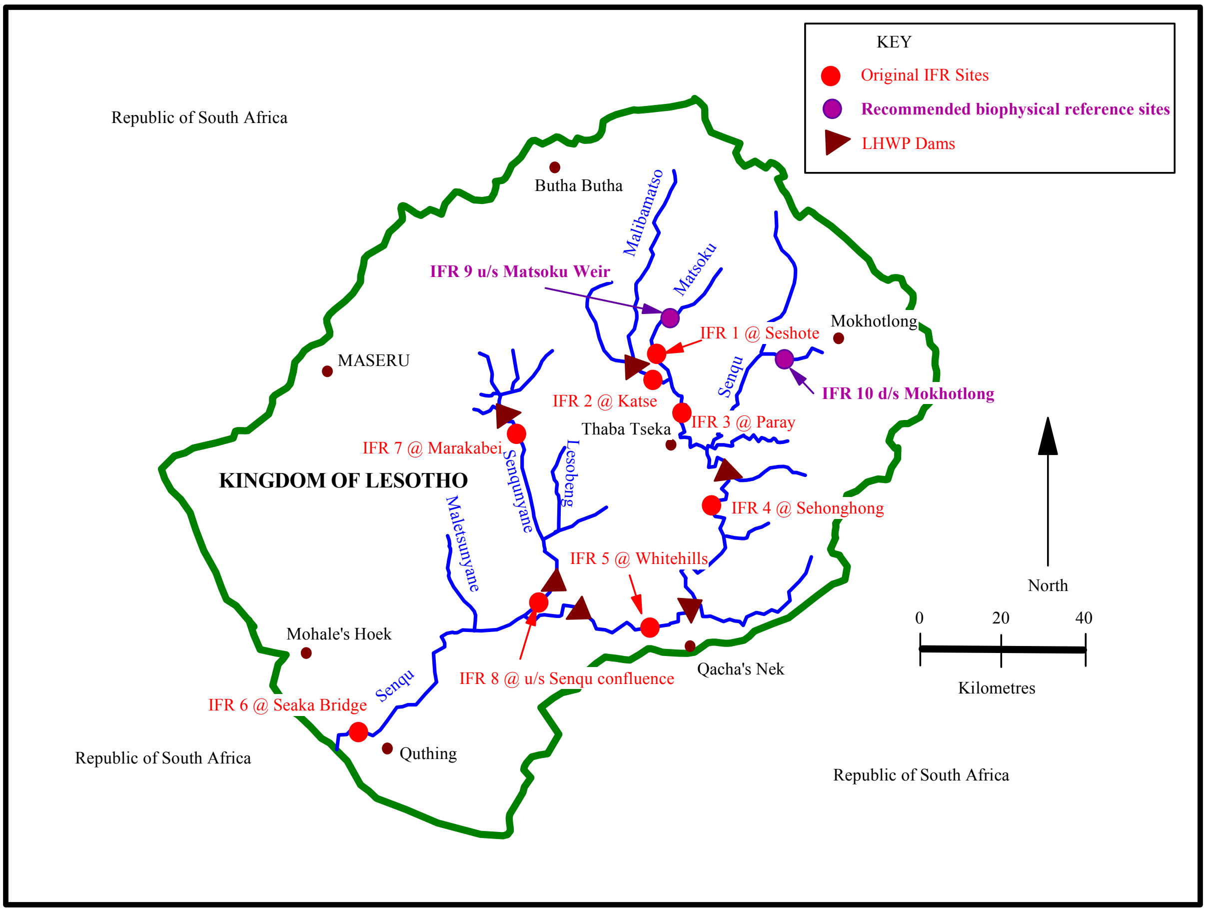
‘Muela dam released 4.74 MCM, as the Nqoe River Mean Annual Runoff. There were no spill occurrences at the dam and no floods passed over the spillway.

3 BIOPHYSICAL MONITORING

Table 3.1 below presents the desired conditions in the river reaches identified according to the IFR Policy. Monitoring conditions in the reaches and evaluating the outcome is carried out to determine the impact of the modified flows on the biophysical conditions.

The monitoring process is also expected to show differences in the extent of degradation between the reaches closest to the dam structures (proximal reaches) and reaches further away (distal reaches). The proximal reaches are identified as reaches 1, 2, 3, 7 and 8 and distal reaches are identified as 4, 5 and 6 located on the Senqu River. Another two sites, 9 and 10, are identified as reference and or control sites.

Figure 3-1: Location of original IFR sites and reference sites



IFR Site 1*	Matsoku near Seshote
IFR Site 2*	Malibamatšo 3 km downstream from Katse road bridge
IFR Site 3*	Malibamatšo at Paray
IFR Site 4	Senqu at Sehong-hong
IFR Site 5	Senqu at Whitehill
IFR Site 6	Senqu at Seaka
IFR Site 7*	Senqunyane at Marakabei
IFR Site 8*	Senqunyane upstream of the Senqu confluence.

* Proximal sites.

The following biophysical parameters are employed in line with the monitoring scheme laid out in Tables 3-1 and 3-2:

- Hydrology
- Geomorphology and hydraulics
- Water quality
- Riparian vegetation
- Macro-invertebrates
- Fish

Various proposals were drafted to establish a cost effective IFR monitoring programme. While routine monthly water quality monitoring continued throughout, other components of the programme have not been fully implemented. A tender was issued during the reporting period but it had not been awarded by October 2004[4].

Table 3-1: Summary of biophysical data collection activities for monitoring river condition

Component	Tasks	Where data should be collected	Frequency of collection	Comments
Hydrology	Continuous time series stage height data	IFR Site 1, 2, 3, 4, 5, and 7 and outlets of Katse, Mohale and Matsoku structures	Continuous	Ongoing, daily. Monthly reports produced.
Habitat	Habitat mapping and characterisation	IFR Site 1, 2, 3, 4, 5, 6, 7 and 8. Reference IFR 9 and 10.	Every two years	
	Re-survey of cross-sections		Every two years	Done only for IFR site 2 during winter 3004
	IHAS		Twice per year	
Water quality	Routine monthly sampling of nutrients	IFR Site 1, 2, 3, 4, 5, 6, 7 and 8. Reference IFR 9 and 10.	Monthly	Ongoing, monthly, network extended to include all IFR sites and reference sites
	WQ and temperature monitoring - using loggers - using hand-held field meters	IFR Site 1, 2, 3, and 7 IFR sites 4, 5, 6 and 8; Reference sites 9 and 10	Continuous Monthly	Once-off exercise to investigate effects of cold temperature flood releases from Katse, in November 2003 Ongoing, part of routine WQ monitoring
	Faecal coliforms	IFR Site 1, 2, 3, 4, 5, 6 7 and 8.	Monthly	Not being done

[4] Southern Waters Ecological Research Consultants of Cape Town in South Africa were eventually procured to undertake the monitoring assignment under the auspices of LHDA Contract 1237, 'Consultancy and Project Management Services to implement the Instream Flow Requirements Biophysical Monitoring Procedures Downstream of Phase I Dams".

