New Hope for Troubled Waters: The Hartbeespoort Dam Test Case

Hartbeespoort Dam, photographed from the dam wall. The algae blooms experienced in April last year triggered DWAF's approval of over R1 million for emergency clean-ups, and an investigation into preventative water treatment strategies.

The Department of Water Affairs and Forestry (DWAF) has embarked on a bold new approach towards eutrophication management in South Africa. This move – which will see the much-debated phosphate standard take a back seat to integrated biological solutions – is a decisive step in a whole new direction.

In 2003, Hartbeespoort Dam near Brits suffered some of the worst algae blooms ever experienced in South Africa. While the cause - high phosphate levels - is not unique to the dam, nowhere else in the country, and possibly the world, do these "hyperscums" grow so rapidly or in such vast quantities.

In June last year, *Water Wheel* spoke to Petrus Venter, Deputy Regional Director of Water Resource Management in the North West province, who explained that upstream treatment actions were unable to reverse the conditions at the dam, largely because they failed to tackle the real root of the problem.

"The most successful management approach so far has been the physical removal of the cyanobacterial scum that forms when the blue-green algae rises to the surface and starts rotting," he says. "During the emergency clean-up last April, it took ten days to pump out the bulk of the three hectares of scum that had accumulated along the dam wall. In doing so, we removed about 500 kg worth of phosphate (as P) from the dam."

Although this put an immediate end to the fumes and foul smell that the rotting algae released, the clean-up did little to counteract the actual level of phosphate in the dam water, which is estimated to be about 25 tons (as P) when full. Considering that at least 20 tons of phosphate

flow into the dam through its tributaries each year, the 500 kg removal pales into insignificance. At a cost of about R1 million per ton, physical removal is also clearly not a viable long-term solution.

Venter has, for some time, been pushing for the adoption of an integrated treatment approach, based both on control of phosphate inflow into the dam, and more importantly on biological solutions that will allow the dam's ecosystem to manage algal growth naturally.

Even if current treatment methods could reduce phosphate levels at both point source and in the dam, they don't cater for the sediment phosphate that could be reloaded into the water at any time.

He explains that last year's algae blooms triggered the approval of a R1,2 million budget for the emergency clean-ups. DWAF's Director-General also initiated the formation of an institute by the end of 2003, to focus on preventative-based eutrophication management.

Venter firmly believes that this is the only way to go. "We need to develop a biological solution for what is really a biological problem. The algae blooms are nature's own way of removing excess phosphate from water. Used in isolation, civil controls – such as the phosphate standard – have not, and will not, make a significance difference."

WHY THE PHOSPHATE STANDARD ISN'T WORKING

"Since the 1970s the South African government and local councils have spent in excess of R800 million developing and implementing the phosphate standard specifically to tackle and control this type of problem," explains Venter. "The reality, after 20 to 25 years, is that it has not achieved its goals."

The National Water Act of 1998 includes strict regulations regarding the phosphate levels in water that is released by industry back into South Africa's river system. While most companies in the Hartbeespoort Dam catchment area meet this standard, and although the concentration of phosphate going into the dam has lowered, the phosphate load measured in the dam water is as high as ever. In Venter's 15 years of working there, last year's algae blooms are the worst he has ever seen.

"They also continued right through the winter months, which is very unusual and difficult to explain," says Venter.

"As an isolated approach, the phosphate standard is a global failure. In many countries it is being pushed aside in favour of integrated treatment approaches with a strong biological component. European countries like Finland and the Netherlands have followed this route successfully for a number of years."

And it's not a question of the phosphate standard being too low, adds Venter. The expense of developing and implementing

HOW SERIOUS IS THE PROBLEM?

Phosphate levels at Hartbeespoort Dam are measured both at point source, to establish how much phosphate is flowing in from the tributaries, as well as in the lower levels of the dam water itself.

The measured inflow of phosphate is around 20 tons per year, and the current measured load in the main water body is estimated to be 25 tons. Real inflow levels could be higher, however, as these measurements don't take into account diffused sources, such as storm-water and related sewer blockages.

