Blesbokspruit

South Africa

Information sheet for the site designated to the List of Wetlands of International Importance in terms of the Convention on Wetlands of International Importance especially as Waterfowl Habitat

1. **Date this sheet was updated**

   21 August 1998

2. **Country**

   South Africa (Gauteng Province)

3. **Name of wetland**

   Blesbokspruit

4. **Geographical coordinates**

   26^{o} 17' S; 28^{o} 30' E

5. **Altitude**

   1600 m

6. **Area**

   1858 ha

7. **Overview**

   Permanently inundated reed-dominated (*Typha* and *Phragmites*) wetland. Permanent flooded status is due to artificial inputs of water (e.g. from mines and sewage treatment works). Reedbeds are probably supported by eutrophic status of water.

8. **Wetland Type**

   M: Permanent river/stream/creek
   Tp: Permanent freshwater marshes/pools; marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season
   U: Non-forested peatland

9. **Ramsar Criteria**

   1c: Wetland is a particularly good representative example of a wetland which plays a substantial hydrological, biological or ecological role in the natural functioning of a major river basin;
   2a: It supports an appreciable assemblage of rare, vulnerable or endangered species or subspecies of plant or animal, or an appreciable number of individuals of any one or more of these species;

3b: It regularly supports substantial numbers of individuals from particular groups of waterfowl, indicative of wetland values, productivity or diversity

10. **Map of site included?**

No

11. **Compiler of this form**

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12. **Justification of the criteria**

Historically, the Blesbokspruit stream was a narrow meandering non-perennial highveld stream with an associated "wet meadow" wetland. Since the early 1930's, the area has become exposed to a variety of developments mainly associated with the gold mining community. Roads and embankments crossing the stream caused flooding of upstream areas, which slowly became colonized by reeds. By the time the Blesbokspruit was designated as a Ramsar site (October 1986), the landscape had been transformed into a permanent wetland that was known and valued for the variety and abundance of bird species utilizing it. The wetland is currently maintained in its artificially inundated state by daily inputs of several megalitres of eutrophic water from sewage works, mines and industries.

The Blesbokspruit is an important river in the Gauteng province since it drains a large area before joining the Suikerbosrand River that ultimately flows into the Vaal River. The latter is a major system providing water for a variety of uses (e.g. domestic, agriculture, industry and recreation). Many other small ephemeral wetlands in the immediate and surrounding catchments coexist with the Blesbokspruit as a "network" or chain of wetlands available at the landscape level to wildlife.

The permanent status of this wetland therefore provides a permanent refuge to a diverse range of waterfowl and other faunal groups in the broader East Rand region. Thus, while peripheral ephemeral wetlands may dry out seasonally or during drought periods, the Blesbokspruit represents a reliable source of food and habitats for waterfowl.

13. **General location**

The site is approximately 3km east of the town of Springs on the East Rand of Gauteng Province. The towns of Boksburg, Benoni and Brakpan lie in the north west while Nigel is located south of the site.

14. **Physical features**

Geology and Geomorphology

The geology of the area is fairly simple with flat lying sedimentary rocks of Karoo and Transvaal age (250 ma and 2200 ma respectively) overlying older formations of gold bearing Witwatersrand (2500 ma).

The Blesbokspruit flows in a southerly direction through the Grootvlei Mines (Pty) Ltd area into the Marievale Bird Sanctuary which is the mining area of Marievale Ltd. Gold has been exploited from the Witwatersrand reefs in the East Rand since the turn of the century, however in the area under discussion, these reefs do not crop out on the surface. The Black Reef Quartzite Formation overlies the Witwatersrand strata unconformably and is in turn overlain by Malmani dolomites which form an important natural water reservoir, these two formations form a part of the Transvaal sequence.

Extensive erosion took place prior to the deposition of the Karoo sequence. The basal formation of this sequence, the Dwyka Diamictite Formation is a clay-rich rock containing rounded rock fragments (up to boulder size) and is the product of Carboniferous continental glaciation. Overlying the diamictite, and the most common rock types to be found in the area, are sandstones and shales of the Vryheid Formation. Associated with these strata are coal seams which have been mined adjacent to the Blesbokspruit in the Groot valley area. During the entire geological history of the area, the whole sequence of rock has been intruded by igneous rock (mainly dolerite).

The pattern of the outcropping rock strata today reflects an inlier, where younger rock (Karoo) has been eroded along the course of the Blesbokspruit and the older rocks (Transvaal) can thus be seen adjacent to the spruit.

