7.2 EROSION OF THE OLIFANTSFONTEIN WETLAND AND THE SEDIMENTATION PROBLEM

7.2.1 EROSION AND DEGRADATION OF THE OLIFANTSFONTEIN WETLAND

An environmentally significant portion of the study area is the Olifantsfontein wetland situated downstream of the Olifantsfontein – Midrand Road (R562) along the Kaalspruit *en route* to pass the Olifantsfontein Sewage Works (**Figure 27**). Miller (2002) points out that wetlands are known for their important ecological and economic roles including *inter alia*:

- Providing food and habitats for fish, waterfowl, amphibians, *et cetera*;
- Improving water quality by filtering, diluting and degrading toxic wastes, excess nutrients, sediments and other pollutants;
- Reducing flooding and erosion by absorbing stormwater and releasing it slowly and by absorbing overflows from streams and lakes; and
- Helping replenish stream flows during dry periods.

"Loss of wetlands leads to a reduction or loss in biodiversity as the plants and animals that are adapted to wetland habitats are often unable to adapt to new environmental conditions or move to more suitable ones ..... Loss of water quality and flow regulation may result in greater extent or severity of flooding" (WRC, 2001).

According to George (2003) the Olifantsfontein wetland appears to be the remains of a much larger wetland which is thought to have had a surface area of some 50 ha. Visual observation reveals that the size of the wetland has substantially decreased in size to approximately 10 to 15 ha in extent. It was also determined that the present-day condition of this wetland is not in a condition conducive for the above-mentioned functions i.e. this wetland is not functioning as a true wetland mainly owing to it being drained by the erosion channel which cuts through the centre of it. This erosion channel is large, being 2 km long, 15 to 40 m wide and 3 to 6 m deep (**Figure 28**).

George (2003) believes that the rate of erosion will probably reduce with time, once the river has established a new gradient through the wetland and lateral erosion (channel widening) has extended far enough to accommodate the largest floods albeit that this process is likely to still take a long time.

Figure 28: Olifantsfontein wetland erosion channel

The degradation of this wetland over the past 20 to 25 years was probably brought about by a combination of factors, including:

- Agricultural encroachment of this sensitive area during the past few decades. Negative impacts from this would be water drainage from the area, ploughing, livestock grazing and uncontrolled burning of the surrounding vegetation and reedbeds of the wetland.

- The construction of the Olifantsfontein – Midrand Road bridge across the Kaalspruit. The road bridge is believed by George (2003) to have channeled and concentrated the Kaalspruit stormwater volumes through a restricted part of the wetland resulting in loss of the underlying sediments. Visual observation of the area shows that previous flood channels which probably dissipated the flood volumes over a larger area have been cut-off from the spruit by the construction of the road.

- The higher volume of stormwater augmented from the industrialised area of Clayville, south-east of the wetland via the concrete-lined Clayville tributary. This tributary currently transports collecting run-off from the entire area down to its confluence with the Kaalspruit before entering the wetland. These higher volumes from the industrialised area are different to the flow conditions which pertained prior to urbanisation. Higher stormwater volumes have significantly contributed to the erosion and degradation of the wetland and are currently eroding the Clayville tributary arm of this wetland as well.

- Untreated waste water (see **Figure 11,** p 37) is also released into the Clayville tributary from the industrialised area which ultimately affects the growth of vegetation downstream at the start of the wetland.

- The Kaalspruit's course through the wetland being a 5 to 6 m deep erosion channel (**Figure 28**) has, according to George (2003), lowered the water table in the wetland resulting in the drying-up of the larger wetland.

- Owing to the drier conditions, veld fires are damaging the reedbeds even further.

The vital functions of the wetland have ceased owing to the erosion and degradation of the wetland over the past 20 to 25 years. Another major concern of its erosion is the volume of sediment loads carried downstream from the wetland.

7.2.2 SEDIMENTATION OF THE KAALSPRUIT, OLIFANTSPRUIT AND HENNOPS RIVERS

George (2003) states that: **"The Olifantsfontein wetland erosion channel is the major source of the siltation problems exprerienced on the Kaalspruit and Hennops Rivers."** High sediment volumes have and continue to occur along certain sections of the Kaalspruit, Olifantspruit and Hennops Rivers between the Olifantsfontein wetland and Centurion Lake. **Figure 27** illustrates the degree of siltation of these rivers. The *total annual sediment yield* for the past two decades calculated by George (2003) is between 12 000 and 16 000 m³/a. Of major concern is that an estimated 67 to 75 % of this sediment yield is contributed by the erosion of the Olifantsfontein wetland. The other sources of sediment yield are released from the dolomites and granites in these areas, effluent return flows containing suspended solids from the Olifantsfontein Sewage Works and to a lesser extent erosion of riverbanks.