Component	**Tasks**	**Where data should be collected**	**Frequency of collection**	**Comments**
	RBA	IFR Site 1, 2, 3, 4, 5, 6, 7 and 8. Reference IFR 9 and 10.	Twice per year in spring and autumn	Ongoing, monthly, with water quality monitoring at all sites
Riparian vegetation	Algae	IFR Site 1, 2, 3, 4, 5, 6, 7 and 8. Reference IFR 9 and 10.	Monthly	Not being done
	Zonation	IFR Site 1, 2, 3, 4, 5, 6, 7 and 8. Reference IFR 9 and 10.	Once per annum in early autumn	1 transect monitored at IFR site 2 10-11 June 2004.
	Braun-Blanquet			
Macro-invertebrates	RBA	*See Water Quality*		
	Visual assessments for simulids and snails	At all IFR sites and IFR Reference sites 9 and 10.	Twice per year in spring and autumn	Not done yet
Fish	Routine fish surveys.	IFR Site 1, 2, 3, 4, 6, 7 and 8. Reference IFR 9 and 10.	Twice per annum (summer and winter).	Once-off sampling done at IFR sites 2 and 7 in August 2004 following released floods, to test effects of floods on fish

Table 3-2: Summary of frequency and timing of the monitoring activities

Discipline	Data	Timing and frequency of monitoring activities											
		J	F	M	A	M	J	J	A	S	O	N	D
Habitat (Geomorphology/ Hydraulics)	Diversity of physical habitat					X							
	Pool depth and area					X							
	IHAS					X				X			
Hydrology	Dam release schedules and flow records at monitoring sites	Continuous (3-hourly)											
Water quality	Temperature, pH and electrical conductivity	Continuous (3-hourly)											
	Nutrients	X	X	X	X	X	X	X	X	X	X	X	X
	RBA				X					X			
	Faecal coliforms and *E. coli*	X	X	X	X	X	X	X	X	X	X	X	X
Aquatic vegetation	'Red-flag'	X	X	X	X	X	X	X	X	X	X	X	X

Discipline	Data	Timing and frequency of monitoring activities											
		J	F	M	A	M	J	J	A	S	O	N	D
	indicators: • Algae												
Riparian vegetation	Species composition, distribution, abundance				X								
Macro-invertebrates	RBAs (see water quality)				X					X			
	'Red-flag' indicators: Snails and Simulids				X					X			
Fish	Composition, relative abundance and recruitment	X						X					

Meanwhile, a start had been made with those components of biophysical monitoring which are monitored once or twice a year. The monitoring also included a series of release-specific monitoring activities. The sections below present the results of the pilot monitoring effort and an interpretation of the results in respect of anticipated target river conditions.

3.1 Biophysical Monitoring Activities

3.1.1 Physical Habitat: Hydraulics Monitoring / Geomorphology

3.1.1.1 Hydraulics

This sub-section presents the hydraulics monitoring exercise that was carried out to establish baseline data for monitoring changes in channel dimensions of the Malibamats'o River at IFR site 2. A total of three cross sections A2, B2 and C2 within reach 2, were surveyed. It was determined that cross section B2, was the appropriate site for taking samples and monitoring discharge measurements. The average discharge measured at site was 1.42 m^3/s.

Cross sections A2 and C2 were not ideal for discharge measurements but were found to be more appropriate for monitoring sediments, wetted perimeter, flow depth and surface water width.

3.1.1.2 Geomorphology

Geomorphological monitoring comprises as follows:

- Monitoring changes in channel shape;
- Provision of visual data to assist the interpretation of changes in the geomorphology of concerned rivers;
- Providing data on particle-size distribution of sediments;

- Monitoring embeddedness of riffle areas (riffles are shallow, fast flowing zones over rocks and/or pebbles); and
- Tracking changes in channel and physical habitat.

o *IFR Reach 2- Lower Malibamats'o River*

This river has a concave, upward longitudinal profile with an overall mean bed slope of approximately 0.00909. IFR site 2 represents a sediment transfer zone. At this site, the river is contained within a valley approximately 250m wide.

The findings of the monitoring exercise indicate the impacts of modified flows below Katse dam as follows:

- The channel is shallow with a variable depth rarely exceeding 1 m. This is attributed to large in-channel sedimentation.
- Formation of sediment bars in the central channel. Stable new islands and bed-rock outcrops have separated the main channel into various active paths at low to medium flows
- Increase in the tributary contribution of sediments into the main channel. This has led to the formation of stable bars at tributary junctions and large in-channel surface deposits of gravel and course sand
- Riffles, characterized by rocks and cobble-bed deposits which cannot be easily transported to the downstream reaches. These have become natural traps for finer sediments.
- Occurrence of over-bank sediment deposition and reduction in channel width. These deposits have been stabilized by trees, shrubs, grass and other forms of vegetation.

o *IFR Reach 7: Senqunyane River at Marakabei*

IFR site 7 is approximately 28 km downstream of Mohale Dam. At this site, the Senqunyane river channel occupies the base of a relatively narrow valley.

The evaluation revealed as follows:

- The riffle sediment samples have a coarse texture with little or no mud at all. The median particle size for all samples is approximately 1.5 mm for both pre and post-flood release; there is an even distribution of gravel, sand in deposited cobbles
- It has not been established whether the released IFR flows were able to flush out course sand and gravel particle sizes from deposited cobbles in riffle, because there were almost identical quantities of these materials before and after the flood release.