Soil type and chemistry

Soil analysis from report of 26.10.1983 provided by the Citrus Exchange:

ELEMENT	**SAMPLE**	
	S6449/A	**S6450/B**
PHOSPHORUS(mg/kg)Bray 1	14.00	5.00
POTASSIUM (mg/kg)	494.00	34.00
CALCIUM (mg/kg)	2656.00	1127
MAGNESIUM (mg/kg)	1500.00	275.00
EXCHANGEABLE AL INDEX(me%)	0.02	0.02
TOTAL NITROGEN (mg/kg)	1414.00	98.00
CHLORIDE (mg/kg)	184.80	693.60
SULPHUR (mg/kg)	427.50	322.50
BORON (mg/kg)	0.80	0.30
MOLYBDENUM (mg/kg)	0.58	0.48
ZINC (mg/kg)	63.21	6.58
IRON (mg/kg)	75.65	153.40
MANGANESE (mg/kg)	235.60	15.71
COPPER (mg/kg)	6.87	5.74

Origins

Before mining operations commenced in the early 1930's the area was typical flat highveld terrain of grassland and crop farming. The Blesbokspruit stream ran unrestricted through the area with little or no reedbeds along its banks. During the development of the mining operations, a number of embankments were built across the Blesbokspruit for roads and pipelines. These caused some flooding and vast stretches of shallow water were formed, creating one of the few permanent wetlands in the region. Rock dumps and slimes dams were built to store mine waste and these have changed the character of the area.

Hydrology

The natural hydrology of the stream has been suppressed by artificial inputs of eutrophic water (from mines, sewage works and various industries). The wetland is thus permanently flooded whereas before the 1930's the wetland would have been temporary and associated with a small non-perennial stream. The site was however designated as a Ramsar site when it was in its permanently flooded (i.e. artificially supported) state.

Seasonal fluctuations

Seasonal fluctuations in water level and depth are largely masked by artificial water inputs. The topography of the immediate catchment is gradual so increases in flow have resulted in a lateral expansion of the wetland (i.e. on the whole, it is wider/broader rather than deeper). Dry season flow is dominated by the point source discharges.

Water quality

Water quality is generally poor due to artificial inputs from mines, sewage treatment works and other industrial activities (i.e. point source discharges). The quality of the water is mainly influenced by total dissolved salts in the previously mentioned effluents. The "fingerprint" of the water chemistry is similar throughout the wetland (high sulphate, phosphate, nitrite/nitrate and ammonia concentrations).

Catchment area

The Blesbokspruit, which in its entirety covers approximately 60km^2, is situated in the East Rand. Approximately 45% of the catchment is urbanized while the remaining land is utilized for agricultural, mining and industrial activities.

Upstream of the designated wetland, the Blesbokspruit has two main branches, which flow eastward through highly urbanised and mined areas. There are several small dams on these branches.

Downstream of the designated wetland, the Blesbokspruit stream flows within the confines of a natural channel. The Blesbokspruit joins the Suikerbosrand River downstream. At Vereeniging, the Suikerbosrand River flows into the Vaal River Barrage, which is an important source of potable water for the greater Gauteng area. The Blesbokspruit is thus a subcatchment of the Vaal River catchment

Climate

The average annual rainfall is 670 mm recorded over a period of 31 years (Madden, 1987). Hailstorms are not uncommon during summer. Snow falls on rare occasions. One of the heaviest snowfalls was recorded in July 1964 when a depth of 200 mm was measured and the area was blanketed for three days. Temperatures vary from -10 C in winter to 35 C in summer. Frost occurs from April through to October. During the coldest months of June and July, ice can occur on the shallow open water.

15. **Hydrological values**

Water from the Blesbokspruit ultimately flows into the Vaal River Barrage where it is distributed to people in the province for drinking and other domestic purposes. Maintaining good quality water in the Blesbokspruit is therefore important. Although the wetland does have a natural purification capacity it is not regarded as the primary purifier of effluents entering the catchment as effluents are required to be treated to Department of Water Affairs standards. Since this ideal is not always realized, the Blesbokspruit wetland undoubtedly assists with purification. Extensive reedbeds (estimated at greater than 90% of the total wetland area) possibly assist with uptake of nutrients, toxins and heavy metals.

Flow of water may be slowed by these reedbeds - flood control? The residence time of water in the system is cause for concern for some adjacent residents whose properties occasionally experience flooding.

