Griffith gets growing

An idea born of necessity looks set to relieve a major environmental headache for Griffith City Council. It may suit the needs of other councils too, writes **Bryony Bennett.**

How many people does it take to grow 1000 tonnes of cereal grain and hay?

On a patch of red-brown earth at Tharbogang, five kilometres west of Griffith, the answer to this question is in the making. The 16-hectare pilot trial area is being laser levelled into irrigation bays, specially designed to receive effluent from the Griffith Sewage Works.

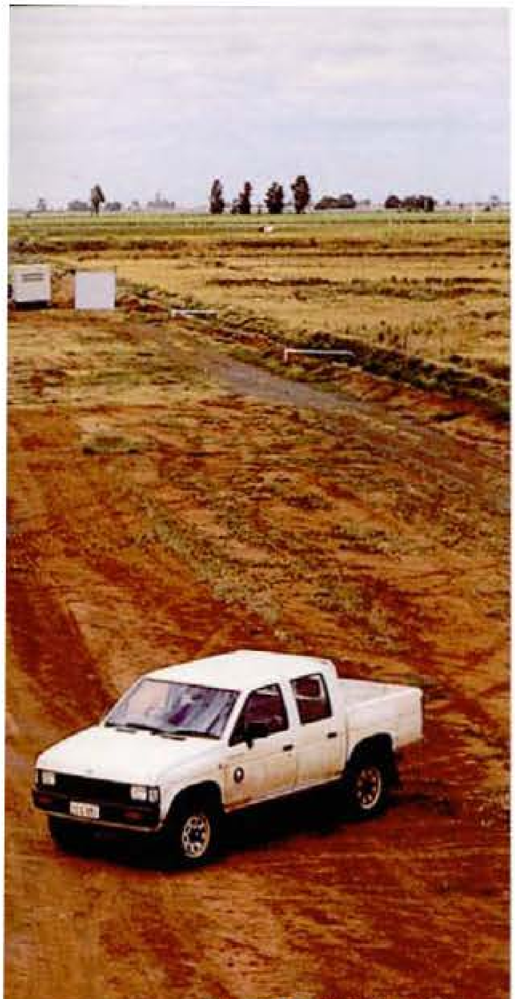
Later this year, the site will become a giant sponge, soaking up nutrients provided by some 18 000 Griffith residents, using a filtration system employing natural soil processes to remove nitrogen and phosphorus from treated sewage effluent.

The system is appropriately named FILTER, short for Filtration and Irrigated Cropping for Land Treatment and Effluent Reuse. Dr Nihal Jayawardane and John Blackwell from CSIRO's Division of Land and Water have led its development, together with director of Engineering Services at Griffith City Council, David Tull.

Sewage effluent discharges are significant sources of nutrient pollution, especially in the Murray River Basin. In 1994, a number of larger towns in country New South Wales were set timetables by the Environment Protection Authority to reduce the levels of phosphorus and nitrogen in water discharged from sewage treatment plants to overland waterways.

