Environmental Impacts of Municipal Effluent Re-use in Armidale NSW

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ENVIRONMENTAL IMPACTS OF MUNICIPAL EFFLUENT RE-USE IN ARMIDALE NSW

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Abstract

In 2004, Armidale Dumaresq Council (ADC) submitted an Environmental Management Plan (EMP) to the then Environment Protection Authority (now Depart. Environment, Climate Change and Water) as a requirement for identifying the potential environmental outcome from irrigating pastures and crops with effluent from the Armidale Sewage Treatment Works (STW). As part of the EMP, objectives and targets were set for soil and water parameters, with the aim to plan, monitor and manage a sustainable re-use enterprise. These targets included: (1) increases in soil carbon of 0.2% per year to 3% and maintain; (2) identify sources of organic matter low in phosphorus and zinc; and (3) develop a long term nutrient budget for each irrigation paddock to define possible application rates of biosolids and effluent.

Armidale STW is a wholly biological system, no chemical additives during treatment or post-treatment, receiving wastewater from an urban population of about 23 000, diverting effluent to 10 ha of maturation ponds and biosolids to four lagoons. Monthly monitoring and reporting of effluent quality from three discharge points are requirements of ADC's environment protection licence (EPL No. 1722) while irrigation onto each of 14 paddocks (accounting for 137 ha) is recorded daily. In four paddocks centre pivot irrigators are set up, two paddocks share a towable centre pivot and the remainder are irrigated with towed portable irrigators.

The two properties owned and operated by ADC as the re-use scheme are separated by a Commissioners Waters, a tributary of the Macleay River. Effluent not re-used is discharged to this river and annual load-based licence fees apply to the nutrient loads. The management of the irrigation system aims to minimise the discharge by maximising utilisation of effluent on 137 ha. Sale of fodder (oats, sorghum, lucerne) and cattle supplement the cost of the re-use scheme, while savings are made in load-based licence fees through reduced loads discharged to the river.

Soils are mostly Kurosols developed on sediments with thin, acid loam surface soil, generally a gravelly A2 varying in depth to 300 mm, over a more strongly acid light to medium clay variously coloured from yellow to red. One paddock has a small area of Vertosol in a drainage depression. Under previous farming conditions, cation exchange capacity was low, organic matter severely depleted by decades of over-grazing, and plant nutrient status was low, reflected by poor pasture cover and low carrying capacity. The initial stages of the re-use program required rehabilitation of the pastures and cropping areas, overseen by an agronomist.

Each year since 2004, A and B horizons have been monitored at 18 dedicated environmental management areas (EMA) with a view to identifying the likely soil impacts with respect to nutrients and possible contaminants, particularly salinity and sodicity. Soil nutrient deficiencies are identified and passed to a consultant agronomist for action. The nature of the wastewater from Armidale is mainly domestic and commercial without contaminants from industry. Average analysis of the irrigated effluent in 2008/09 was pH 7.91, EC 0.613 dS/m, sodium adsorption ratio 2.5, nitrogen 7.53 mg/L, phosphorus 7.15 mg/L.

Very low levels of trace elements are typical of Armidale's wastewater quality, although copper and zinc from domestic sources are typically elevated in biosolids.

Surface soils are collected from each EMA as 30 cores (25 x100 mm deep), composited and sub-sampled for analysis. The top 100 mm of the B horizon is sampled at three sites within each EMA, the samples composited and sub-sampled for analysis. Lanfax Laboratories conducts the soil sampling and analysis using methods set out in Rayment & Higginson (1992). An annual soil reported is prepared as part of the EPL's annual return and used for management planning.

In 2008, a licence amendment was granted to monitor the B horizon every three years instead of annually. Changes to the monitored parameters over five periods have been minor and it was accepted that observations over three years were sufficient. As an example, on the Vertosol B horizon soil pH_{Ca} changed over 5.40 to 5.49, $EC_{1:5}$ 0.053 to 0.065 dS/m and ESP from 4.6 to 6.2. On a Kurosol under two crops per year pH_{Ca} changed from 5.16 to 5.64, $EC_{1:5}$ from 0.030 to 0.029 dS/m and ESP from 9.9 to 9.3. These were in years of below average rain.

After the annual report and review of performance of 2008/09, a similar application was made for a licence amendment for the surface soil. Changes in the Vertosol A horizon soil pH_{Ca} changed over 5.27 to 5.52, $EC_{1:5}$ 0.110 to 0.106 dS/m, organic carbon 3.00 to 2.75% and ESP from 4.3 to 3.5. On the same Kurosol under double-cropping, the A horizon pH_{Ca} changed from 5.34 to 5.64, $EC_{1:5}$ from 0.134 to 0.100 dS/m, organic carbon1.7 to 1.4% and ESP from 8.8 to 8.4. ESP levels are generally low because of low calcium and magnesium.

Overall, the annual addition of nutrients from effluent on the 40 ha lucerne (Vertosol) and the removal of crops left a deficit of 150 kg N/ha, 56 kg K/ha and an excess of 14.7 kg P/ha. On the double crop paddock, the nitrogen deficit of 160 kg N/ha, 52 kg K/ha and an addition of 14.2 kg P/ha. While the nitrogen is boosted with urea and the potassium with potash, the additions do not compensate for the losses. Biosolids, with N and P levels around 2%, give some additional N but at the expense of an unnecessary addition of P. The phosphorus sorption capacity of the soil is accommodating these additions. Unfortunately, the production of biosolids over the last few years was insufficient to meet the demand for additional nutrients and organic matter to top-dress some of the previously neglected paddocks. Biosolids are used judiciously.

The current outcome of the six years of effluent re-use from the Armidale STW is that considering the annual removal of nutrients in cattle and fodder, the application of nutrients from the effluent and biosolids, together with chemical fertiliser is not resulting in a measureable loss of soil fertility. There has been a slow building of reserves in some nutrients, particularly phosphorus. Increases in soil carbon have been below expectation but plant density is now high.

Currently available phosphorus is moderate. At the current rate of 40% effluent re-use, additional irrigation is limited by the land available for hydraulic loadings rather than nutrient loadings. The budget calculations for a deficiency in potassium are not being seen in the crops although the deficit of nitrogen on the oats and sorghum requires urea applications. Phosphorus loads exceed demands but soil P sorption has a reserve capacity calculated beyond 100 years.

The environmental benefits to Commissioners Waters by re-using 600 ML/yr of municipal effluent is also a benefit to the community through the re-use project, maximising the use of the water and nutrients to grow crops, fodder and cattle sold into local markets.

References

Rayment & Higginson 1992, *Australian Laboratory Handbook of Soil and Water Chemical Methods*, Inkata Press. Melbourne.