CONCURRENT SESSION

RURAL ISSUES

EFFLUENT DISPOSAL - THE SODIUM FACTOR

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INTRODUCTION

Septic tanks provide more than 2 million Australian households with an effective, if not efficient, means of removing household domestic wastes away from the living area. Their continued construction in rural residentialand fringe urban ares acclaims the communities ready acceptance of septic tanks as something more than a stop gap measure. It is estimated that 130,000 dwellings connected to reticulated mains water in New South Wales rely upon septic tanks to dispose of their household wastewater (Bureau of Statistics, 1987) while a further 120,000 septic systems rely upon rainwater inputs.

Aerated wastewater treatment systems (AWTS) are becoming more commonly accepted as an effective means of treating and disposing of the domestic wastewater other than through sub-surface disposal fields (or trenches). While the solid particles may be greatly reduced and chemical treatment of bacterial populations performed, sodium salts pass through the system completely unaffected. All common sodium salts are highly soluble and cannot be preapitated from solution.

Municipal sewage treatment systems combine a number of engineering principles to treat a community's gross wastewater. In a similar manner, sodium slats pass through the system, in some cases concentrated because of the effects of evaporation over large surface areas in treatment lagoons. Finally, however, the treated wastewater is disposed of either back to the river system or through a reuse project. Unfortunately the detrimental effects of these sodium rich waters are overlooked.

This paper will address some of the misconceptions of treated domestic effluent and the effects of sodium in the environmental disposal of the final product.

While the problems of high nitrogen, phosphorus and bacterial populations are similar for sub-surface and surface disposal from septic tanks, aerated systems, and municipal sewage treatment works outflows, only the sodium factor will be treated here.

CURRENT AUSTRALIAN RESEARCH

Most of the research into the disposal of septic tank effluent has been lifted from the United States. Few projects have looked at the reasons for failure and assumed an under-designed length of disposal trench based upon hydraulic loadings. Similarly aerated wastewater treatment systems are designed upon the disposal of clean water rather than sodium rich water

Research work being undertaken by post graduates at Sydney University has investigated aerated treatment systems, predominantly with respect to nitrogen and phosphorus. Similarly, work on re-use projects by CSIRO and others, particularly in light of the cyanobacteria (blue-green algae) outbreaks has not adequately addressed the effects of sodium on re-use and disposal.

The author is currently researching the soil absorption and treatment of septic tank effluent as part of a Doctor of Philosophy thesis. The thrust of that research encompasses the effects of high sodium absorption ratios in all wastewater, whether single dwelling or community based.

CURRENT EFFLUENT DISPOSAL

Sodium Factor

The majority of septic tank effluent disposal problems stem from the inability of the soil profile to adequately dissipate the water away from the trench. This results in the effluent surfacing at some point along the trench or blocking the flor of effluent from the tank in which case the overflow occurs at the tank.

In the case of aerated wastewater treatment systems, loss of infiltrative capacity under sprinkler systems, or death of vegetation has not been identified as related to the chemistry of the wastewater, in particular to the sodium adsorption ratio.

Re-use projects commonly monitor the chemistry of the treated water, in terms of bacterial contamination, residual chlorine, nitrogen and phosphorus. Few projects monitor the effects of high sodium adsorption ratios even though annual sodium budgets are more than ten times the phosphorus loadings. Hydraulic loadings are often the determinant in design of re-use systems, particularly in wetland systems.

PERCOLATION TESTS

The information available to Local Government bodies suggests that the standard percolation test (Department of Public Health, 1961; Victoria Health Commission, 193 and AS 1547) should be employed for the design of sub-surface disposal trenches. No percolation test makes mention of soil structural stability, impervious horizons or duplex soil profiles. One criterion that each test has in common is that the water used for the test is clean water. While the test may give some indication of the clean water percolation of the soil, it does not account for the cations within the septic tank effluent which may have a deleterious effect upon the infiltrative capaaty of the soil.

The hydraulic conductivity of the soil may be greatly reduced by the presence of sodium ions within the effluent. The sodium ions increase the dispersion of the clay colloids causing a physical blocking of the micropores within the soil. This physical blocking is irreversible through the use of hydrogen peroxide, gypsum or other chemicals. The effects of the sodium ions can be further exacerbated by the ammonium ions in the effluent (from the partial nitrigication of organic materials).