The reedbeds have a well-developed root structure that traps sediments. Reedbeds occur as rooted structures and floating "islands". The relative proportions of these two colony types/growth forms is not known. The relative contributions of these to purification, nutrient uptake and sediment trapping is not known.

16. **Ecological features**

The Blesbokspruit wetland predominately provides dense (*Typha sp.* and *Phragmites sp.*) reed habitat. These reedbeds exist mainly as large and small single species colonies with some mixed species clumps.

Open water habitat is limited to small deep-water pools. Shallow water habitat suitable for wading birds is rare.

Inundated sedges and grassland (marshy habitat) is a small component, which exists mainly during the summer rainfall periods. These portions occur as a narrow band on the outer edge of the wetland.

Natural plant communities adjacent to the Blesbokspruit are described as Highveld Grassland. These communities are however currently limited due to urbanization and surrounding land use practices (mining, agriculture etc). Adjacent lands are utilized for agricultural purposes e.g. maize and other vegetable crops.

Trees are not a natural feature in the landscape. The exotic South American water fern (*Azolla filiculoides*) has been introduced into this country and occurs in many wetlands, including the Blesbokspruit. Transfer of this species between wetlands probably occurs when portions of the plant, seeds or spores become attached to waterfowl. This plant occurs mainly in slow moving or stagnant portions of the wetland.

17. **Noteworthy flora**

The Blesbokspruit is situated in the Cymbopogon-Themeda veld (Acocks veld type no 48). This veld type merges with the Bankenveld and is a spare, tufted sourveld. The aquatic habitat consists mostly of *Phragmites australis*, bulrushes *Typha latifolia* and sedges which cover 90% of the water surface. These wetlands cover an area approximately 85% of the Marievale Bird Sanctuary. The remaining 15% is a grassland which is broadly classified as Bankenveld.

A wide variety of flowering plants occur. A few of the more spectacular are the Orange River lily *Crinum bulbispermum*, plough breaker *Erythrina zeyheri* and *Aloe ecklonis*.

18. **Noteworthy fauna**

The Blesbokspruit supports significant numbers of waterfowl, including up to 4000 yellow-billed duck, *Anas erythrorhyncha* and 1000 spur-winged goose *Plectropterus gambensis* in the dry season, when levels are maintained artificially at a high level. The high-productivity water provides food for greater flamingo *Phoenicopterus ruber*, and lesser flamingo *Phoeniconaias minor*, which are South African Red Data Book Species. Other notable birds include avocet *Recurvirostra avosetta*, purple heron *Ardea purpe* rata, spoonbill *Platalea alba*, glossy ibis *Plegadis falcinellus* and yellow-billed stork *Mycteria ibis*. African marsh harrier *Circus ranivorus*, which has been displaced from much of the veld, maintains a strong population here. There are at least three heron roosts with a total of over 3500 birds.

Increasing urbanization and industrialization in the central Gauteng reduce the number of sites available to the local fauna and flora. The Blesbokspruit supports a variety of fish, amphibians, reptiles, crustaceans and rodents. Spotted-necked otters *Lutra maculicollis*, water mongoose *Atilax palidinosus* and many larger birds depend on these animals for their food.

The reedbuck *Redunca arundinum* regarded as uncommon in South Africa, has also been recorded here. See attached list for other fauna recorded.

Avifauna count data is available from biannual CWAC (Coordinated Waterfowl Counts) reports, while species lists are submitted by reserve visitors to BIRP (Birds In Reserves Programme) - both programmes are run by the Avian Demography Unit at the University of Cape Town.

19. **Social and cultural values**

Before mining started in the area in the early 1930's the Blesbokspruit flowed unrestricted through a broad, grassy valley. A single bridge, built in 1899-1900 linked the town of Springs to the farm Vlakfontein. By the mid-1940's, mines in the area were in full production. Residential areas had been established for mine employees and thousands of trees and shrubs planted. Several roads built on embankments crossing

the spruit had dammed up large areas of shallow open water which provided habitat for beds of *Phragmites* and *Typha.*

In the past, hunting was popular along the spruit. The mining companies owning land along the spruit afforded some protection to the wildlife of the area. Both on Marievale and Daggafontein annual duck shoots were held. In 1963 Marievale prohibited shooting on their property.

Approximately 1000ha of the designated site falls in a proclaimed provincial nature reserve (Marievale Bird Sanctuary). The reserve is mainly valued for its bird watching facilities. Short walking trails are also available on the reserve.

