ECOLOGICAL RESERVE DETERMINATION FOR LAKE SIBAYA, QUATERNARY CATCHMENT W70A, KWAZULU NATAL COASTAL PLAIN

Integrated Report

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1 BACKGROUND

1.1 Introduction

This report details an Ecological Reserve Determination for Lake Sibaya on the KwaZulu Natal Coastal plain. The Reserve is set for the extent of the Lake, while the groundwater component of the Reserve addresses the full extent of quaternary catchment W70A. The report is divided into four main sections:

- Chapter 1 – Gives an overview of the catchment and Lake Sibaya
- Chapter 2 – Presents the Ecological Reserve
- Chapter 3 – Recommended Management Actions from the Reserve
- Appendices 1 and 2 - Contain the detailed specialist reports.

1.2 Water Use Application

An application for a water use licence, for the abstraction of 1.8 Mm^3/a of water for basic human needs, from Lake Sibaya was made to the Department of Water Affairs and Forestry.

The licence application is for the following water uses:

Surface water use:
Section 21(a) - taking water from a water resource
Section 21(b) - storing water
Section 21(d) - engaging in a stream flow reduction activity contemplated in section 36

Groundwater use:
Section 21(a) - taking water from a water resource
Section 21(j) - removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people.

1.3 Study Area

Lake Sibaya, is the largest freshwater lake in South Africa with a surface area of 77.5 km^2 and a shoreline of +/- 127 km (1977). The Lake lies on the Kwazulu Natal coastal plain, approximately 60 km north of Lake St Lucia and 50 km south of the Mozambique border, within quaternary catchment W70A. The lake lies against a high dune cordon and represents the exposed water table of the Maputaland peneplain.

Lake Sibaya was declared a Ramsar wetland site on the 28 June 1991 and was included into the Greater St Lucia World Heritage Site which was proclaimed in December

1999. As such the area is considered a sensitive environment demanding the highest levels of protection and conservation.

The Lake is inhabited and frequented by a number of rare and endangered Red Data Book species of reptiles, fish, birds, mammals, and plants, including the Nile Crocodile, Samango monkey, fish species *Croilia mossambicus* and *Silhouetta Sibaya*; plants – the climbing orchid, *Vanilla roscheri*.

1.4 Geomorphology and bathymetry

The lake can be divided into five regions. The main basin is the largest (56% – 59%) of the area of the lake and contains the deepest water, the south west and south basins are shallower, and about 9% each of the total area. The long western arm and shorter northern arm comprise some 20% of the total area. Shoreline development varies with lake level.

With the exception of the south basin, the remaining areas all show a continuation in bathymetric profile with the main basin. Sand infilling due to the proximity of the dune cordon caused this segmentation during the Holocene, and presumably it is continuing to do so. The bathymetry of the southeast basin shows that in January 1970, there was an extensive shallow bar (<5m) separating the basin from the main lake. Of particularly significance is the steepness of the slope below a wave cut terrace on all shores with the exception of the north and south shores of the main basin.

1.5 Resource Units

The surface water resource unit is defined as the aerial extent of Lake Sibaya, while the groundwater resource unit includes the lake Sibaya sub-catchment.

1.6 Components of study

Specialist studies conducted as part of the Reserve Determination for Lake Sibaya, include:

- Appendix 1 Ecological Specialist Report
- Appendix 2 Geohydrology Specialist Report

Each of these studies forms a separate appendix to this report.