It has been shown by a number of researchers that the ratio of the sodium ions to the calcium and magnesium ions (Sodium Adsorption Ratio) can be related to the potential for a water to affect the hydraulic conductivity of a soil. This is more particular for a soil already high in sodium (high exchangeable sodium percentage) and exacerbated by low electrical conductivity.

Research undertaken by the author (Patterson, 1989; 1991) has quantified the changes in hydraulic conductivity for a number of soils, with levels of SAR common in septic tank effluent. All soils tested reflected a significant decrease in infiltration with sodium rich water. This reduction will occur in both sub-soils and surface soils, thus affecting both traditional drainfields, aerated wastewater treatment plants and land disposal re-use options.

Data will be presented which indicates the change in hydraulic conductivity (infiltration) of a grey brown podzolic (duplex) with three simulated septic lank effluents. A typical septic tank effluent with a rainwater input has an outflow SAR in the order of SAR 8. This indicates a reduction of effluent infiltration compared with rainwater infiltration in the sub-surface horizon by twenty five times (100 to 4mm/day). Similar results have been obtained on a range of soils and indicate the lack of correlation between rainwater and effluent in percolation tests.

Reticulated Water Supplies

Many reticulated water supplies throughoutnorthern New South Wales have SARs at levels where dispersion of soil colloids may occur from infiltration of treated water through the soil. Without any additional sodium contribution from soaps, laundry detergents or human diet, these waters are unsuitable for traditional drainfield disposal. Thus variability in soil percolation tests will result from the chemistry of the treated water supply.

Sodium Increments from Domestic Usage

A survey of a number of sewage treatment works was undertaken to indicate the increase in sodium ion concentrations consistent with urban usage. Graphical data will be presented to indicate the input water from a treated reticulated supply and the oufflow from the final treatment pond. As all sodium salts, there is no mechanism fro removal of the offending sodium ions. Sodium adsorption ratios (SAR) greater than 3 to 5 have the potential for soil dispersion. These values, whiie lower than septic tank effluent reflect the alteration of water quality through domestic consumption.

The potential impact of the higher SARs is on both the river system and the soil disposal field in re-use projects. As loading rates equivalent to 5 tonnes per hectare of common salt are typical, many systems exceed that annual dosing rate. Thus salinity is of concern in one area but not in sewage disposal options.

Laundry Detergents

The largest single contribution to sodium ions in domestic effluent is from laundry detergents. Sodium salts are used because of their high solubility and are generally not a problem where wastewater is disposed of to ocean outfalls. Where outfalls are to clean river systems, wetlands or soil absorption, the potential for sodium problems is significantly increased.

Some branks of laundry powder contain more than 40% of the contents as sodium sulphate, used as a filler and of dubious value in wash performance. Where septic tank effluent is to be disposed of by sub-soil infiltration, selection of low sodium detergents should have a high priority. Unfortunately, this information is not readily available for the cdnsumer. The author has examined 41 popular brands and concluded that only five are suitable for septic tanks.

FUTURE DIRECTIONS

That septic tanks will continue to be an important part of both rural and peru-urban developments cannot be overstated. The problems assodated with disposal of septic tank and aerated wastewater treatment system effluent will continue while ever there is little or no education of the home owners, poor standard trench dimensions with respect to soil type and lack of understanding by local authorities of the specific effects of sodium upon that soil.

Similar problems will become apparent after aerated wastewater treatment systems continue to dispose of their effluent on the same soil environment. Re-use projects must address the sodium factor to ensure the long term viability of expensive disposal systems.

The effects of sodium on the majority of Australian soils is underrated in most guidelines for the disposal of wastewaters to a soil profile. The exchangeable sodium percentage at which Australian soils tend to disperse is as low as 6 units (Northcote and Skene, 1971) while American soil scientists use 15 as a cut off.

Other statutory authority guidelines fail to differentiate between clean water and sodium rich water in determining hydraulic conductivity in percolation tests. Until acknowledgment is made of the contribution of sodium ions to soil dispersion, the failure of traditional drainfields will continue.