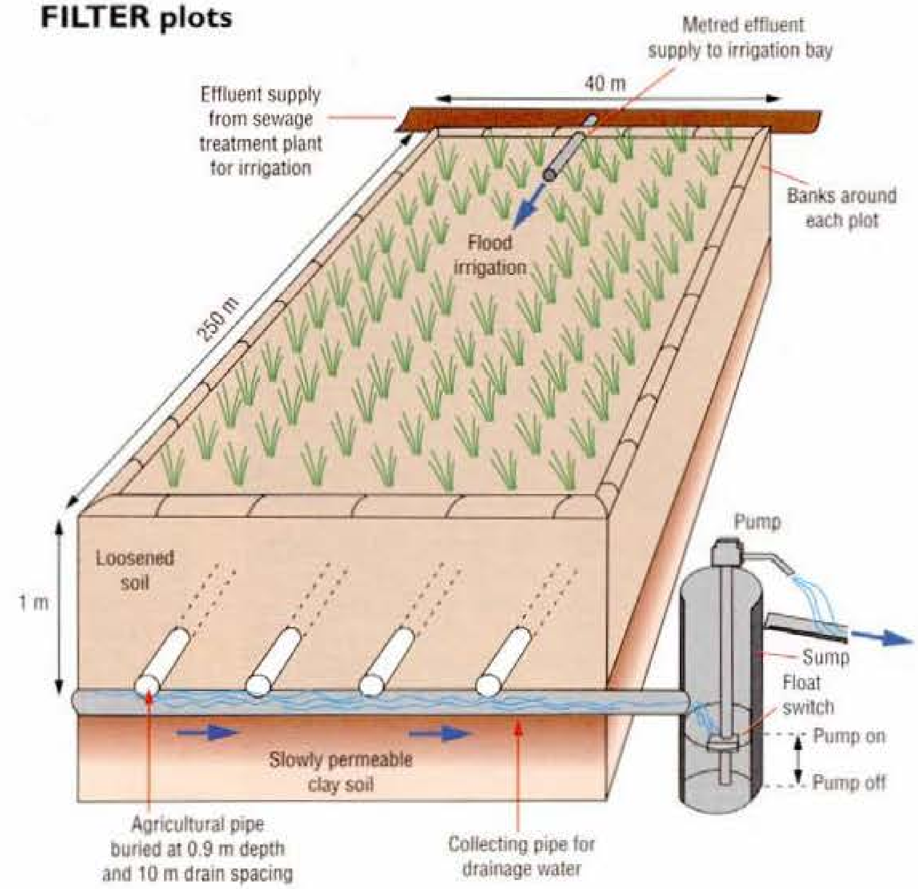
The target set for Griffith was a reduction in phosphorus from 2-8 milligrams per litre to less than 1 mg/L and in nitrogen from about 20 mg/L to less than 15 mg/L by 1999. This would help to reduce nutrient pollution in local waterways, including Mirrool Creek and Barren Box Swamp, the main impoundment for drainage water from the Murrumbidgee Irrigation area. To meet the EPA targets, the council needed a nutrient-removal system that was sustainable and efficient.

Land treatment of sewage effluent, using artificial wetlands, cropping and woodlots, is gaining popularity as a technique for nutrient removal. But



The FILTER system enables fortnightly effluent applications to cereal and pasture crops during summer and winter. Effluent flow through the soil profile, and the level of the watertable, is controlled by a sub-surface drainage network.

FILTER plots



sewage effluent managers in larger urban centres have found such land applications expensive, mainly due to the cost of storing excess effluent during wet weather and winter periods (when crop and pasture growth is slow).

A further obstacle is that on slowly permeable soils, which occur extensively in the urban areas of eastern Australia, effluent irrigation can lead to problems of waterlogging and salinisation. This can reduce crop yields and nutrient removal, inhibiting the long-term sustainability of such sites.

David Tull, wary of these potential difficulties, sought the advice of Jayawardane and Blackwell who were based at CSIRO's Griffith laboratory. They suggested the problems could be overcome by growing crops over a network of sub-surface drains.

A major advantage of the proposed system was that it combined irrigated cropping with filtration of effluent through the soil to a drainage system during periods of low cropping activity. By providing an outlet for excess water, effluent could safely be applied year round, without causing waterlogging or the need for wet-weather storage. Also,

10 good reasons to FILTER

- Based on existing, low-technology proven agricultural practices.
- Reduces land area requirements by more than 50% of the area needed for normal effluent irrigation.
- Expensive winter and wet-weather water storage is eliminated.
- Potential to produce high-yielding cash crops and reuse drainage water.
- Low-value salinised land may be used and ameliorated.
- A nutrient and salt balance is achievable under good management.
- No harmful chemicals are used.
- The high nutrient-buffer capacity of the FILTER system eliminates the need for real time monitoring of effluent to optimise nutrient removal.
- Eliminates pollution from treatment plant by-pass flows and run-off from land application sites.
- FILTER area can be progressively increased to meet gradual increases in annual effluent volumes with urban expansion.

FILTER systems can be designed to meet the site-specific requirements of the wastewater managers, which complement existing primary or secondary treatment systems, to meet future EPA requirements at minimum costs. The feasibility of converting existing effluent irrigation lands to the more intensive FILTER system, to cater for future urban expansion and preventing by-pass flows could also be examined.