This problem has had major negative **environmental**, **social** and **economic** impacts especially further downstream in the residential and business areas of Centurion. The main problem concerning the Centurion Lake is that it has become an effective "collecting point" of the sediment loads. George (2003) estimates a *silt trap efficiency* of 75 % for this urban impoundment.

In terms of *environmental* impacts the sedimentation according to George (2003), has filled many of the deep pools and channels with sand and silt in these rivers (**Figure 29**) thereby either destroying or degrading the habitat and life-support systems of fish and invertebrates (see section **2.4**, p 24). As a result animals higher up in the food web such as birds and otters have been negatively impacted upon. Aquatic environments, especially their biota, are negatively affected by sediment loads either in suspension, after deposition or by both as discussed in section **2.4**, p 24.

Figure 29: Olifantspruit at Irene bridge

Social impacts of the sedimentation problem are mostly experienced in the Hennops River and Centurion Lake. Recall that after the confluence of the Sesmylspruit and Olifantspruit, the Hennops River flows through recreational and residential public spaces such as the Irene Country Club, Irene Dairy Farm, Centurion Golf Estate and the Centurion Lake. Sedimentation has affected the aesthetic appeal and intrinsic value of the Hennops River flowing through the golf courses and dairy farm as certain sections are totally silted-up, river degradation is evident and desilting operations raise concerns from visitors to these areas. Additional to this, the 12 km long Hennops hiking trail, starting upstream of the lake and ending at the Zwartkop Lapa, has been hiked by very few people during the past five years.

Studies conducted by George (2003) show that the former Centurion Town Council estimated that after Centurion Lake's construction in 1982 up to the end of 1994 approximately 43 000 m^3 of sediment accumulated in the lake. It can therefore be said that during this period an annual sediment volume of 3 500 m^3 accumulated in it. From December 1994 to April 2000 the amount of sediment deposited in the lake increased to approximately 120 000 m^3 at which point the lake was almost completely silted up as the lake has a volume of 145 000 m^3. The average sediment volume had therefore increased to 12 833 m^3/a and George (2003) believes the volume could even reach 15 000 m^3/a.

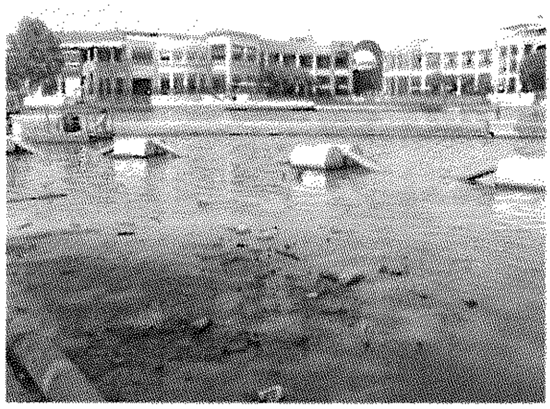

Figure 30: Centurion Lake siltation

Being an affected urban impoundment in the centre of Centurion's CBD, the Centurion Lake has inevitably also had an impact on the social sphere of the environment. As discussed in **Chapter 3,** the lake was constructed in 1982 for aesthetic and recreational purposes. A musical fountain constructed in the middle of the lake attracted large numbers of people during the eighties and nineties to the shopping complex. This attraction no longer exists due to the sedimentation problem. Complaints concerning odours and aesthetics of the lake have also become frequent since the mid-nineties. The number of people utilising the braai facilities on the northern side of the lake has also decreased as it became unpleasant visiting the lake in its deteriorated state. Recreational uses of the lake which included boat cruises, paddle boats, canoeing, windsurfing, rowing, angling and swimming (Freeman *et al.*, 2000) have ceased during the past 15 years due to the lake's water quality and it becoming too shallow in certain areas as sediment loads have gradually filled most of it.