Additionally, the sediment at the bottom of the dam holds phosphate, which is released when the sediment is disturbed, or in summer when the deeper layers of water become anaerobic (oxygen depleted). This is known as re-loading. Venter warns that Hartbeespoort's sediment could contain as much as 140 tons of phosphate, while the annual load from incoming sediments could be as much as180 tons.

Based on the minimum legal phosphate levels, Venter has calculated that about 200 tons of phosphate are generated by industries in the catchment area each year. "However, historic measurement models are based on incoming water *after* filtration," he says. "If only 20 tons are measured in the water load, then at least 180 tons of phosphate are being carried into the dam by sediment."

In other words, even if current treatment methods could reduce phosphate levels at both point source and in the dam, these methods don't cater for the sediment phosphate that could be reloaded into the water at any time.

"We need to get phosphate levels in the dam down from an average of 0,12 mg/ℓ to less than 0,05 mg/ℓ in order to significantly reduce algae growth ," says Venter. "Reducing the inflow load to ten tons of phosphate per year would be the point at which we'd move away from the current eutrophic state."

In looking at the algae currently accumulating along the Hartbeespoort Dam wall, it is easy to think that one good flood would literally wash the problem away. In fact, it would have the opposite effect. While a flood washes the algae out, it also brings in massive sediment and phosphate, effectively "supercharging" the dam with nutrients.

a revised standard blows this alternative right out of the water. "At the moment, chemical treatment alone costs R4 to R6 million in the catchment area, and upgrading the infrastructure needed to cope with a stricter standard could cost as much as R100 million."

THE WAY FORWARD

Although still in planning stages and subject to the set-up of appropriate financial systems, DWAF plans to follow in Europe's footsteps by implementing biological water management systems in South Africa. Simply put, this means adjusting the biodiversity in a water body to increase the amount of zooplankton, specifically the *Daphnia* water flea and other zooplankton species, which feed on algae. In Hartbeespoort's case it also means removing carp and some species of barbel. These bottom-feeders stir up the nutrient-rich sediment, causing phosphate to be released into the water. The carp also feed on vegetation, destroying the essential habitat of some algae-eating organisms, such as the water flea.

"This combined approach could reduce phosphate levels in Hartbeespoort by as much as 80%," says Venter. "The balance can then be controlled by floating wetlands, which function as natural nutrient filters."

Venter explains that DWAF is investigating how to customise this approach to suit South African conditions. Once achieved, it will form the blueprint for eutrophication management countrywide.

"R2 million has been made available for planning, costing and selection of the best options, which will be tested on a small scale in the first few months of 2004," he says. This all sounds relatively simple, but the Department faces a number of hurdles, not least of which is the R5-R9 million implementation price tag.

"We need to treat the water as it comes into the dam, and then set in place a biological system that can keep these reduced levels in balance," says Venter. "However, there will always be some need for the physical removal of algae. Our current technique isn't very effective in

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Petrus Venter, Deputy Regional Director of Water Resource Management in the North West province. Petrus is spearheading the Department of Water Affair's drive towards biologically-based eutrophication management.

that a great deal of water is pumped out along with the algae. Optimising this pumping system will cost about R1,2 million."

The Department also has to find a way to ring-fence an equal amount for annual maintenance, which theoretically could be generated through tariffs on water users in the area. "If such tariffs were to be implemented, they would have to target the historical polluters, recreational users, local authorities (who currently provide little in the way of other services besides water provision and basic municipal services). Special tariffs could also be implemented on waste discharges that are facilitated by DWAF."

These costs are quickly put into perspective, however, when you consider that each of last year's "emergency clean-ups" cost around R600 000. It is also unlikely that the owners of the multi-million rand homes dotted around the dam, will argue against a minimal tariff if it comes with a sustainable, long-term solution to the dirty waters.

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Venter emphasises, however, that the project is not about preserving the playground of the rich and famous. "Although the economic spin-offs surrounding the dam and its adjacent properties are significant, the vital thing here is that DWAF and the North West province have made a massive commitment to finding a permanent solution - one that will also benefit at least another 12 dams in South Africa with similar water quality problems." Once the system is fully operational, it could also lead to other economic benefits such as commercial fishing and harvesting of floating water plants.