Sewage effluent and wastewater managers requiring assistance in evaluating, designing and operating a FILTER system should contact Dr Nihal Jayawardane (06)246 5811, fax (06) 246 5800, email: Nihal.Jayawardane@cbr.dwr.csiro.au.

Griffith City Council has embarked on a commercial-scale trial of the FILTER system. This time the plots will cover 16 hectares, an area sufficient to treat about one eighth of the town's sewage effluent.

the rate of sub-surface drainage could be regulated to ensure adequate nutrient removal, producing water meeting EPA criteria.

Tull liked the concept, so he put it up to council, securing support for field trials at Tharbogang, the effluent-disposal site for the council's Sewage Treatment Works. Further funding has been provided by CSIRO, the New South Wales Department of Land and Water Conservation and the Federal Department of Primary Industries and Energy.

In *1994*, effluent irrigation, drainage and monitoring facilities were installed for eight, one-hectare field plots. The soil was loosened by deep ripping to about one metre, gypsum was added to stabilise the increased soil porosity, and a network of sub-surface drains layed at 10 m intervals and about one metre deep.

During summer and winter growing seasons, fortnightly applications of effluent were made to cereal and pasture crops. Effluent flow through the soil profile, and the level of the watertable, was controlled by the drainage network (by regulated pumping from sumps attached to the drains).

This regulated flow of effluent allowed nutrients to be sorbed on the surface of soil particles, to be taken up by the crop and weeds; or to be lost through volatilisation and denitrification, thereby reducing phosphorus and nitrogen in the drainage waters.

A mixture of grasses was grown for fodder and oat and millet crops were grown for fodder and grain. During the summer cropping trial, three fodder cuts were taken from the pasture, and the millet crops were harvested once for fodder and once for grain and straw. At each harvest, plant samples were collected and analysed for dry matter content, seed weight and nutrient content. Also monitored were soil and water conditions, and the volumes and chemistry of the effluent and drainage water.

Crop dry matter yields (tonnes/ha) during summer and winter cropping

Season	Crop	Yield (tonnes per hectare)
summer (block A)	cereal	10.7
	pasture	12.5
winter (block B)	cereal	6.3
	pasture	4.1

Economic and climatic factors need to be considered in the final choice of a suitable crop. Specific combinations of filtration and cropping phases are site dependent. In some cases, the filtration phase alone may be enough to maintain phosphorus and nitrogen levels below EPA limits. In others, a filtration phase with high hydraulic loading could be followed by a cropping phase with reduced hydraulic loading to remove any nutrients stored in the soil, thereby providing a sustainable system.

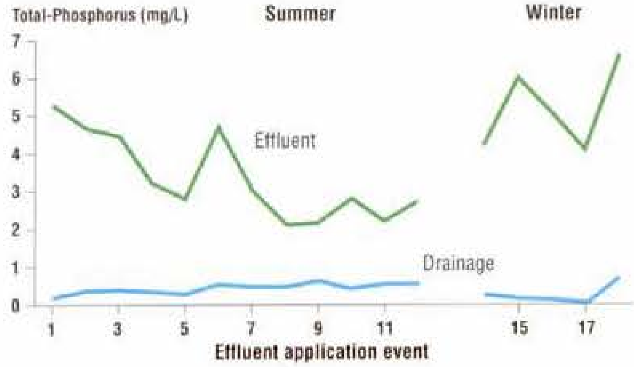
Nutrient levels down

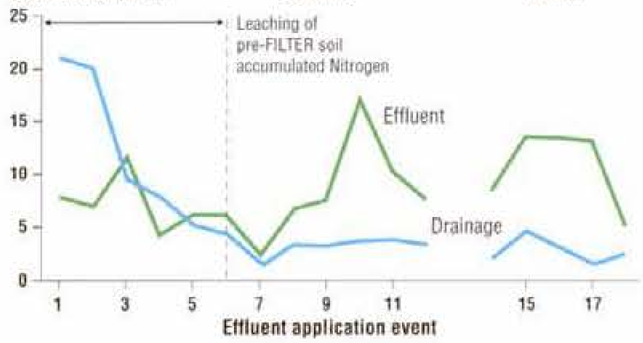
Results of the summer and winter trials showed the FILTER system reduced nutrient levels to below EPA limits, while maintaining high rates of water application. Mean phosphorus concentrations fell by 98%, from 2-6 mg/L (inflow) to less than 0.5 mg/L (outflow). Total nitrogen concentration was reduced by 85%, to less than 5 mg/L. The low nitrogen levels were reached after leaching of nitrate nitrogen which had accumulated in the soil during effluent irrigation before the FILTER plots were installed.