Added to this, the Centurion Mall situated on the southern side of the Centurion Lake has, since March 2003, been upgraded at a cost of R380 million (Du Plessis, 2004)*. The shopping mall presently consists of 90 new shops, including two hotels and 11 restaurants around the lake, which brings the total to 207. According to Du Plessis (2004)* 1,4 million people currently visit the mall per month and before the upgrade the number of people was 800 000. Being the centre of this new upgrade to the already successful Centurion Mall the current status of the Centurion Lake has to be improved such that it is free of sediment volumes. The lake should therefore once again be seen as an asset and attraction to the commercial hub surrounding it.

*Personal communication

Economic impacts borne from the Centurion Lake's sedimentation problem include major expenses needed for its restoration/rehabilitation of the Centurion Lake. As discussed in section **8.4**, p 109 Pienaar (2004) mentions that sediment/silt is continually pumped out of the lake at a cost of R2,5 million per annum. The sediment/silt are conveyed via a pipeline to be deposited in a built silt deposit dam and the costs involved for this amounted to R8,1 million.

Added to this is the fact that investors have been reluctant to invest in projects within the lake's vicinity until improvements were evident. Expenses in the desilting of the Hennops River upstream of the lake have also been needed.

7.3 EROSION OF SECTIONS ALONG THE HENNOPS RIVER AND ITS FEEDER STREAMS

It is seen in the previous section that major erosional activity has taken place in the Olifantsfontein wetland situated along the most downstream section of the Kaalspruit. Visual observations reveal that the Kaalspruit and its smaller tributaries flowing northwards through Birch Acres, Tembisa and surrounding settlements are not affected by riverbed and riverbank erosion. As such, these streams cannot be the source of significant sedimentation taking place further downstream as is confirmed by the study conducted by George (2003).

Downstream of the wetland, along the Olifantspruit, only localised erosion of riverbeds and riverbanks were observed. Erosion of riverbanks are more common along the Hennops River which could increase in time if no action is taken. According to George (2003) once erosion is initiated the erosion process becomes on-going and spreads upstream and downstream from its initial starting point.

The Hennops River's erosion is probably initiated by the increased sediment loads carried downstream from the Olifantsfontein wetland. These sediments cause increased abrasion along certain sections of the Hennops River especially where it bends and where the River is narrow. Furthermore, the Olifantsfontein Sewage Works' return flows to the Olifantspruit *en route* to the Hennops have increased the flow volumes by more than 70 Mℓ/d (see section 3.4.3, p 38) when compared to previous natural conditions. This increased flow of water has eroded and widened sections of the Olifantspruit and Hennops River. It was mentioned in section 7.2.2 that the sewage works also release suspended solids into the river and this would contribute to the erosional activity as well.

Even though the Centurion Lake traps approximately 75 % of sediment loads, erosion of riverbanks and river widening were also observed along sections of the Hennops River downstream of the lake. Since most sediment loads are trapped by the lake the increase in stormwater run-off augmented from Centurion's urbanised areas into the Hennops must be the significant factor of erosional activity taking place. This additional run-off is produced by *inter alia* the watering of gardens, backwashing of pools and leaking water supply lines.

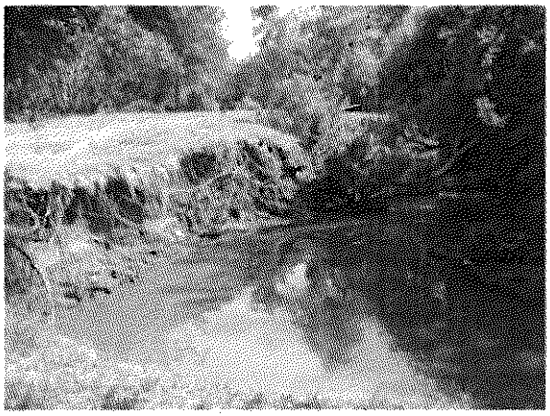

Figure 31: Erosion of riverbank

The researcher is of the opinion that the erosion problem is greater upstream from the lake than sections downstream from it. Undercutting of riparian vegetation and the silting-up of the lake are problems having direct impact on the natural environment, social and economic spheres. The eroded sections downstream from here go unnoticed by most people such as residents in the area. Eroded sections of the Hennops River down to the end of the study area seem to be stabilised and as such, the rate of further erosional activity is low.