3.1.2 Water Quality

Water quality monitoring was effected on monthly routine schedule. It included the following parameters:

- physical
- chemical variables
- macro-invertebrates
- macro-invertebrate surveys (only done annually)

The monitoring programme was expanded to include all the IFR sites as well as the two reference sites 9 and 10.

Water quality outcome should determine:

- The extent to which water quality monitoring has been implemented;
- The degree of compliance of selected key indicators against the various river condition classes on the basis of the IFR policy; and
- A way forward.

The evaluation of the monitoring results have indicated a significant variance in temperature at IFR sites 1 and 2 from that of the reference site, on Malibamats'o at Kao in March and October 2003, respectively. The other stations (IFR sites 3, 4, 5, 6) showed similar results which demonstrated a Class 5 ('severely modified') river condition.

3.1.3 Biotic Habitat - Riparian Vegetation

A transect of the selected riparian zone was used as a sample area. The parameters used to enable assessment of extent of impact suffered, and the observations, were as follows:

- Species richness

  The abundance or richness of species in the transect was observed despite the fact that tests were carried during winter time. There was very little observed under the other categories. This could be attributed to the inappropriate monitoring schedule in winter which had severe impacts to the quality and quantity. In addition, there was no baseline data to evaluate against.

- Vegetative cover and condition

  Vegetation cover, where the frequency of occurrence of a limited range of species could be determined, was

  - Mature plants of *Eragrostis plana* showed 25% frequency, especially in the dry sub-zone,
  - *Equisetum rammoissisimum*, *Scirpus fisciniodes* and *Bromus* spp. were each 12.5%.
  - *Scirpus fisciniodes* showed a 25%
  - *Cyperus* spp. were at 12.5%

  Overall the vegetation cover was satisfactory. It could be deduced that in the absence of disturbance in the form of burning /overgrazing there is a good potential for regeneration of most plant species given the seed occurrence on the ground.

Photographic observations show consolidation of in-channel substrates by the settling of fine particulate material and subsequent growth of plants, notably woody shrubs.

- Recruitment success of indicator species and other plants of economic importance

  Recruitment of willow species (*Salix* spp.) was pronounced.

Baseline data for a full range of vegetation parameters required for assessment of riparian vegetation will start December 2004 – April 2005.

3.1.4 Macro-invertebrates

IFR monitoring specifies two kinds of macro-invertebrate monitoring: Rapid Biological Assessment (RBA), as a general indicator of river ecological condition, and bi-annual (autumn and spring) identification and enumeration of indicator organisms, in particular, disease vectors (snails and blackflies (*Simulidae*)). Since the indicator organism monitoring has not commenced yet, this report presents only the results of monthly RBA.

While LHDA intends to implement the SASS5 technique for IFR macro-invertebrate monitoring, RBAs undertaken by the LHDA since 2002 have been conducted using the SASS4 technique (SASS5 is a refinement of SASS4, both developed in South Africa). A pilot study using the SASS5 method was undertaken with the August 2004 flood release from Katse Dam, but the results are not definitive and cannot be compared with the SASS4 results. This report uses only the analysis of the 2002-2004 SASS4 results. Sampling is not uniform across all sites for all months, because of access logistics and river conditions (sampling cannot be done during a big flood).

Table 3.3 presents the results of the analysis, comparing average SASS4 scores against the RBA score criterion for each targeted river condition class. The generally low scores recorded, including at the reference sites, suggest problems in the system somewhere: the reference sites should have RBA scores between 80 and 95, whereas the results below suggest that sites 9 and 10 too have a Class 4 status - 'significantly modified'. It is worth noting that in the original IFR study, a greater number of species and specimens were recorded compared with all LHDA's monitoring results. Due to methodological inadequacies, no strong inferences can be drawn from this monitoring with regard to river condition.

Table 3-3: 2002 to 2004 SASS 4 Scores: mean and median values of the ten IFR sampling sites and their target river condition criteria

IFR site	Target River condition	SASS Score	n	Mean	Median
1	3	70 – 94	24	59	60
2	4	45 – 69	28	39	42
3	4	45 – 69	22	55	58
4	3	70 – 94	20	60	69
5	2	≥ 95	25	49	46
6	2	≥ 95	26	50	46
7	4	45 – 69	22	50	56
8	3	70 – 94	11	38	32
9*			17	46	49
10*			26	67	72

*Reference site

3.1.5 Fish

The fish monitoring undertaken at IFR sites 2 and 7 was done to test the effect of flood releases on fish populations. Apart from identifying some species at both sites, the exercise was inconclusive with respect to its specific objective (effect of flood on fish) or in assisting in assessing river condition at these sites for the purposes of IFR verification.

Methodological and logistical problems with the monitoring exercise render the results useless as scientific data, but do provide direct and anecdotal evidence of the occurrence of some fish species. At IFR site 2, the sampling was done 3 days after the flood release; at IFR site 7 it was done during the flood release, so that methods were limited (electro-shocking cannot be used at high depth and water velocity). Using 3 methods – electro-shocking, gill and seine netting to catch fish – the researchers intended to evaluate population assemblage structure, length-frequency and catch-per-unit-effort (using only results from electro-shocking, to indicate relative abundance), fish age, fish condition (qualitative observation only) and sexual maturity. There is some evidence of following the methods used in the original IFR study in an effort to be able to compare results.

At IFR site 2, only trout (*O mykiss*) and yellowfish (*Barbus aeneus*) were caught. At site 7, only trout and Maloti minnow (*Pseudobarbus quathlambae*) were encountered. Trout were widespread at both sites, but IFR reach 2 is dominated by trout. The Maloti minnow was found for the first time ever in this part of the Senqunyane. The researchers conclude that they had been washed down from the dam in the flood and would not survive for long under the aggressively predatory regime of trout. The researchers were surprised not to find yellowfish (*Barbus* spp.) at IFR site 7. (It is a prediction of the IFR study that yellowfish species would decline under the greatly reduced flows prevailing). Catch per unit effort for IFR Site 2 and Site 7 is 0.07 and 0.15 fish per hour respectively, given the fact that most of the fish at Site 2 were caught by the gill net. These are very low figures.

This survey was conducted in August, at the end of winter. Lower populations of fish would be expected at this time of year, quite apart from the effect of a flood, which often washes fish downstream. The results of the study therefore cannot be seen as definitive with respect to evaluating river condition. Since the entire LHDA Fisheries staff has been retrenched, any deficiencies in the fish report will not now be remedied.