Importantly, the ratio of nitrogen to phosphorus was increased during the FILTER process. Previous studies have indicated that as the N:P ratio falls below 12, the risk of blue-green algae progressively rises.

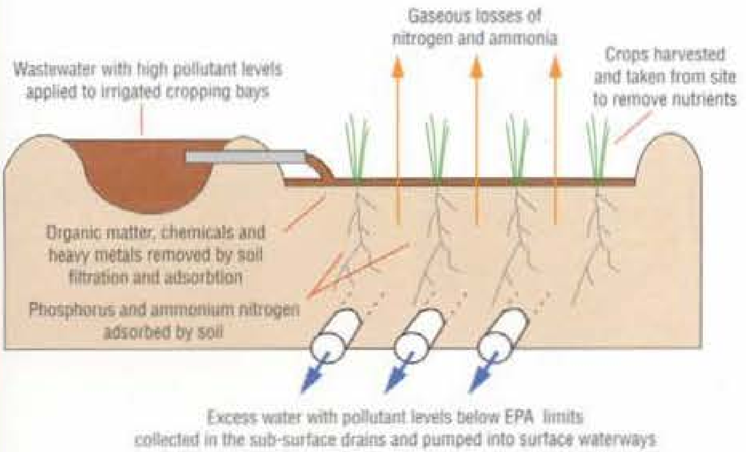
The N:P ratio in the applied effluent was very low, with a mean value of 3 and contained blue-green algae (Mycrocystis). In contrast, the drainage waters were colourless and free of blue-green algae, with a mean N:P ratio of 23. Downstream blue-green algal blooms therefore were much less likely to occur.

Before installing the FILTER system, the site was highly salinised by effluent application and had very poor grass cover. Substantial crop yields from the trial site after establishing the FILTER system indicated that a well-managed commercial operation could offset operating and capital costs (see table). Soil salinity was reduced by leaching of the excess salts through the sub-surface drains.





How the FILTER system removes pollutants



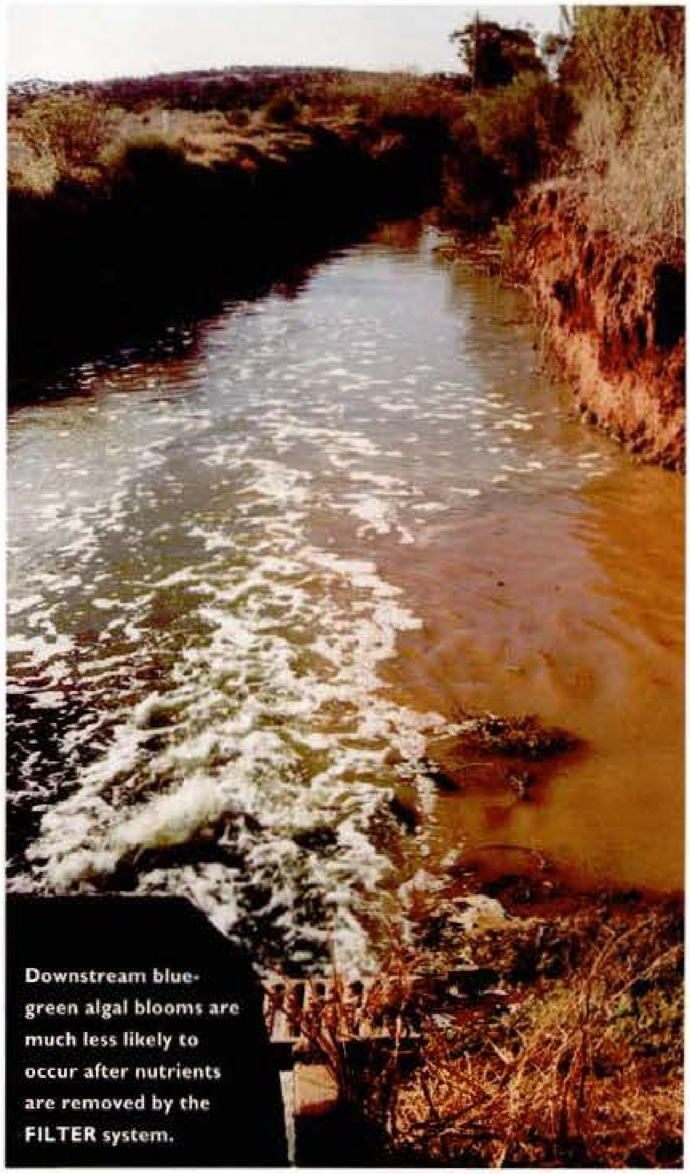
In a separate trial involving spiking the effluent applied with agricultural pesticides, the pesticide loads in drainage waters were reduced by more than 98%. This indicates the FILTER system could be used to clean up pesticide-contaminated run-off from farms, before discharge to streams. FILTER systems could also be modified to treat industrial and commercial effluent containing chemicals and heavy metals which adsorb to soil particles, or even to manage salinity problems in irrigation regions.