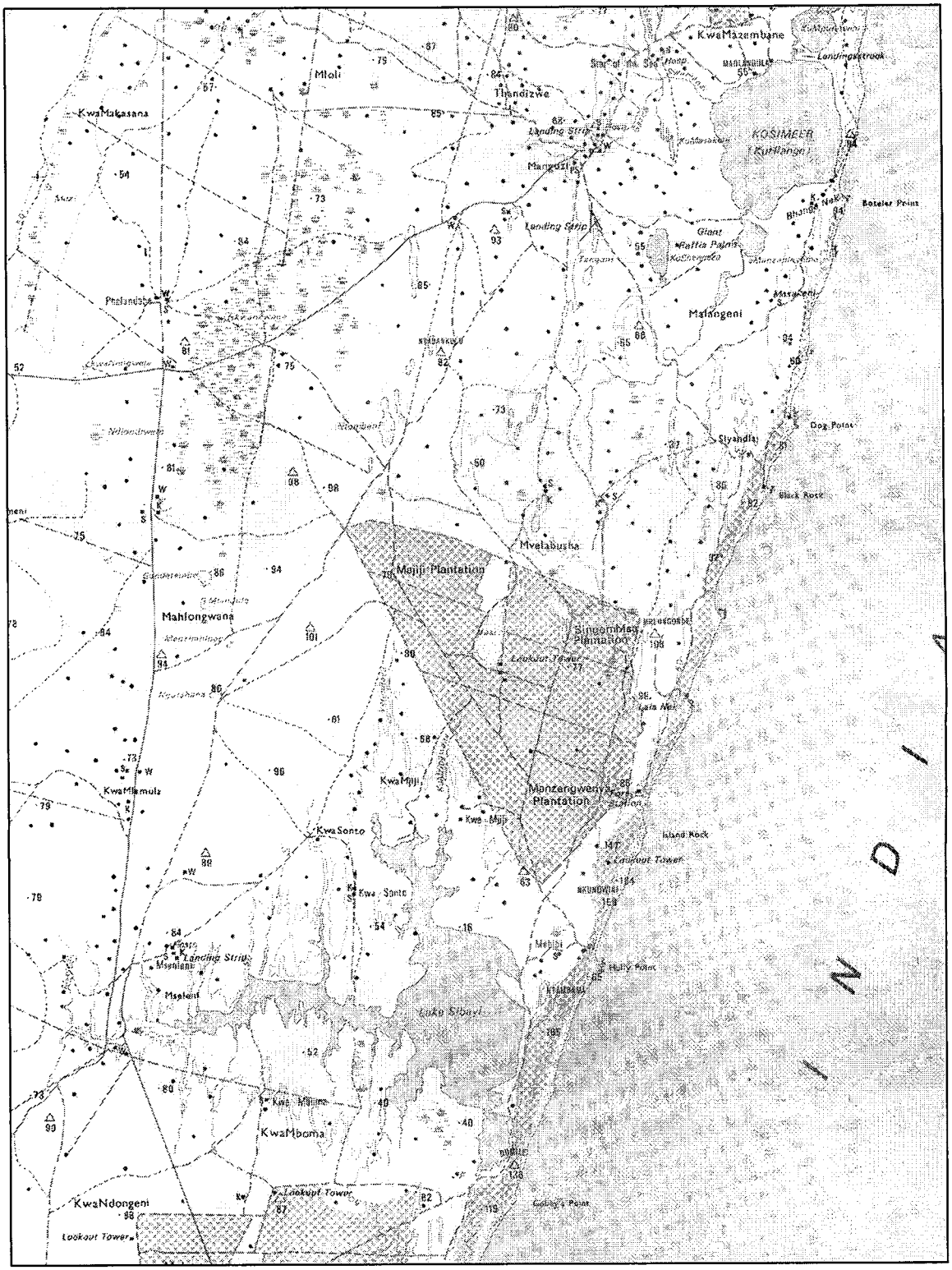

Figure 1. 1:50 000 Topographical map of Lake Sibaya

2 ECOLOGICAL RESERVE

2.1 Present Ecological Status

***Habitat Integrity*: Category B: largely natural**. There have been small impacts due to a) Mseleni Mission b) Research station c) new rest camps and a hotel near the western arm. The road to Mbibi was rebuilt in early 1980.

***Biotic Integrity*: Category A: unmodified natural**. Notwithstanding minor disturbances to the habitat of the lake, its biological component has proved resilient. The faunal structure is unique - freshwater and estuarine animals are found in the same lake. There is no other natural freshwater body in South Africa exhibiting this feature.

Water Quality [1]: **Category A: unmodified natural**

Dissolved Oxygen Pelagic zone	Nutrients SRP, NOx [µg/l]	Chl a [µg/l]
80 – 102 of satd.	25-55,17-32	1 - 4

Principal ions	mg/l	pH
Na	80 – 87.6	8.3
K	7.0 – 7.4	
Ca	27.6 – 24.3	
Mg	8.2 – 9.0	
HCO_3	134.5 – 151.9	
Cl	131.3 – 138.1	
S04	10.1 – 24.4	

[1] Data derived from Allanson and van Wyk (1969) and Allanson (1979)

2.2 Ecological Importance and Sensitivity

The Ecological Importance and Sensitivity (EISC) rankings for Biota and Habitat are given in Table 1.