3.2 Conclusion: River Classification Targets

The results of the monitoring exercises undertaken are inconclusive in relation to the biophysical criteria for river condition assessment defined in the river condition classification (*Table 2-2*). A summary analysis for selected IFR sites is presented in Table 3-3. Only the most important sites are shown, because monitoring of other sites and of the reference sites has been only for water quality and RBA. Monitoring of sites 3 and 8 – the sites downstream of the proximal sites 2 and 7 for Katse and Mohale, respectively – has also been sparse.

This is partly due to the fact that a number of these exercises were conducted in connection specifically with flood releases; they were not the routine IFR monitoring envisaged in the

Procedures. Also, all the emphasis seems to have been placed on IFR sites 2 and 7, with no monitoring other than routine water quality monitoring having taken place at any other sites.

Furthermore, it is unlikely that definitive conclusions can be drawn from a single year of sampling, since different components of natural systems respond to physical conditions at different rates. This, coupled with the highly variable manipulation of releases from Katse, would make it impossible to track river condition class at IFR site 2 over this time span.

These observations are in addition to potential problems in establishing the baseline about which fluctuation is expected to occur, notably for parameters such as water temperature and habitat diversity. This is an important problem, given that the river condition criteria are defined as limits to deviations from a baseline mean. The river condition classification itself needs revisiting in terms of the precision of the definitions, as do the monitoring protocols in relation to determining that river condition. In essence, the evaluation of river condition remains dependent on subjective judgement, which can be done only by scientists with considerable experience of such matters. Without further refinement it is highly unlikely that any amount of monitoring can deliver results in terms of compliance with the river condition targets.

Table 3-4: Summary status of performance against river condition targets

Definitions of the River Condition Classes using key indicators / descriptors.

Indicator	IFR Site 2	IFR Site 7	IFR Site 1	IFR Site 3	IFR Site 8
Target River Condition	**4**	**4**	**3**	**4**	**3**
Target flow at IFR site/ status	15.3% MAR/ 13.8% Deficit	22.0% MAR/ 9.7% Deficit	40.0% MAR/ 22.2% Deficit[1]	*No target specified*	*No target specified*
GEOMORPHOLOGY/ HYDRAULICS					
Instream Habitat Diversity	Unquantified loss in diversity	unknown	unknown	unknown	unknown
Pool depth	Significantly reduced (<1 m)	unknown	unknown	unknown	unknown
Bank erosion or collapse	Insignificant erosion	unknown	unknown	unknown	unknown
WATER QUALITY					
Mean monthly temperature[2]	Not definitive	Not definitive	Not definitive	Not definitive	Not definitive
pH annual range change	Not definitive PH range appears to remain within natural range	Not definitive PH range appears to remain within natural range	Not definitive PH range appears to remain within natural range	Not definitive PH range appears to remain within natural range	Not definitive PH range appears to remain within natural range
Rapid Biological Assessment Score[3]	Ave score: 39 Within Class 5 range	Ave score: 50 Within Class 4 range	Ave score: 59 Within Class 4 range	Ave score: 55 Within Class 4 range	Ave score: 38 Within Class 5 range
VEGETATION					
Zone definition	unknown	unknown	unknown	unknown	unknown
Species composition of riparian vegetation	unknown	unknown	unknown	unknown	unknown
Structure	unknown	unknown	unknown	unknown	unknown
FISH					
Community composition	Not definitive Species reduced from 4 to 2, dominance reversed in favour of Trout (exotic) BUT winter sample	Not definitive. Diversity reduced, but new, sensitive species (Maloti minnow) found	unknown	unknown	unknown

1 Matsoku shows 22.2% deficit from the IFR *target* release, but the recorded flows in the river downstream of the weir is reported as higher than the estimated *in*flow to Matsoku weir (Table 2-8)

2 This parameter is poorly defined. If the individual monthly average is taken, then exceedences are expressed for each month. But then, how many monthly exceedences does it take to push the result into a lower or higher class? Or is this supposed to be the Annual Mean Monthly Temperature?

3 Based on analysis of 2 years' 2002-2004 of monthly sampling, using the SASS4 method, for most sites. The reference sites 9 and 10 on this basis emerged as Class 3 or 4, whereas they should reflect Class 2 conditions.

3.3 Lessons Learned

The monitoring exercises conducted to date have been largely *ad hoc* attempts to test aspects of flood releases, with the emphasis appropriately on IFR sites 2 and 7. Unfortunately, however, there has been little consistency, with different levels of sampling being applied in some cases to the two sites. Only routine hydrological and water quality monitoring has occurred at any other sites. Given the critical relationship between monitoring and compensation for resource losses, all the sites have to be monitored.

Monitoring to track subtle changes in natural systems, in the context of high levels of natural system variability, is extremely difficult. There are significant problems in the so-called scientific characterization of the environmental quality objectives being monitored for, namely the criteria laid down in the river condition classification. For instance, the water quality criteria lack precision: "change in mean monthly temperature" is one of them. Is this the long-term mean for that site? Is the monthly mean compared with the reference site's mean for that particular month? Is the parameter to be averaged over the year in relation to river condition overall, or, for how many months must the criterion be exceeded for the river condition to be considered to have changed? With respect to the RBA, no time period is given for the parameter (it is assumed to be the annual average in this report).

So despite the problems in implementation, the system itself needs refining before satisfactory results will start coming through.

3.4 The Way Forward

LHDA has recognized these problems and has put in place resources of budget and staff training and development to ensure that the monitoring programme delivers on the Policy requirements and plays its appropriate role in river management in the Phase 1 rivers. In particular, the following recommendations will be pursued:

- Revision of the river condition classification and refinement of the measuring criteria.
- Development of very specific protocols and methods for monitoring against these criteria.
- Rigorous training in monitoring purpose, field methodologies and analytical techniques.
- Development of a template for reporting each component and report-writing courses.

4 SOCIAL IMPACT: COMPENSATION AND MONITORING

4.1 *Proximal Reaches: Compensation Implementation Plan*

By the time the IFR Policy was approved in December 2002 considerable progress had been made in consulting with key stakeholders in Lesotho, from high levels of government and the Principal Chiefs, to the directly affected communities on the ground, laying the foundation for the compensation plan that would be implemented in the proximal reaches (reaches 1, 2, 3, 7 and 8), where significant impacts on resources had been predicted and resource loss values computed.