An effluent future

Encouraged by the trials' success, Griffith City Council has embarked on a commercial-scale trial of the FILTER system. This time the plots will cover 16 ha of the Tharbogang site, an area sufficient to treat about one eighth of the town's sewage effluent.

If the year-long pilot trial proves successful, the module will be duplicated eight times across the site, in time to meet the EPA's 1999 deadline. With a irrigation rate of 4-8 mm a day on about 100-130 ha, nitrogen and phosphorus from the 4-8 megalitre per day effluent output from the sewage works will be comfortably removed.

The aim of the FILTER project has been to provide a sustainable and economically viable land treatment system to reduce pollutant levels in sewage effluent below EPA limits, on the limited areas of high value land available around urban centres in the high-rainfall areas of Australia. David Tull says the process needs to be optimised during the next trial phase, but believes that in a year's time he will be in a position to promote the system to 'most local governments with a bit of land'.



Downstream blue-green algal blooms are much less likely to occur after nutrients are removed by the FILTER system.

He says the best return on investment from the FILTER system would probably come from operating on a sharefarming basis, but under strict council control. What better way for a farmer to grow 1000 tonnes of cereal grain and hay which, by the way, would probably take one summer with the cooperation of 18 000 Griffith residents. By the year 2000, we'll know for sure.

Rural waste recycled at Poowong

NUTRIENTS in the wastewater from an abattoir in Victoria's Gippsland region are being removed by a simple process developed by CSIRO. Since May, 1996, all the wastewater generated by Poowong Meat Packing Pty Ltd has been safely irrigated to a nearby dairy farm in an operation approved and licensed by the Victorian EPA.

Abattoir effluent normally contains about 250 milligrams per litre of nitrogen and about 40 mg/L of phosphorus. These are essential elements of fertilisers, but when applied in excess, groundwater, pastures and watercourses can all be damaged. Generally, application rates are excessive, and therefore unsuitable unless nutrient levels are reduced.

The EPA aims to reduce the nitrogen and phosphorus content of effluent from rural industries and sewage treatment plants discharging to inland Victorian waters to 10 mg/L and 0.5 mg/L respectively by the year 2000.

This new process uses a mechanically aerated lagoon in conjunction with an anaerobic lagoon to remove 95% of the nitrogen and organic material by bacteria. The nitrogen is removed by a process known as nitrification-denitrification which results in the nitrogen being discharged safely to the atmosphere. About 40% of the phosphorus is also removed, which is sufficient for most irrigation applications.

A major feature of the process is a simple system for disposal of sludge. This is pumped back to the anaerobic lagoon where it is digested by anaerobic bacteria, eliminating day-to-day sludge handling.

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