CONCLUSIONS

The need for the effects of sodium upon soils used for the disposal of wastewaters cannot be too highly stressed. Whether the effluent id disposed of to sub-surface (absorption) trenches or the surface soils (irrigation), the effects of sodium salts on hydraulic conductivity are pronounced.

In quantifying wastewaters for disposal to a soil it is imperative that both the exchangeable sodium percentage (ESP of the soil) and the sodium adsorption ratio (SAR of the wastewater) are clearly indicated. Where either the ESP or SAR are unsuitable, amelioration either of the effluent or the soil will be required. In any circumstances soil percolation tests using clean water are unsuitable and will inevitably lead to incorrect designs.

Solutions to the above disposal problems are achievable within simple economic terms. However, a holistic approach by a number of government instrumentalities is required for guidance of homeowners for the benefit of sustainable wastewater disposal.

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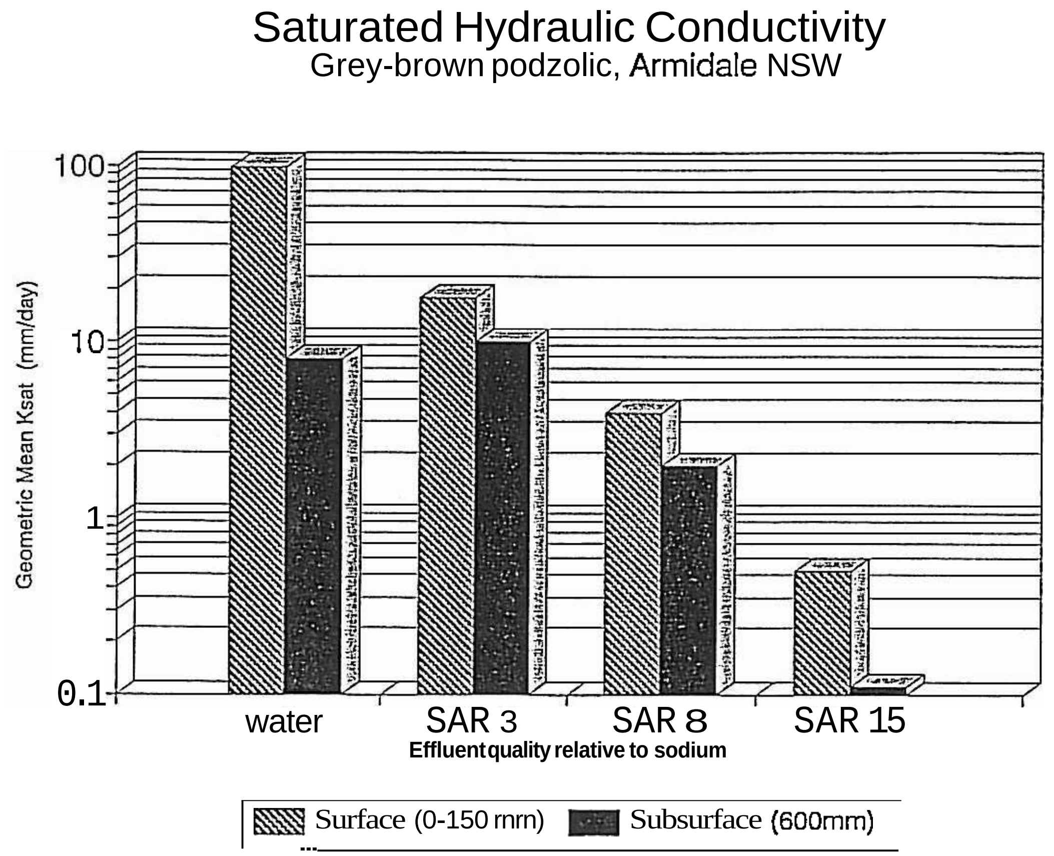