4.1.1 Establishment of Downstream Compensation Dedicated Task Team

LHDA community liaison staff who had worked alongside the IFR consultants in conducting these initial consultations were seconded to create a Downstream Compensation Dedicated Task Team, whose job it was to roll out the compensation implementation plan.

During 2003 the DCDTT continued the consultation process and repeated it in preparation for the establishment of Local Legal Entities (LLEs). The local legal entities were to be based on Area Chief areas, all the affected villages in the Area Chief's jurisdiction forming a local legal entity.

4.1.2 Establishment of Local Legal Entities

Compensation was to be paid as two tranches, one immediately and one in ten years' time, of the present value of predicted resource losses over the life of the project (50 years), at an appropriate discount rate and escalated for inflation from the start date. The lump sums were to be invested to fund community defined development projects.

The second round of consultations saw to the training for and setting up of local legal entities (LLEs) or community trusts, in whose name the lump sum compensation funds would be vested. This round of consultation involved:

- Translation of the IFR policy into Sesotho for public distribution
- Drafting of the policy brief to be used as a standard document by the teams during discussions with the communities
- Drafting of the Memorandum of Understanding (MOU) between LHDA and the Community, liaising with the legal department of LHDA
- Translation of MOUs into Sesotho
- Drafting of a Training Manual encompassing the following topics:
    - Conceptualization of the LLE
    - Leadership Skills (guidelines)
    - Drafting of the bylaws (guidelines)
    - Election of the Committee(s)

- Communication: Management Structures
- Registration of LLE (guidelines)
- Basic Bookkeeping

- Carry out a ground-truthing exercise with the following specific tasks:
    - Production of a 10-km corridor map for each of the IFR rivers
    - Show Area Chiefs' boundaries
    - Identify villages falling under the Area Chief in question
    - Check demographic statistics to household level
- Produce Training Schedule

4.1.2.1 Ground-truthing

In preparation for the implementation plan, the original IFR study socio-economic report provided the baseline information on affected communities. However, it was quickly realized that the information might be out of date, since several years had elapsed since the surveys were conducted. It was also found that village names did not always tally with those on the 1:50 000 topocadastral maps and when the 10-km wide corridor along the rivers was accurately plotted, a number of villages listed in that study did not actually fall within the corridor. It was therefore decided to update the demographic information and verify other aspects.

The ground-truthing exercise identified 53 core villages at area chief level in the proximal reaches 1, 2, 3, 7 and 8.

4.1.2.2 Training

To date, 23 five-day workshops have been held in preparation for the establishment of 23 LLEs in IFR river reaches 1, 2 and 3. All villages falling within the 10 km corridor and in the boundaries of the particular area chief were invited. The contents of the workshops were: IFR policy dissemination and discussion of MOU from day 1 to day 2 respectively, days 3 to 5 concentrated on the actual training on the concept of LLE, leadership skills, drafting of the bylaws, election of the committee and basic bookkeeping.

While the first round of consultations was completed in reaches 7 and 8 during 2003, persistent logistical difficulties have delayed the extension of the detailed LLE preparation programme to reaches 7 and 8. However, the programme is scheduled to start in April 2005 and end in August, 2005.

4.1.2.3 Registration and opening of Bank Accounts

Once the bylaws were in place, the members of the LLEs-in-the-making began to pay the agreed registration fees and membership contributions to enable formal registration of a particular LLE and opening of a bank account. By May 2004 all 23 LLEs (5 in reach 1; 5 in reach 2 and 13 in reach 3) had received the certificates of registration from the law office and had secured sufficient funds to open savings accounts with Lesotho Bank.

4.1.2.4 Formalization of relationship between LHDA and LLE

A Memorandum of Understanding template was drawn up and discussed with communities. The MOU would define the relationship between the LHDA and the LLE and regulate their interactions.

The two parties (LLE and LHDA) drafted and signed a Memorandum of Understanding (MOU) as a document that defines and formalizes the working relationship between them. The MOU highlights issues of common understanding of IFR Policy and Procedures, LHDA's involvement in compensation disbursement and utilization, definition of the LLE and its role and the settlement of disputes between the parties.

4.1.3 **Payment of the first 10-year tranche**

Compensation for downstream communities was disbursed between the 7th and 14th May 2004 to the 23 community LLEs in reaches 1, 2 and 3 (the approved compensation payment schedule is attached). The money was immediately invested into the savings accounts, which the LLEs had opened with the Lesotho Bank in Thaba-Tseka. The Net Present Value for 10 years was calculated from the compensation allocation per reach using January 2003 as a base date, at the discount rate of 8 %. Refer to compensation Payment Schedules at the end of this document (Annex B).

4.1.4 **Technical assistance**

A further commitment of the Policy is to provide technical assistance to affected communities on how to spend their money, in drawing up project proposals and helping them manage contractors. To date, assistance has been in the financial sector, advising LLEs on how best to invest their funds. None of the LLEs has proposed spending any of the money on projects. An in-house Technical Assistance Unit is being set up while an in interim unit is currently operational in IFR reaches 1, 2 and 3.

Since LHDA is constrained by the law from going beyond Lesotho, a challenging task was to choose locally available money markets with the highest return on investment. The banks have been identified as the safer investment options. Other institutions, such as insurance companies, did not have attractive products, especially not for the LLEs.

Inquiries were made with three banks (the Central Bank of Lesotho, Lesotho Bank Ltd. and Nedbank) as to what products could be offered by these banks, the condition of each product and, most importantly, the existing rates. Based on the information provided in the market research the communities were advised as follows:

(a) Bid for Three (3) months GOL Treasury Bills (TB)

All 20 LLEs who accepted the advice failed to secure bonds, for small technical reasons (signatories could not provide passport numbers, as required by the bank). The three other LLEs had then refused LHDA's advice.

(b) Bid for Six (6) months GOL Treasury Bills

A second attempt was with the six- (6) months TB of Central Bank. All but one of the LLEs failed on account of an unsatisfactory letter of introduction, again related to the absence of passport numbers for signatories

Current status of investments: Following the failure with the Treasury Bills, further negotiations continued with the two other banks, namely Lesotho Bank and Nedbank, regarding unit trusts and fixed deposit savings accounts.