The overall EISC for Lake Sibaya is given as **Very High.** Lake Sibaya is the largest lake in South Africa – there are only two, and Lake Sibaya is the most accessible. The lakes biodiversity is unique, containing rare and endangered species in an association of freshwater and estuarine animals living together.

Table 1. Ecological Importance and Sensitivity Ranking

CRITERIA	Rating
Biotic determinants:	4
Rare and endangered biota: Vertebrates the Nile *crocodile ;* Samango monkey, two fish taxa – *Croilia mossambicus and Silhouetta* sibaya. Plants – the climbing orchid, *Vanilla roscheri*	
Unique Biota: An array of estuarine animals living together with an equally diverse array of freshwater invertebrates. No other lake exhibits this feature and is consequently of international importance.	4
Intolerant Biota: Principally the most abundant fish species, Mozambique tilapia, Oreochromis mossambicus, the young of which depend totally upon the rich food resources on the terrace sands. If the level of the lake is allowed to permanently fall below the terrace, this food habitat will be lost.	4
Species/taxon richness: The bird diversity is high and 62 species of 273 recorded at the lake are dependent on the lake for breeding, feeding and roosting sites. The lake has the highest diversity of fish of any other lake in the Maputaland plain. It is these features, together with its importance to both the Nile crocodile and hippo that the lake has been registered as a RAMSAR site.	4
Habitat determinants:	
Diversity of aquatic habitats: This defines the species richness of the lake. As habitat diversity decreases so animal species richness will fall.	4
Refuge value of habitat types: All submerged or emergent plant communities are used as refuges by young fish and birds against natural predators. Loss of these refuges will reduce plant and animal diversity.	3
Sensitivity of habitat to water level change: At high lake level providing extensive inundation of marginal wetlands, there is a positive breeding response among many of the lake fauna. The permanent submerged and emergent water plants, eg *Potamogeton schweinfurthii* provide essential refuges during periods of low lake level.	3
Sensitivity to water quality changes: The lake is endorheic – no surface outflow so that the addition of nutrients as a result of increasing human occupation of its littoral will serve to rapidly change the N and P concentrations and the N:P ratio in the water column. The result will be an increase in phytoplankton growth and succession to cyanobacteria (blue-greens) which are often toxic which would, therefore, cause tastes and odours in water taken from the lake, if not become directly toxic to humans and their animals.	3
Migration route & corridor: Changes in water level downwards will influence hippo and Nile crocodile occupancy of the lake negatively.	3
National Park area: Lake Sibaya and its environs are a declared RAMSAR site. The State has, therefore, an international obligation to ensure optimal survival of the ecosystem. The Lake is also situated within the Greater St Lucia World Heritage Site.	4
Ecological importance and Sensitivity category: Confidence rating	**4**

2.3 Ecological Management Category

Based upon the above PES analysis, the Importance and Sensitivity Rating, the Ramsar status of the Lake and the fact that it is included within the Greater St Lucia World Heritage site, the appropriate Management Class for the lake is set as a **Category A**.

2.4 Lake Water Level Requirements

Based on recorded lake water levels for the period 1980-2002 (W7R001-A03), lake water level requirements were set for Lake Sibaya (Figure 2), for:

- *Drought levels*: reflect those levels which will be achieved during drought periods only, and should not be maintained for extended periods of time unless indicated by the length of a period of actual drought.

- *Maintenance dry season levels*: reflect the levels which should not be exceeded for lengthy periods during winter. If these levels are exceeded for short periods during the dry season, maximum draw down must never exceed the drought levels.

Table 2. Lake Water Level Requirements

Water Level	Lake Water Level [mamsl]	Equivalent Lake Volume [Mm^3]
Current Full Supply Level	20.5	-
Drought Minimum Water Level	18.0	693.19
Maintenance Minimum Dry Season Water Level	18.9	752.67
Maintenance Minimum Water Level	19.6	802.22
Maximum Drawdown Rate [m/annum]	0.5 – On a long-term declining water level trend	
	1.0 – On a long-term rising water level trend	

mamsl = metres above mean sea level

(1) Since the maximum lake water level can not be managed, no 'Management Maximum Level' has been set for Lake Sibaya.