Figure 1. Loss of infiltration capacity with increasing SAR

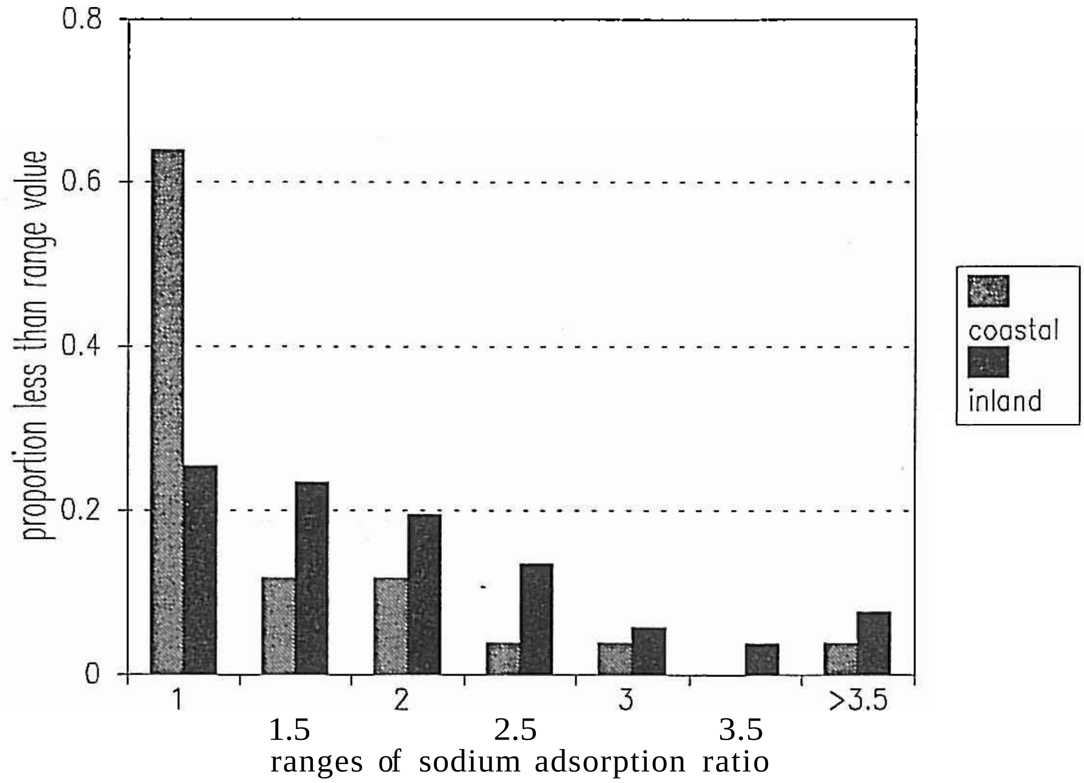

Figure 2. Range of SAR in reticulated town water supplies (NSW)