Once these options had been communicated to the 23 LLEs they decided as follows:

- Three (3) LLEs opted for investing all their money into Lesotho Bank Unit Trust
- Three (3) LLE invested just part of the funds with the Lesotho Bank Unit Trust
- Sixteen (16) LLEs have opted to invest all their funds into Nedbank; this is inclusive (3) other LLEs who had partly invested into Unit Trust have.

Three (3) LLEs refused to cooperate with LHDA's advice despite signing the MOU. They are:

- Thabana Mahlanya Association
- U Khopo Malibamats'o Society
- Lihloliloeng ke Bophelo Matsoku Society

4.2 Compensation in Distal Reaches

The Policy commits the Project to paying compensation for losses in distal reaches (reaches 4, 5 and 6, all on the Senqu River) *which are demonstrated* through monitoring or claims made by affected parties. This was done because the predicted levels of impact in these reaches were so low that a high degree of uncertainty was attached to them. As of September 2004 no progress has been made on establishing a monitoring program to achieve this. The issue is scheduled to be dealt with in the upcoming year.

4.3 Socio-economic Monitoring

Socio-economic monitoring of the LHWP has been problematic overall and even more so in the downstream context, where impacts are anticipated to be more subtle and are spread over a vast area. The debate has been vigorous since approval of the IFR Policy on how to accomplish the necessary monitoring of affected communities in downstream river reaches. It has been decided that there must be consistency to some extent with upstream monitoring approaches; therefore the two have been linked, since a new cycle of upstream monitoring was due. A tender for Contract 1204 "Consultancy and Project Management Services to conduct a socio-economic and epidemiology impact survey upstream of Phase 1 dams and to conduct the socio-economic and epidemiology impact survey downstream of Phase 1 dams" was issued in 2004 and the bid evaluation process is almost complete.

4.4 Intangible Resource Losses

The IFR Policy declares a commitment to addressing 'intangible', unquantifiable resource losses caused by reduced flows in downstream river reaches, such as sense of place, landscape aesthetic quality, tourism value of the landscape. While this was not addressed in the procedures for compensation encapsulated in the present IFR Procedures, it was decided to initiate an investigation of the issue with a view to developing an approach to the problem, if it was found to be an issue with stakeholders.

A contract awarded to NulConsul (National University of Lesotho consulting arm) was terminated after the inception phase due to unsatisfactory performance. A variation to LHDA Contract 1204 for the Socio-economic Monitoring will be given to re-start this study.

4.5 Lessons Learned

The compensation programme in reaches 1, 2 and 3 has, to a large extent, proven to be a successful participatory venture. However, a major setback realized through the consultative process with all stakeholders is that provision of technical assistance to the LLEs came too late in the process.

4.6 The Way Forward

The affected downstream communities strongly feel that in the future, they need to be trained on how best to use compensation funds at their disposal prior to the actual disbursements of funds by the LHDA.

5 CONCLUSIONS AND LESSONS LEARNED

5.1 Compliance against Release Targets

IFR management is in its infancy in Southern Africa, and this report covers the first 20 months of IFR management in Phase 1 of the LHWP. Teething problems could be expected, and have probably been exacerbated by the coincidence with IFR Policy implementation of the first dry cycle the Project has experienced since the impoundment of Katse Dam in 1995.

While only releases from Katse were below target. Recorded river flow at all proximal IFR sites were below target. At Mohale increased releases were made to compensate for the accumulating deficit in targeted flows at IFR site 7 (although this failed to eliminate the deficit). Due to the dry early spring and summer, scheduled flood releases were not met, but were made late in the season.

At Katse Dam over the 2003/04 year regular and *major* adjustments to IFR release schedules were made and scheduled flood releases were not made in response to the very variable rainfall conditions. These changes are detailed in Incident Reports. These adjustments were so pronounced that the releases displayed almost the complete possible variation.

The difficulty of dealing with the drought conditions lead to discussion of possible revision of the Procedures during the latter part of 2004, to allow for quarterly re-setting of the IFR release schedule. Other approaches have been proposed and all options will be further investigated by appropriate experts.

The DRIFT database is not being used. It is hoped that the initiation of the contract for management of the biophysical monitoring programme will see this situation reversed in the near future.

LHDA acknowledges that lag times between data gathering, data analysis and data interpretation, and decision-making and approvals, are problematic in an adaptive management system that needs to be responsive to natural dynamics.

5.2 Verification of River Condition Status

Biophysical IFR monitoring, a critical component of the management system, has got off to a slow start. Monitoring to date has been unable to make any conclusive statements about river condition status.

Related problems include:

- All the monitoring emphasis has been on IFR sites 2 and 7. Only routine hydrological and water quality monitoring has occurred at any other sites. Given the critical relationship between monitoring and compensation for resource losses, **all** the sites have to be monitored.

- For the most part, no direct comparison can be made between baseline studies conducted in the IFR Study (Contracts 648 and 678) and the LHDA monitoring exercises, because of the general lack of attention to detail and rigorous methodology.

There are significant problems in the so-called scientific characterization of the environmental quality objectives being monitored for, namely the criteria laid down in the river condition classification.

5.3 Compensation and Socio-economic Monitoring

The affected downstream communities strongly feel that in the future, they need to be trained on how best to use compensation funds at their disposal *prior* to the actual disbursement of the funds by the LHDA.

5.4 The Way Forward

- Explore in depth options for revising the Procedures for hydrological year classification and IFR release scheduling, and making intra-annual changes to the schedules.
- Where particularly dry conditions appear to militate against flood releases, different options for scheduling them will be considered, such that spring freshets and early summer, within-year floods are not cancelled completely.
- Training LHDA technical staff in the use of the DRIFT database and linking this to the results of biophysical monitoring, is an urgent requirement.

IFR decision-making procedures will be streamlined. The IFR schedules must be set and approved on time, and any changes made must be done timeously and the motivation therefore must be well documented. Monitoring reports must be compiled quarterly and consolidated annually, and reacted to within one to two months

A major effort around IFR biophysical monitoring will be fast-tracked. This will come about when the Contract 1237 commences. In particular, the following are recommended:

- Revision of the river condition classification and refinement of the measuring criteria.
- Development of very specific protocols and methods for monitoring against these criteria.
- Rigorous training in monitoring purpose, field methodologies and analytical techniques.
- Development of a template for reporting each component monitored.