20. **Land tenure/ownership**

(a) Designated Site

In 1971 an area of about 500 ha of mainly vlei and grassland at the southern end of the vlei was donated by Marievale Consolidated Mines to the Transvaal Division of Nature Conservation (now called Gauteng Nature Conservation) to be managed as a Bird Sanctuary. A further 385 ha was donated in 1976. With additional land purchased by the Transvaal Provincial Administration, the total area of the Marievale Bird Sanctuary is at present approximately 1 000 ha and is about 7,4 km long.

Since the Sanctuary was officially proclaimed in 1978, further areas of 860 ha of the farm Grootvaley, at the northern end, have been protected by the Anglo American Group and the Nature Conservation Division. The total length of the Blesbokspruit now under protection is roughly 20 km (approximately 1858ha).

(b) Surrounding Land

Surrounding land comprises mainly mines and agricultural lands with ownership being largely private.

21. **Current land use**

(a) Designated Site

Bird watching, recreation

(b) Surrounding Land

Agriculture e.g. maize, vegetable, lucerne, kikiyo (lawn grass), fodder, flowers. Water from the Blesbokspruit is used to irrigate these crops.

Mining - mainly gold mines. Dewatering of mine shafts contributes large quantities of poor quality water to the Blesbokspruit. Fish kills have occurred due to the presence of a red iron precipitate in the discharged water. Settling ponds and a pilot desalination plant have/are been introduced to reduce the pollution to the wetland.

An open-cast coal mine and clay extraction facility has been proposed for a site adjacent to the designated site (approximately opposite the Grootvlei Mine, but on the other bank).

Sewage treatment works - several sewage treatment works are located along the Blesbokspruit and treated sewage is discharged into the Blesbokspruit. These discharges have contributed to the eutrophic status of the wetland. Continued urban growth in the catchment has necessitated the upgrading of existing, and creation of new, sewage treatment works. The impact of sewage discharges on the Blesbokspruit is likely to increase (unless more efficient treatment technologies are introduced).

Both mining and sewage works contribute more water to the system than would be expected in pristine conditions. These quantities of water are likely to increase in the future due to urban expansion in the catchment.

22. **Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land use and development projects**

The site has been listed on the Montreax Record due to upstream and adjacent activities, which threaten the ecological nature of the site. Due to the linearity of the system and the fact that the site is located downstream of potentially harmful industries, mines and sewage works these threats are difficult to control. The lack of an integrated catchment management plan also contributes to the difficulties experienced with the site. It has been proposed that the Department of Water Affairs and Forestry in conjunction with a Catchment Management Agency will develop such a plan.

(a) Designated Site

An application to remove gold-bearing slime from a vlei area within Marievale Nature Reserve was received during 1997. The application was not approved due to concerns about the potential impact of exposing and mobilizing undesirable elements during rainfall events.

(b) Surrounding Land

Urban expansion in the catchment will increase runoff and demand for land adjacent to the site.

The proposed upgraded sewage treatment works will discharge greater quantities of effluent into the Blesbokspruit system. The ability of the proposed treatment technologies to sufficiently treat the water is uncertain. While the quality of the water is a problem, the proposed increased volumes, which will further mask any natural hydrological regime, is believed to be a greater threat.

A variety of applications to extract gold-bearing "slimes" deposited within the vlei have been received and are under evaluation. There are concerns about mobilization of harmful materials (particularly in vlei areas upstream of the site) during proposed extraction operations.

Lack of funds to treat discharged mine water from gold mine shafts adjacent to the site means that the quality of water discharged into the Blesbokspruit could conceivably deteriorate.

23. **Conservation measures taken**

The Blesbokspruit Ramsar site has suffered a lack of committed management for many years. This has undoubtedly contributed to its precarious status. An Interim Blesbokspruit Management Committee was formed to discuss objectives for the site. A management plan has yet to be developed and implemented (but see #24 below).

Gauteng Nature Conservation has undertaken management of the provincial nature reserve, Marievale, located in the southern portion of the designated site. A staff member has been allocated to the reserve and a variety of infrastructure developments have added to the services offered and appeal of the reserve (e.g. upgrading of roads, wheel chair access to bird hides and toilet facilities, bird hides upgraded or repaired, new hides built, thatched shaded picnic facilities supplied). Scientific input on the creation or promotion of bird habitat has been given - this was believed to be important as reedbeds dominate the wetland and continue to encroach on other marginal habitats.