(2) Seasonal fluctuations in water levels are considered important in the long-term maintenance of the lake. Fluctuations must therefore take place between the maintenance dry season and Full Supply Level.

(3) Due to the uncertainty in the datum for gauging station W7R001-A02 and the resultant measured water levels, only data from W7R001-A03 has been used to set the Lake Reserve levels.

The equivalent lake volume corresponding to the set Lake water level requirements are based on the bathymetry study conducted on Lake Sibaya by the Council for Geoscience (Perritt et al., 2002).

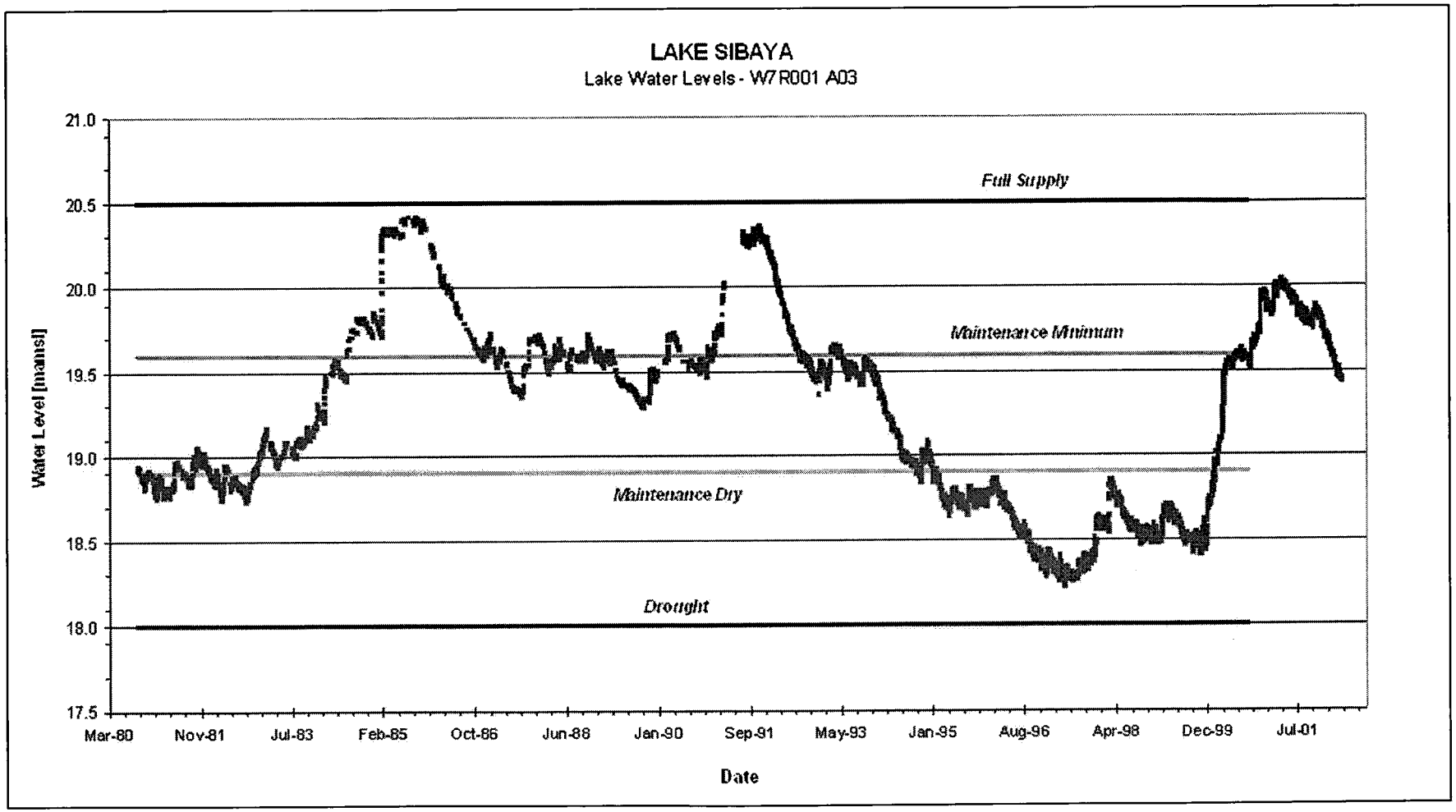

Figure 2. Lake water levels for Lake Sibaya (W7R001-A03)