Annex A: IFR Release Schedules

Table A-1: Summary of IFR release schedules for Katse Dam and target flows at IFR Site 2 downstream of Katse Dam for all hydrological year classes (*Source: IFR Procedures*)

Plus 2													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Low Flow Volume (MCM)	3.48	3.14	3.48	3.24	3.21	2.85	2.95	2.68	2.59	3.21	3.24	3.21	37.30
Lowflow (m^3/s)	1.30	1.30	1.30	1.25	1.20	1.10	1.10	1.00	1.00	1.20	1.25	1.20	1.18
Freshets[5]													
Volume (MCM)	3.5		3.5		1.5		1.5		1.5		3.5		15.06
Magnitude (m^3/s)	**21**		**21**		**9**		**9**		**9**		**21**		
Flood Duration (Days)	5.3		5.3		2.3		2.3		2.3		5.3		
Within-year floods[6]													
Magnitude (m^3/s)	**31**	**71**	**31**	**31**		**31**		**31**			**142**	**71**	
Volume (MCM)	4.5	9.0	4.5	4.5		4.5		4.5			16.0	9.0	56.50
Duration Days	7.0	7.0	7		7			7.0			9	7	
Total (MCM)	11.5	12.14	7.98	7.74	3.21	7.35	2.95	7.18	2.59	3.21	19.24	12.21	**108.90**
Plus 1													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Lowflow Volume (MCM)	3.48	3.14	3.48	3.24	3.21	2.85	2.41	2.41	2.33	2.95	3.11	3.21	35.84
Lowflow (m^3/s)	1.30	1.30	1.30	1.25	1.20	1.10	0.90	0.90	0.90	1.10	1.20	1.20	1.14
Freshets[1]													
Volume (MCM)	3.5		3.5						1.5		1.5		10.0
Magnitude (m^3/s)	**21**		**21**						**9**		**9**		
Flood Duration (Days)	5.3		5.3						2.3		2.3		
Within-year Floods[1]													
Magnitude (m^3/s)	**31**	**71**		**31**				**31**			**71**		
Volume (MCM)	4.5	9.0		4.5				4.5			9.0		31.50
Duration Days	7.0	7.0		7.0				7.0			7.0		
Total (MCM)	11.5	12.1	7.0	7.7	3.2	2.9	2.4	6.9	3.8	2.9	13.6	3.2	**77.4**
Average													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Lowflow Volume (MCM)	3.48	3.14	3.48	3.24	3.21	2.85	2.41	2.17	2.15	2.95	3.11	3.21	35.42
Lowflow (m^3/s)	1.30	1.30	1.30	1.25	1.20	1.10	0.90	0.80	0.85	1.10	1.20	1.20	1.13
Within-year Floods													
Magnitude (m^3/s)	**31**	**71**		**31**				**31**			**71**		
Volume (MCM)	4.5	9.0		4.5				4.5			9.0		31.50
Duration Days	7.0	7.0		7.0				7.0			7.0		
Total (MCM)	7.98	12.14	3.48	7.74	3.21	2.85	2.41	6.64	2.20	2.95	12.11	3.21	**66.90**
Minus 1													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Lowflow Volume (MCM)	3.21	3.14	2.95	2.59	2.41	1.45	1.61	2.14	2.33	2.68	2.85	3.08	30.45
Lowflow (m^3/s)	1.20	1.30	1.10	1.00	0.90	0.56	0.60	0.80	0.90	1.00	1.10	1.15	0.97
Freshets[1]													
Flood Volume (MCM)				1.5									1.5
Magnitude (m^3/s)				**9**									
Flood Duration (Days)				2.3									
Within-year Floods[1]													
Magnitude (m^3/s)	**31**	**71**						**31**					
Volume (MCM)	4.5	9.0						4.5					18.00
Duration Days	7.0	7.0						7.0					
Total (MCM)	7.7	12.1	2.9	4.1	2.4	1.5	1.6	6.6	2.3	2.7	2.9	3.1	**50.0**
Minus 2													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Lowflow Volume (MCM)	2.68	2.30	2.41	2.20	2.14	1.81	1.61	1.47	2.07	2.28	2.33	2.68	25.99
Lowflow (m^3/s)	1.00	0.95	0.90	0.85	0.80	0.70	0.60	0.55	0.80	0.85	0.90	1.00	0.83
Within-year Floods[1]													
Magnitude (m^3/s)				**31**				**31**					
Volume (MCM)				4.5				4.5					9.00
Duration Days				7.0				7.0					
Total (MCM)	2.7	2.3	2.4	6.7	2.1	1.8	1.6	6.0	2.1	2.3	2.3	2.7	**35.0**

[5] 'Freshets' must be released regardless climatic conditions when they are scheduled (see Section 2.2.4.3).

[6] Within-year floods must be released to coincide with natural rainfall/flood events in the catchment.

Table A-2: Summary of IFR release schedules for Mohale Dam and target flows at IFR Site 7 downstream of Mohale Dam for all hydrological year classes