These findings are also supported by results of a biomonitoring survey of the Hennops downstream of the Centurion Sewage Works conducted by Niehaus *et al.* (2002) where it was found that *"sediment deposition was low and categorised into a good class. The channel flow status and bank vegetative protection was fair with approximately 70 % of the stream bank surfaces covered by vegetation. Bank stability was good with only small eroded areas on both banks mostly healed over. The riparian vegetative zone was good and human activities have impacted on this zone only minimally".*

7.4 DEBRIS: URBAN LITTER AND VEGETATION

The other significant hydrological problem present in the study area is the large amount of debris present in sections of the Kaalspruit, Olifantspruit and Hennops Rivers. Two categories of debris can be recognised, *viz.*:

- *Urban litter debris* ranging from cans, bottles, plastic bags, clothing, tyres, shopping trolleys including dead animals, and
- *Vegetation debris* comprising largely of branches and trees (**Figure 30**).

A certain amount of this non-point source pollution of *urban litter* is being discarded directly into these rivers but most of it is flushed into them during rains. During dry periods litter collects *inter alia* in streets and stormwater drains from where it is flushed into these rivers especially during the first rains after such periods.

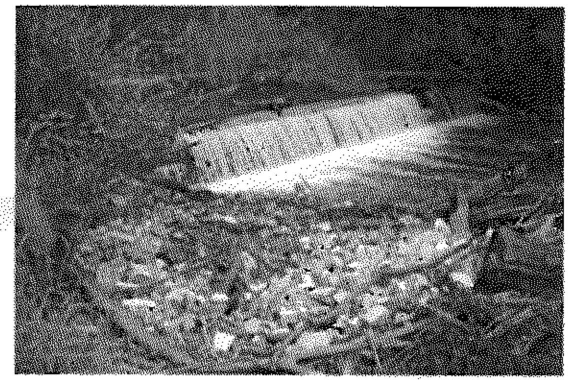

Figure 30: Vegetation and urban litter debris

The Kaalspruit receives urban litter from Tembisa and its surrounding areas due to the lack of proper waste collection, handling and removal services. The Olifantspruit does not receive high amounts of litter except near roadside bridges and gutters flanking the spruit. The Hennops River's urban litter volumes are not as high as the Kaalspruit's but still remain an environmental and social problem. Urban litter is also found along the Hennops where it flows under bridges, busy roads and residential areas – upstream and downstream of the Centurion Lake.

Vegetation debris is found in the Olifantspruit and Hennops River – mostly upstream from the Centurion Lake. The erosion of riverbanks, as discussed in section **7.3**, p 97 also contributes to the undercutting of riparian vegetation resulting in such vegetation to collapse into these rivers. The vegetation ranges from small shrubs and tree branches to larger tree trunks such as *P. canexens*. The problem with vegetation debris is that it accumulates against most obstructions (depending on river flow volumes) such as protruding rocks, river bends, weirs and bridge supporting structures (**Figure 31**). This, in turn, affects the river flow regime and habitat for aquatic biota negatively as river flow is impeded and riverbeds and riverbanks become blocked with debris which limits available space and sunlight needed especially by benthic life forms.

Aesthetically this is also displeasing to residents and visitors to areas such as Irene Village, golf course and dairy farm, the Centurion Lake and residential areas downstream of the lake such as Hennops Park and Clubview. The Hennops River appears deteriorated and in a poor environmental state along certain sections.

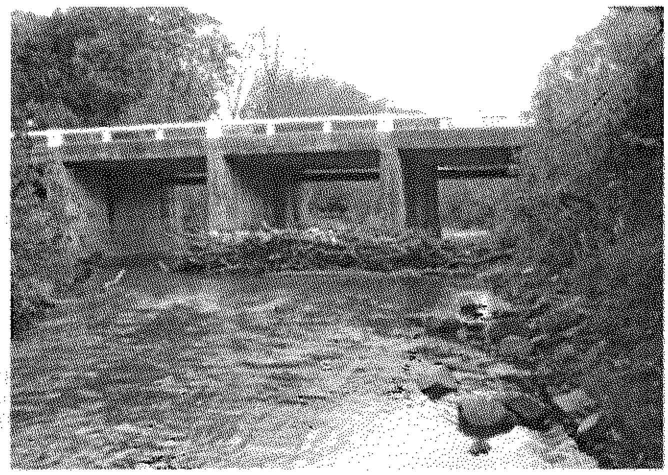

Figure 31: Vegetation and urban litter debris blocked by bridge

7.5 SYNTHESIS OF DISCUSSED HYDROLOGICAL PROBLEMS

It was found that the major hydrological problems experienced in the catchment have been initiated by anthropogenic activity. Rapid urbanisation over the past three decades in the form of informal settlements, industry and business areas as well as formal residential areas have altered the pristine conditions of the study area. As such deterioration of the Hennops River and its feeder streams has been taking place where most of the deterioration is also experienced further downstream as in the case of Centurion Lake.