2.5 Motivations for water levels

Table 3. Motivation of Lake Water Level Requirements

CURRENT FULL SUPPLY LEVEL: *20.5 mamsl*			
Description of water level	**Motivation**	**Why not higher**	**Source**
MOTIVATOR			
Hydrology	The highest recorded natural lake water level for W7R001-A03 is 20.42 mamsl (August 1985).	No lake level higher than this has been recorded in the period 1980-2002. Full supply level is dependant upon rainfall and can not be managed for.	Miller, 2001 DWAF, 2002

DROUGHT MINIMUM WATER LEVELS: *18.0 mamsl*			
Description of water level	**Motivation**	**Why not lower**	**Source**
MOTIVATOR			
Hydrology	Lowest recorded natural lake water level is 18.2 mamsl (May 1997).	Actual recorded minimum level already downscaled slightly.	Miller, 2001
Fish	Below this level the cichlid fish community would be unable to feed successfully, because of a reduction in the food quality on the terrace. This would apply particularly to the east and western shores.	Relationship between reduction in level and available functional biological areas in the lake is critical	Allanson (1979); Bowen (1978)
Riparian Vegetation	The longer the dry shore line remains dry, the greater the wind action on it, resulting in erosion of the shore line, encouraging encroachment of Acacia Karoo		Allanson (1979); Bowen (1978)
Water Quality	Below this level, the distance between the water level and the riparian vegetation is too large to allow active contribution of nutrients to the lake terrace		Allanson (1979); Bowen (1978)

MAINTENANCE MINIMUM DRY SEASON WATER LEVELS: *18.9 mamsl*			
Description of water level	**Motivation**	**Why not lower**	**Source**
MOTIVATOR			
Habitat	At this level, an extensive beach around the lake is evident.	Observed stress when lake levels have reached these levels naturally (i.e. stress in relation to reduction in terrace and marginal vegetation habitats	Allanson (1979); Bowen (1978)

MAINTENANCE MINIMUM WATER LEVELS: **19.8 *mamsl***			
Description of water level	**Motivation**	**Why not lower**	**Source**
MOTIVATOR			
Habitat	Median recorded lake water level, sufficient water on the terrace of the entire lake, to maintain productivity		Allanson (1979); Bowen (1978)

MAXIMUM DRAW-DOWN RATE: *0.5 m/annum*			
Description of water level	**Motivation**	**Why not lower**	**Source**
MOTIVATOR			
Hydrology	Based on historical records for gauging stations A02 and A03. The 0.5 m drop accommodates abstraction on a long-term declining water level trend.	Based on the Ramsar status of the lake, a conservative approach is adopted in setting water level drawdown.	
	On a long-term rising water level trend, a 1.0 m drop in water level is recommended.		

2.6 Groundwater Component of the Reserve

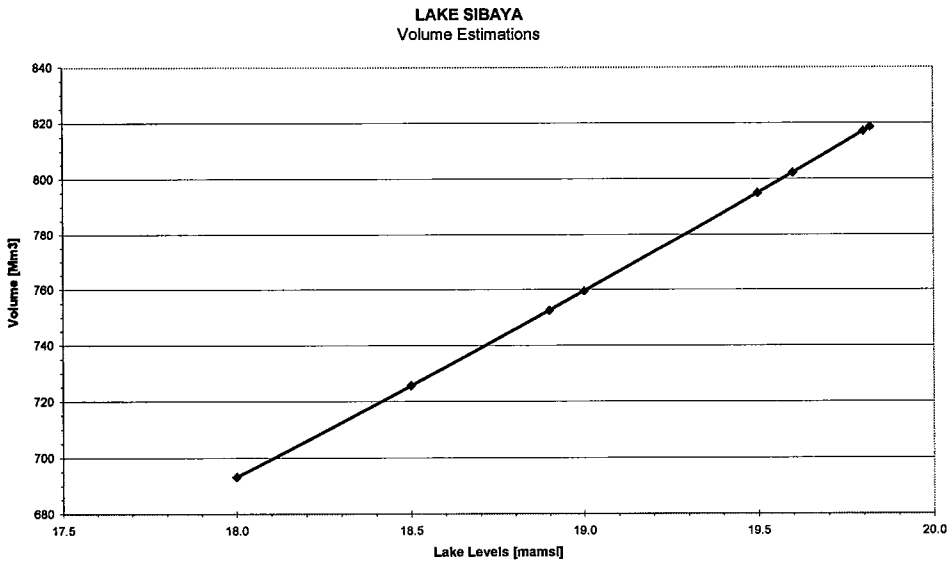

Figure 3. Lake level – volume relationship (Perritt, 2002).