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Plus 2													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Lowflow Volume (MCM)	4.48	3.08	3.50	3.12	3.58	2.53	1.99	2.70	2.28	2.08	3.24	2.02	34.60
Lowflow (m^3/s)	1.65	1.25	1.35	1.20	1.35	0.95	0.75	1.05	0.90	0.80	1.20	0.75	1.10
With-Year Floods[7]													
Magnitude (m^3/s)		**58**									**36**		
Volume (MCM)		11.3									7.3		18.60
Duration Days		7.0									6.0		
Total (MCM)	4.42	14.32	3.62	3.12	3.62	2.46	2.01	2.81	2.33	2.14	10.41	2.01	**53.3**
Plus 1													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Lowflow Volume (MCM)	2.52	3.14	2.79	2.05	1.61	1.43	1.34	1.47	1.94	2.41	2.07	2.68	25.45
Lowflow (m^3/s)	0.95	1.30	1.05	0.80	0.60	0.55	0.50	0.55	0.75	0.90	0.80	1.00	0.81
With-Year Floods[1]													
Magnitude (m^3/s)		**36**						**17**					
Volume (MCM)		7.3						3.9					11.20
Duration Days		6.0						5.0					
Total (MCM)	2.54	10.44	2.81	2.07	1.61	1.43	1.34	5.37	1.94	2.41	2.07	2.68	**36.7**
Average													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Lowflow Volume (MCM)	2.38	3.36	2.02	2.40	1.59	0.72	0.39	0.66	0.49	2.00	3.28	1.44	20.74
Lowflow (m^3/s)	0.90	1.40	0.75	0.90	0.60	0.30	0.15	0.25	0.20	0.75	1.20	0.55	0.66
With-Year Floods[1]													
Magnitude (m^3/s)		**36**						**17**					
Volume (MCM)		7.3						3.9					11.20
Duration Days		6.0						5.0					
Total (MCM)	2.41	10.69	2.02	2.33	1.61	0.78	0.39	4.56	0.52	2.00	3.11	1.47	**31.9**
Minus 1													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Lowflow Volume (MCM)	1.77	2.69	2.18	1.70	0.83	0.52	0.54	0.70	0.41	0.99	1.37	1.87	15.56
Lowflow (m^3/s)	0.60	1.05	0.95	0.85	0.25	0.20	0.20	0.25	0.20	0.25	0.45	0.70	0.50
With-Year Floods[1]													
Magnitude (m^3/s)		17						17					
Volume (MCM)		3.9						3.9					7.80
Duration Days		5.0						5.0					
Total (MCM)	1.61	6.44	2.54	2.20	0.67	0.52	0.54	4.57	0.52	0.67	1.17	1.87	**23.3**
Minus 2													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Lowflow Volume(MCM)	1.12	1.45	1.55	0.62	0.91	0.78	0.54	0.54	0.65	0.94	1.30	1.53	11.91
Lowflow (m^3/s)	0.40	0.60	0.60	0.20	0.35	0.30	0.20	0.20	0.25	0.35	0.50	0.60	0.38
With-Year Floods[1]													
Magnitude (m^3/s)		**17**											
Volume(MCM)		3.9											3.90
Duration Days		5.0											
Total(MCM)	1.07	5.35	1.61	0.52	0.94	0.78	0.54	0.54	0.65	0.94	1.30	1.61	**15.8**

[7] Within-year floods must be released to coincide with natural rainfall/flood events in the catchment.

Annex B: Compensation Schedule

LOCAL LEGAL ENTITY AND COMPENSATION PAYMENT DETAILS FOR REACHES 1, 2 AND 3

Reach: 1

* Using January 2003 figures

	LLE Name	H/Holds Number	H/Holds *Rate*	LLE Amount
1	Malula-Moho Society	720	*4,363.48*	3,141,708.65
2	Imoneng Monoana Ka Lihloliloeng Liphakoe Society	596	*4,363.48*	2,600,636.61
3	Koallang Malingoana Society	242	*4,363.48*	1,055,963.19
4	Kutloano Ke Bophelo Methalaneng Society	431	*4,363.48*	1,880,661.71
5	Lihloliloeng Ke Bophelo Matsoku Society	127	*4,363.48*	554,162.50
	Total	**2,116**	***4,363.48***	**9,233,132.65**

Reach: 2

* Using January 2003 figures

	LLE Name	H/Holds Number	H/Holds *Rate*	LLE Amount
1	Terateng Phaphamang Basotho Society	343	*5,380.06*	1,845,359.50
2	Kopanang Liphofu Cooperative	180	*5,380.06*	968,410.24
3	Maloli Association	277	*5,380.06*	1,490,275.75
4	Khoro-li-Majoe I Association	170	*5,380.06*	914,609.67
5	Boipopo Makhoabeng Association	56	*5,380.06*	301,283.18
6	Luma-Luma Khohlo-Nts'o Association	215	*5,380.06*	1,156,712.23
6	Total	**1,241**	***5,380.06***	**6,676,650.57**

	Reach:	3		
* Using January 2003 figures				
LLE		H/Holds		LLE
Name		Number	*Rate*	Amount
1	Nts'abelle Basotho Society	77	*3,151.37*	242,655.65
2	U Khopo Malibamats'o Society	543	*3,151.37*	1,711,195.07
3	Shosholoza Society	42	*3,151.37*	132,357.63
4	Ts'epahalang Mats'umunyane Society	158	*3,151.37*	497,916.80
5	Khutlo se Setse Society	61	*3,151.37*	192,233.70
6	Khoro-li-Majoe II Association	293	*3,151.37*	923,352.03
7	Akofang Maapola Association	182	*3,151.37*	573,549.73
8	Kamohelo Khoanyane Association	257	*3,151.37*	809,902.64
9	Lebohang Kolberg Association	292	*3,151.37*	920,200.66
10	Thabana-Sefako Association	115	*3,151.37*	362,407.80
11	Thabana-Mahlanya Association	1,183	*3,151.37*	3,728,073.23
12	Moqekela Association	113	*3,151.37*	356,105.05
13	Bula Mohlaka Association	292	*3,151.37*	920,200.66
	Total	**3,608**	***3,151.37***	**11,370,150.65**

SUMMARY OF COMPENSATION PAYMENT SCHEDULE FOR 10-YEAR TRANCHE FOR IFR PROXIMAL REACHES

IFR Compensation – Local Legal Entities [LLE-10 years]

Summary

* Using January 2003 figures

	Reach 1	Reach 2	Reach 3	Sub-Total	Reach 7	Reach 8	Sub-Total	TOTAL
Total Compensation	9,233,133	6,676,651	11,370,151	**27,279,934**	7,866,147	1,034,670	**8,900,817**	**36,180,751**
Number of H/Holds	2,116	1,241	3,608	**6,965**	0	0	**0**	**6,965**
Rate / H/hold	4,363.48	5,380.06	3,151.37	**12,894.91**				
Number of LLEs	5	6	12	**23**	0	0	**0**	**23**

LHWC Letter: Reference LCG/678, Dated 30 July 2003

Total Compensation

Cost of financing (positive real interest rate {8%} plus [+] inflation rate {5.9%}) 13.90%

	Reach 1	Reach 2	Reach 3	Sub-Total	Reach 7	Reach 8	Sub-Total	TOTAL
1 January 2003	8,106,350	5,861,853	9,982,573	**23,950,776**	6,906,187	908,402	**7,814,589**	**31,765,365**
1 January 2004	9,233,133	6,676,651	11,370,151	**27,279,934**	7,866,147	1,034,670	**8,900,817**	**36,180,751**