Case Study: Camp Somerset- sewage effluent irrigation in a sensitive environment

Summary
MEDLI model simulations were used to consider water and nutrient balances as part of an effluent disposal plan for a holiday camp situated in a sensitive area. Measures adopted to reduce potential off-site movements of nutrient include sub-surface irrigation emitters, vetiver grass, and interception drains for trickle flows.

To date, monitoring indicates that the site is performing to specification. Accumulations of salt and nutrient have been noted in drought periods when both leaching and plant growth were reduced. One conclusion is that performance of effluent disposal areas must be assessed within the context of prevailing weather and plant growth.

Introduction
Camp Somerset is situated on a 340 ha property on the eastern side of Somerset Dam in SE Queensland. It is owned and leased by the Australian Conference Association, and is used for church youth and family cabin and bush camping activities, for camps for the disabled, and for activities under the Duke of Edinburgh Award Scheme. Accommodation is available for up to 130 people in a ridge-top complex. Sewage from this complex is initially treated using an *Enviroflow Biofilter* system. Secondary-treated effluent is then used to irrigate landscaped gardens, with a mix of trees, shrubs and grass, on the ridge top area.

Because of the environmental sensitivity of the effluent disposal area (close to a major water supply storage) movements of nutrients and pollutants off-site must be maintained at negligible levels for Environmental Licensing purposes.

Design of the effluent management system
The ridge top area close to the accommodation was chosen for irrigation because it was not subject to run-on and flooding, and because the water table was at least 60 m below the ground surface at this elevated position. The irrigation area was divided into 7 zones, with 18 KL of effluent to be applied to one zone daily on a rotational basis (expected daily volume of effluent when the camp is at peak occupancy). The irrigation schedule for peak occupancy is equivalent to about 13 mm irrigation per week, or 660 mm/yr - an average irrigation requirement for a sub-humid climate. Special irrigation strategies were developed for periods of dry and wet weather, and low occupancy.

The software package MEDLI was used to assess the capacity of the proposed irrigation area to use the amount of water and nutrients supplied in effluent. Two failsafe strategies were incorporated in the design plan to minimise any off-site effects from seepage and nutrient or sediment movement:

- Rows of Vetiver grass were planted on the slope around the irrigation area to control sediment movement and to take up any nutrients in lateral seepage.
- A drain was planned to carry the initial flow and trickle flow from runoff and seepage, which would contain the majority of any nutrients transported off-site, and direct it into a storage dam. The drain was designed to capture 5mm runoff per day.

Analysis with the GLEAMS model showed that this drain would not only collect the initial runoff, and any interflow following rainfall, but it would also capture the total runoff from 60% of runoff events. Runoff from larger events is directed into the drainage system associated with a road surrounding the ridge top complex.

The major concern with effluent irrigation at this site is transport of nutrients off-site in runoff. Subsurface irrigation emitters were installed so that surface runoff could not be directly contaminated by effluent irrigation. Off-site movement of nutrients from applied effluent can then only occur if prolonged ponding on the less permeable B horizon in the soil profile causes the ponded water to mix with surface runoff *via* lateral seepage. Use of subsurface emitters allows irrigation during rainfall, but management procedures stipulate that irrigation must cease when ponding develops on the clay layer of the soil. Ponding is monitored using piezometers inserted into the top of the B-horizon. Effluent produced during these periods must be stored until irrigation can resume.

Wet-weather storage: Because the site is steep, there is no potential to build large wet weather storages, and for that reason, the ability to irrigate during rainfall is important. For normal day-to-day operation, effluent from the *Enviroflow Biofilter* is stored in a 45KL tank prior to irrigation. Additional storage of effluent was planned using three interlocked 18 KL tanks. In combination, the day-to-day and wet-weather storages (99 KL) have the capacity to store 5.5 days of effluent production at full capacity.

Analysis of infiltration into the soil, and examination of long-term climate records, showed only one occasion in the last 100 years when irrigation would not have been possible for three consecutive days due to persistent ponding on the B-horizon. There were no occasions where irrigation would have been impossible for 4 consecutive days. Therefore, 3 days wet weather storage, with an additional 2.5 days buffer through day-to-day storage, is regarded as sufficient. In the unlikely event that storage is exceeded, effluent can be pumped to the storage dam used to intercept part of the storm water runoff, and a range of other management responses have been identified.

Sustainable soil P life: One concern is that P added in effluent will eventually saturate the soil and P will be lost in drainage water or runoff. The ability of soil to adsorb P was assessed using a P-adsorption isotherm which showed that the soil at Camp Somerset could strongly adsorb about 2800 kg P / ha in the top 0.5 m soil. Using the design inputs of 660 mm/ yr effluent containing 8 mg P /L, and neglecting plant uptake, a "sustainable soil P life" of about 50 years was calculated. This value was re-calculated after effluent irrigation commenced, on the basis of 400 mm/yr hydraulic loading and 3 mg P /L (a P loading of 12 kg P/yr), giving a value of about 230 years if based on peak occupancy all year (which is unlikely).

The P loading of 12 kg P/yr is similar to expected plant uptake of P. Therefore, if grass clippings and shrub trimmings are removed from the site (as recommended in the Environmental Management Plan), P accumulation in the soil should be minimal.

Performance to date:

At this stage (2003) accommodation for 130 people has been constructed. In the long term, cabins will be built to house 250 people at one time, but bookings will be managed to ensure that long-term average occupancy does not exceed 130. Effluent irrigation has been carried out for over 4 years, and the Vetiver barrier has been planted. The drain to carry the initial flow and trickle flow from rainfall runoff is being installed.

As part of compliance with the EPA license, a 2-yearly soil monitoring program has begun, with measurements made prior to commencement of effluent application in 1998, and subsequently in 2000 and 2002. Accumulation of both salt and exchangeable sodium has occurred, but salt levels are not sufficient to affect plant growth. Levels of exchangeable sodium in the surface soil are unlikely to affect soil hydraulic conductivity as vegetative cover is high and the soil is undisturbed. However, chloride levels in the soil profile in 2002 increased significantly compared with 2000.

The relative increase in chloride in 2002 is explained by the low rainfall over the previous 2-year period, and by an increase in the amount of effluent applied as the camp development progressed, so that the salt loading from effluent increased at the same time as the total water application, and hence salt leaching, decreased.

The dry period in 2000-2002 also resulted in increased N and P in the soil profile. During this dry period, losses of N by denitrification (which requires wet conditions) would have been reduced, and uptake of both N and P by plants would have been reduced by water stress. The accumulation of both salts and nutrients is likely to be reversed under wetter conditions. In prolonged dry conditions, supplementary irrigation in addition to effluent irrigation, may be needed to leach salts and maintain plant growth.

The general message for compliance monitoring of effluent land application projects is that soil conditions can vary greatly due to differences in weather, and consequently, differences in salt leaching and plant growth. Monitoring procedures cannot consider the soil in isolation; climate and plant growth must also be taken into account.

Conclusion:

Like all effluent disposal activities, a major requirement for this site was to develop an effluent reuse strategy appropriate to the site, its resources, and the limitations imposed by the surrounding area. The “design” developed is defined as much by the management system prepared as by the physical attributes of the area irrigated and the methods employed.

Close liaison with site staff has been important in achieving successful and environmentally sound performance.

Effluent disposal area – gardens and lawn

Vetiver rows planted to prevent lateral movement of nutrients

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