Based on the set Maintenance Minimum water level, the corresponding lake volume has been used as the groundwater required by the lake (Table 5).

Table 5. Groundwater component of the Reserve.

Quaternary Catchment [1]	Area (km^2)	Recharge [2] (Mm^3/a)	Population	Available groundwater resource [3] (Mm^3/a)	Groundwater component of lake [4] (Mm^3/a)	BHN Reserve (Mm^3/a)	Reserve as % of Available Groundwater Resource
RU1	530	52.5	44 100	5 200	802.2	0.402	15.4

Notes:

[1] RU1 – Lake Sibayi sub-catchment, part of quaternary catchment W70A (Pitman and Hutchison, 1975).
[3] Volume of groundwater available within sub-catchment
[4] Lake volume at set Reserve level of 19.6 mamsl (Maintenance) (CGS, 2002)

Groundwater must be managed within the available Recharge volume, which based on recorded MAP, varies between 29.9-112.5 Mm^3/a (at 11% recharge).

Definitions

Recharge: Water reaching the aquifer directly from precipitation and the infiltration of surface water. [2]
The Reserve constitutes the sum of the groundwater component of baseflow plus the BHN reserve expressed as a percentage of the Recharge.

[1] Bredenkamp, D.B., Botha L.J., van Tonder, G.J. and Van Rensburg, H.J. (1995). Manual on quantitive estimation of groundwater recharge and aquifer storativity. WRC Report TT 73/95
[2] Assume that entire population of catchment is served with groundwater.
[3] Based on a consumption of 25 litres per person per day.

3 RECOMMENDED MANAGEMENT ACTIONS

Based on the findings of the Reserve Determination for Lake Sibaya, the following management actions are recommended to ensure protection of the set Lake water level requirements.

- To ensure protection of the Reserve, proper management and operation of the lake water level recorder must be maintained.
- Due to the current development of a sand bar between the main basin of the lake and the southern basin, a drop in water level of approximately 1m could result in the isolation of the southern basin from the main basin. In such a case, abstraction from the smaller southern basin would have a greater impact upon the available habitat. It is therefore recommended that any water abstraction take place from the main basin, and not the south basin.
- Lake water level recorder must be established in the main basin.
- A rainfall monitoring station must be established in close proximity to the lake, to accurately assess the relationship between lake levels and rainfall.
- The possibility of developing a groundwater well field in proximity to the water users, rather than abstraction of water from the Lake must be considered. However, should this option be followed, proper construction and development of the well field, is critical to ensure long-term sustainability.
- Groundwater monitoring boreholes need to be established in proximity to the lake, to assess the relationship between lake water levels and groundwater levels.
- Specific ecological indicator monitoring
- Any development of pumping stations along the lake shore, to abstract water, must be constructed so as to minimise impact on the riparian vegetation.
- A numerical model should be developed for the lake, to assess the effects of abstraction on the lake ecosystem and associated groundwater levels.
- Due to the nature of the Lake, i.e. a Ramsar Wetland site, within a World Heritage Site, all developments must be subject to Environmental Legislation, i.e. EIA process.

4 CONCLUSION

On a long-term rising water level trend, a 1.0 m drop in water level (within any given 12 month period), through abstraction, is allowed. Note, the 1.0m drop in water level must remain within the set water level requirements for the Reserve.

On a long-term declining water level trend, a 0.5m drop in water level (within any given 12 month period), through abstraction, is allowed. Note, the 0.5m drop in water level must remain within the set water level requirements for the Reserve.

In light of the level of confidence of the Reserve determination (medium) and the fact that the current Reserve is considered specifically for the licence application (Reference), any future licence applications for Lake Sibaya must be submitted to the RDM Directorate for determination.

This Reserve does not apply to any water abstraction from any of the other lakes systems within the quaternary catchment W70A or within the coastal plain, e.g. Kosi lake. Any other licence applications for lake abstractions must be submitted for assessment, and if required a separate Reserve determined.

5 REFERENCES

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