The most prominent hydrological problem in the study area is the erosion of the Olifantsfontein wetland and its high volume of sediments released. Most of the important functions of this wetland have therefore ceased. The sedimentation problem has, in turn, not only affected aquatic biota in these rivers but has also been a contributing factor in the erosion of riverbeds and riverbanks. This has resulted in the undercutting of riparian vegetation along the banks of the Olifantspruit and Hennops Rivers which in itself is an environmental concern in need of attention.

Another problem negatively impacting the Kaalspruit, Olifantspruit and Hennops Rivers is the increase in urban litter ending up in them. Together with vegetation debris this litter debris is collecting against obstructions in the rivers which not only affects aquatic ecosystems but the social and economic spheres of the environment as well.

What has also been found is that the recreational, residential and business areas of Centurion have been the collecting point of all of these hydrological problems. The Centurion Lake continually receives sediment loads from the upstream rivers. Vegetation and litter debris are also ultimately washed down to Centurion via the Hennops River.

In terms of comparing existing knowledge concerning hydrological problems, findings by Hoffmann (1994) were able to be used. Hoffmann (1994) found that during 1993 and 1994 the Centurion Lake contained 50 % silt (section 4.2.3, p 50). It was believed to be the result of soil run-off from the upper reaches of the catchment *viz.* Tembisa and Ivory Park. Recent work by George (2003) though, reveals that the erosion of the Olifantsfontein wetland is contributing between 67 and 75 % of sediment yield in the Kaalspruit, Olifantspruit and Hennops Rivers. George (2003) also mentions that since December 1994 (i.e. after Hoffmann's study) to April 2000 the amount of sediment deposited in the lake reached 120 000 m^3. This means that the impoundment lost 83 % of its volume to collected sediment which is 33 % more than Hoffmann's estimation of 50 %. It can therefore be said that during the last decade a continual flow of sediment/silt volumes brought down by these rivers has occurred and no improvement to this situation can be proved.

Downstream of the study area the hydrological problems are probably less severe as no significant urbanisation has taken place in these areas. However, changes in the flow regime of the Hennops from the return-flows of Centurion Sewage Works would also pose problems concerning erosion of riverbanks, river widening and undercutting of riparian vegetation.

It was therefore determined that the principal hydrological problems are occurring along the upper sections of the study area and that most of these problems have become issues of concern further downstream especially in the CBD of Centurion. The problems upstream need to be addressed in order to alleviate problems further downstream. For example, the silting-up of Centurion Lake due to the erosion of the Olifantsfontein wetland situated approximately 14 km upstream.

The present status of the Hennops River and its principal tributaries in terms of their water quality and hydrological conditions have been determined. In the chapter to follow rehabilitative

CHAPTER 9: CONCLUSION

As mentioned earlier in the statement of the problem the Hennops River has gradually deteriorated in terms of its water quality and hydrological conditions over the past three decades. This can mainly be attributed to the catchment's position which is situated between Johannesburg and Pretoria within the provincial boundaries of Gauteng – the smallest of South Africa's nine provinces but housing approximately 8,8 million people and regarded as the economic powerhouse of the country. The study area's associated land use, activities and increasing urbanisation taking place negatively affect the Hennops River and its principal tributaries. Moreover, the river system is the responsibility of a number of local authorities, making co-ordinated planning and management difficult.

Owing to the deterioration of the water quality and hydrological conditions of the Hennops River affected parties concerned such as local authorities, residents and business people of Centurion have started considering the Hennops River as a liability instead of the environmental asset with intrinsic values it offers to its surrounding environments. Causes of its deteriorated water quality and hydrological problems needed to be ascertained so that rehabilitative and mitigatory measures could be proposed and it is for this reason that this study was conducted.