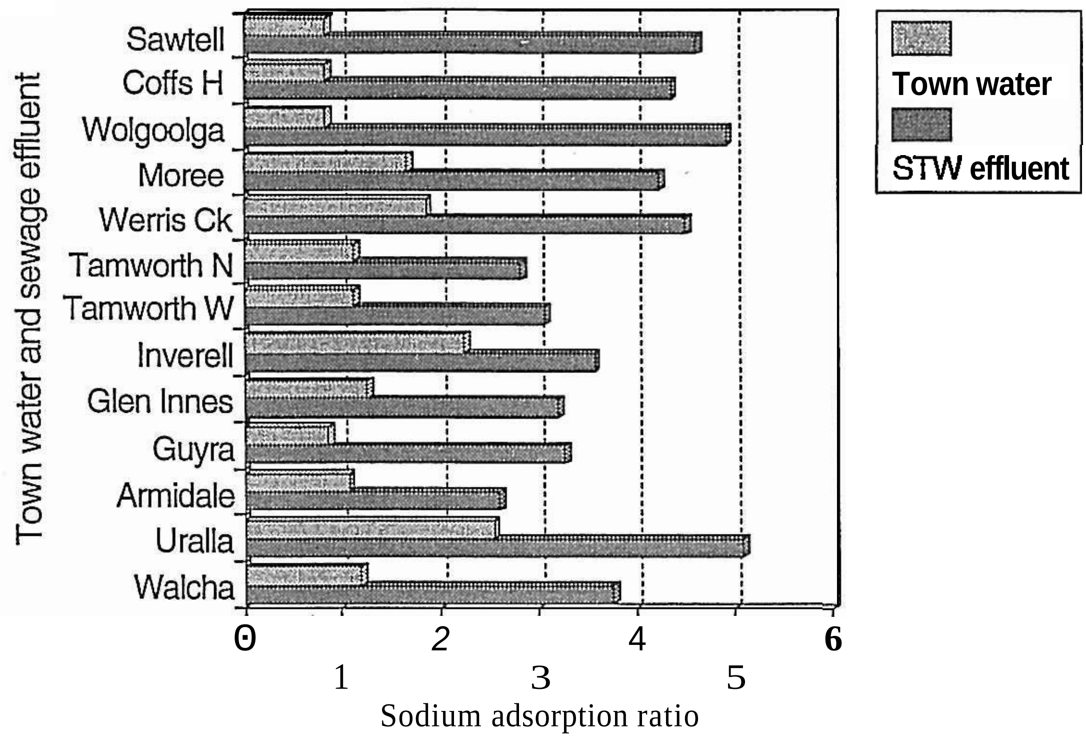

Figure 3. Change of SAR in selected towns due to urban consumption

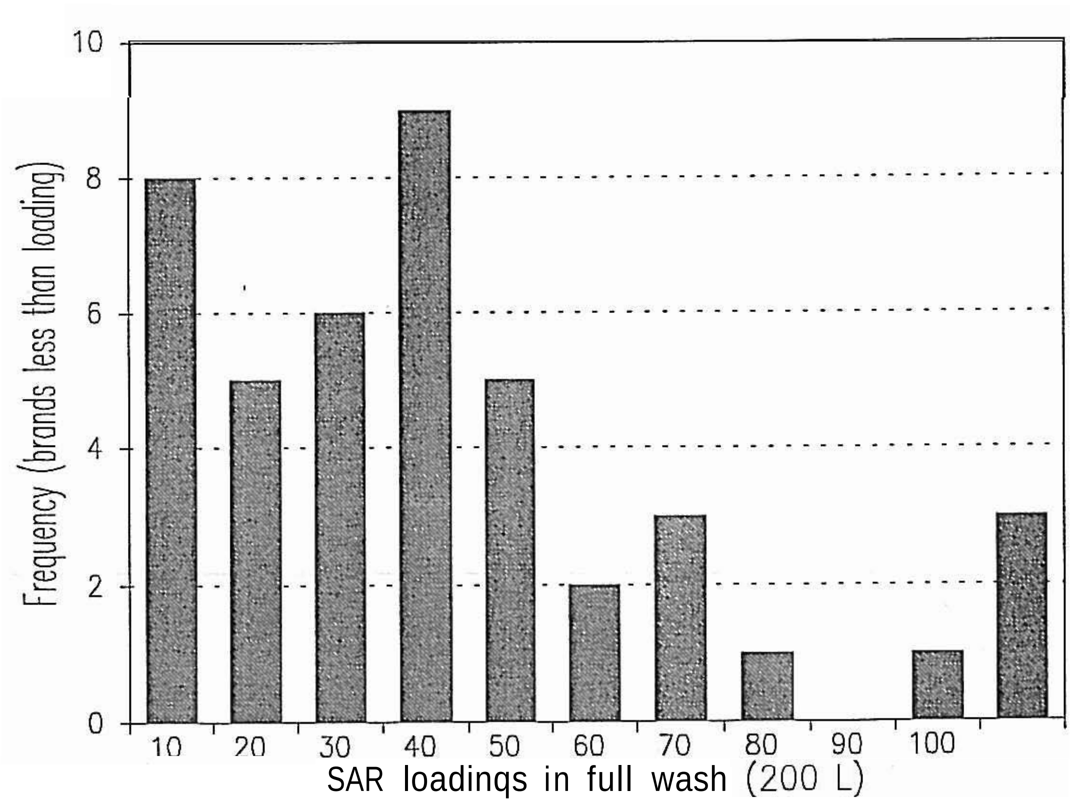

Figure 4. Frequency distribution of popular brands of laundry detergents.