Fire is a serious potential hazard on the provincial reserve. Accidental or deliberate fires frequently burn uncontrollably in the vast reedbeds. This poses a significant threat to visitors and reserve or private properties. Creating firebreaks in grassland adjacent to

the reedbeds is difficult as fire can easily enter the reeds. During 1997, managers of Marievale used herbicides to create fire safety zones in high risk areas - i.e. along the southern (50m wide), eastern and western boundaries (100m each).

24. **Conservation measures proposed but not yet implemented**

Proposed measures: A management plan for the Ramsar site is to be developed by external consultants in consultation with all landowners and affected parties. If approved, provincial government will fund the study. Part of the study will address the lack of clarity around the boundaries of the Ramsar site.

Management activities within the Ramsar site will have to be funded and implemented by all stakeholders.

25. **Current scientific research and facilities**

Gauteng Nature Conservation undertook a one-year pilot project to test the feasibility of utilizing registered herbicides for the control of *Typha* and *Phragmites* reeds. Control of reeds was deemed necessary to create a variety of bird habitats. The test addressed the economic and ecological aspects of this management technique.

A variety of Environmental Impact Assessments have been prompted by development proposals adjacent to, and upstream of, the designated site. These studies generally addressed various ecological and environmental issues, which contributes to the knowledge of the Blesbokspruit system.

The Avian Demography Unit at the University of Cape Town is running a countrywide project called BIRP (Birds in Reserve Project). Bird watchers fill in a species list for nature reserves and then forward them to Cape Town for analysis. Marievale Nature Reserve is listed on the project. An information request service is available through Cape Town - a fee is charged for information retrieval and printing of reports.

An interested member of the public undertakes a bird survey approximately once a month along the entire Blesbokspruit system - this information is available to interested parties.

26. **Current conservation education**

Several bird hides are available on Marievale.

No formal education programme. There however a number of environmental interest groups that occasionally use Marievale Nature Reserve for social and educational visits e.g. Friends of Marievale, Witwatersrand Bird Club, Wildlife and Environment Society of SA.

27. **Current recreation and tourism**

Marievale in the south of the designated site receives visitors who are mainly interested in bird watching.

28. **Jurisdiction**

The Blesbokspruit Ramsar site is located within Gauteng Province. Provincial government (i.e. Department of Agriculture, Conservation and Environment) is therefore responsible for the management of the site. This department reports to the national Department of Environment Affairs and Tourism, which in turn reports to the Ramsar Convention on the status of all listed sites in South Africa.

Multiple (private) land ownership of this site complicates management issues.

29. **Management authority**

Gauteng Directorate: Nature Conservation.
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Status of two South African Wetlands of International Importance listed on the Montreux Record

17 March 1998

1. Blesbokspruit

In July 1996, Blesbokspruit was placed on the Montreux Record in response to contamination by large quantities of polluted water discharged from adjacent Grootvlei Proprietary Mines Limited. The water originated from underground workings and threatened to irretrievably flood the mine. Permission for continued pumping was granted by the Department of Water Affairs and Forestry on condition that measures to improve the quality of the water were installed and a permanent solution to the problem, in the form of a desalination plant, was investigated.

Despite these measures, however, the impact of the discharge on the ecological character of the Ramsar site has been severe. The high concentration of dissolved solids and large volumes of water being discharged have impacted on the hydrology and ecology of the wetland to the extent that it no longer fulfills the criteria under which it was designated a Ramsar site in 1986.

The impacts are manifested primarily in two ways. Firstly, water quality has deteriorated, resulting in a decline in the abundance and diversity of aquatic animal species. Secondly, the seasonal fluctuation in water levels in the wetland has been replaced by permanently flooded conditions. Being in a climatic region characterised by summer rainfall, the system originally displayed a natural regime of high summer flows and reduced water levels in winter. This dynamic fluctuation in water levels maintained habitat diversity and ecosystem productivity. The result of high stable water levels, together with large concentrations of nutrients derived from domestic and industrial discharges upstream of the wetland, is a severe reed encroachment problem that has brought about a decline in habitat diversity. This loss of the dynamic habitat mosaic has induced a corresponding decline in diversity of birds and other species depending on the wetland for feeding, roosting and breeding sites.

Since the listing of Blesbokspruit on the Montreux Record, the following developments have taken place:

- Clarifying tanks were constructed by the mine, with government assistance, in order to remove the high levels of iron hydroxides in the water prior to its being discharged. While this has resulted in a visible improvement in the clarity of the water entering the wetland, the high salt loads and large volumes of water continue to impact on the system.