As such, this study's main aim was to establish the present water quality condition and hydrological status and condition of the Hennops River. The water's suitability for aquatic ecosystems well-being was also determined as fish mortalities continue to occur in sections of the Hennops and its principal tributaries. These sections include the upper Hennops River and Centurion Lake forming the centre of Centurion's CBD. Once the overarching problems and causes of these were determined and understood, rehabilitative and mitigatory measures were proposed towards the improvement of the water quality and hydrological status.

Before this could be achieved the meaning of water quality, its various physical and chemical constituents affecting aquatic ecosystems and the recommended Target Water Quality Range (TWQR) as stipulated by DWAF for the well-being of these were reviewed and discussed. Added to this, hydrology and its relevance in terms of this study were explained.

The study area also needed to be described. Not only was attention given to the position of the Hennops River and its principal tributaries, but also to the associated physical features and existing land uses within its boundaries. In order to gain insight, understanding and ascertaining the causes of water quality and hydrological problems, it was deemed necessary to describe the study area in detail.

Following this, existing knowledge of previous conditions of the study area was reviewed so that a comparison could be made between previous and existing conditions. It was found that the Hennops River catchment had already experienced deterioration between the 70's and 90's due to factors such as increasing urbanisation, industrialisation and rapid human settlement. Coupled with the fact that the study area is currently experiencing further developments and an increase in human population, the rationale of this is that an improvement in water quality and hydrological conditions of the rivers without implementing rehabilitative measures will not be possible. Therefore, rehabilitative measures need to be implemented.

The existing knowledge of the study area was then compared to the most recent water quality of the study area i.e. the two year period between January 2002 and December 2003. Data in terms of water quality monitoring results were collected from two authorities responsible for monitoring the Hennops River, *viz.*: DWAF and CTMM. Only certain water quality constituents were collected and analysed i.e. those having an effect on aquatic ecosystems (**Table 14**). Since water quality monitoring results would differ along different sections of the Hennops and its principal tributaries, the actual positions of the DWAF and CTMM monitoring points were described with the areas of the study area represented by their monitoring results.

The recent water quality data showed that only certain water quality constituents could be causing debilitating effects on aquatic ecosystems i.e. five out of the ten different water quality constituents showed mean concentrations not complying to the TWQR. These constituents were dissolved oxygen, ammonia, chloride, nitrate and nitrite nitrogen and orthophosphates. As expected, the upstream sections of the study area comprising the formal and informal settlements of *inter alia* Tembisa, Ivory Park and industrial areas of Clayville and Olifantsfontein, had higher mean constituent values than the downstream sections. This can be attributed to the land use and activities present in these areas surrounding the Kaalspruit (**Table 15**).

In terms of comparing the recent water quality data to the data from the past studies, it was concluded that the Hennops River catchment has experienced deterioration in terms of its water quality over the past three decades. The comparison showed that mean constituent concentrations of ammonia, phosphorus, COD and chlorine have increased over the years.

The Hennops River and its principal tributaries, especially the Kaalspruit and Olifantspruit, experience not only water quality problems but additional hydrological problems as well. These problems were dealt with in detail and include typically the erosion of the Olifantsfontein wetland and riverbeds and riverbanks of the Kaalspruit and Hennops River due to the sediments released from the wetland. Furthermore, large amounts of debris are also carried downstream by floodwater flows. This debris consists of urban litter and vegetation debris.

Rehabilitative and mitigatory measures have been proposed. They are aimed at improving the water quality and hydrological problems of the Hennops, Olifantspruit and Kaalspruit Rivers. Measures proposed include the construction of sediment traps and debris traps, the erosion control of riverbeds and riverbanks, rehabilitation of the Olifantsfontein wetland and the construction of another in Centurion.

It is recommended that monitoring of the water quality of the Hennops and principal tributaries continue to be conducted by DWAF and CTMM in order to monitor the state of these rivers on a continual basis. Significant changes in water quality should be investigated to determine causes for this and to address such problems. Furthermore, the situation of the Hennops River system must be one of the more important environmental issues between Johannesburg and Pretoria. Therefore, the situation illustrates the need for rivers (and water management areas) to be managed holistically as opposed to the fragmentalised planning by different local councils and government departments which is currently the scenario. Responsible parties need to formulate and follow an environmental management plan which will address the upstream water quality and associated problems as these in turn are causing problems such as the silting-up of Centurion Lake and the loss of aquatic biota further downstream.

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