- During 1996 a Joint Venture Committee (JVC) was established, comprising the Department of Environmental Affairs and Tourism (DEAT) and several other government departments. The JVC produced a cost-benefit analysis of a number of scenarios for handling the mine water discharge, and the future management of the Blesbokspruit. From this analysis a number of recommendations were made to the Cabinet, which subsequently recognised that the construction of a desalination plant was inevitable and that a management committee should be created to co-ordinate the management of the Ramsar site.

- An Interim Management Advisory Committee (IMAC), chaired by the provincial authority responsible for managing the Ramsar site, has been established. All major stakeholders are represented on the Committee, whose mandate is to develop a management plan for the wetland. Preliminary goals and objectives have been compiled and a comprehensive management plan will be developed within the next two years. The vision for the plan is:

  to restore, maintain and enhance the ecological characteristics for which the Blesbokspruit was designated to the List of Wetlands of International Importance, and to provide human benefits compatible with the concept of wise use advocated by the Convention on Wetlands.

- The Gauteng Directorate of Nature Conservation has initiated a number of pilot projects aimed at finding a feasible means of controlling reed encroachment.

- Public hearings sanctioned by Cabinet and co-ordinated by the Gauteng Directorate of Environment were held during August 1997, in order to elicit feedback from interested and affected parties on the JVC report and to discuss possible solutions and management options for the wetland. A record of the proceedings of the hearings has been produced and will be submitted to Cabinet.

- The DEAT and provincial authorities are involved in processes to ensure that the Ramsar site is not further impacted by other developments in the Blesbokspruit catchment. Proposed developments include the construction of a regional sewage treatment works upstream of the wetland and the opening of an opencast coal mine on the site's eastern boundary. The DEAT is opposing any further discharges of effluent into the Blesbokspruit upstream of the wetland, on the grounds that these will further disrupt the flow patterns of the system.

- The Department of Water Affairs and Forestry has commenced a study on the Blesbokspruit catchment, with the aim of producing a catchment management plan. Together with the management plan for the Ramsar site, this will provide the authorities with a sturdy framework from which to assess the potential impacts of future developments on the wetland.

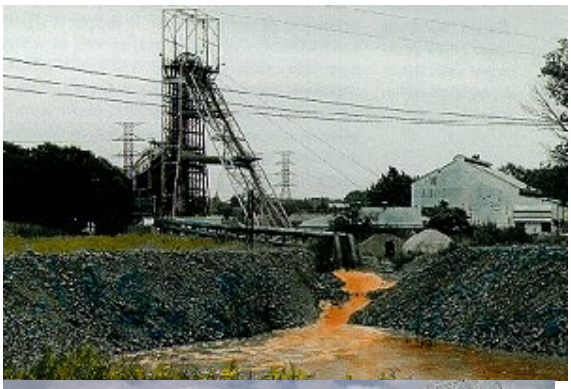
- Water birds in the Ramsar site are counted twice a year and monitoring of the water quality, both chemically and biologically, is conducted by the Department of Water Affairs and Forestry and Rand Water. The quality of Grootvlei's discharge is also closely monitored to ensure it complies with the permitted standards.

Conclusion

The issue of the discharge of water by Grootvlei mine has proven to be highly complex, involving social, economic and political elements. The threat of job and revenue losses following the closure of Grootvlei mine, should it no longer be permitted to discharge into the wetland, has been effectively used at a political level to motivate for the continued discharge of water. It is clearly an issue that will not be easily resolved.

With the increase in development in the Blesbokspruit catchment, it is becoming clear that only an integrated approach to the management of the wetland, which takes into account all major stakeholders, will succeed in restoring and maintaining the ecological character of the wetland. The survival of Blesbokspruit Ramsar site will depend on the sound management of its catchment.

Despite the developments listed above, the primary cause of the degradation of the Ramsar site, Grootvlei mine, is continuing to disharge polluted water into the wetland. As a result, there has been no improvement in the ecological character of the site, and there is thus no reason to consider the removal of Blesbokspruit from the Montreux Record at this time.



Initial discharge of highly polluted water directly to the wetland by Grootvlei mine, December 1995

Current situation. Iron hydroxide-rich water is pumped from underground to a settling facility at the mine

Precipitation of iron compounds and suspended solids in clarifying tanks

Discharge of partially treated mine water to the wetland