# A Resident's Role in Minimising Nitrogen, Phosphorus and Salt in Domestic Wastewater

Robert A. Patterson

*Lanfax Laboratories Armidale*

*presented as an oral paper to*

Tenth National Symposium on Individual and Small Community Sewage Systems Proceedings.

American Society of Agricultural Engineers

**Reference:** Patterson, R.A. (2004) A resident's role in minimising nitrogen, phosphorus and salt in domestic wastewater. in *Tenth National Symposium on Individual and Small Community Sewage Systems Proceedings,* Kyle R. Mankin (Ed) held in Sacramento, California March 21-24, 2004. American Society of Agricultural Engineers pp 740-749.



*Phone +61 2 6775 1157 Website www.lanfaxlabs.com.au*

*(Page layout may vary slightly from that printed in the proceedings)*

# A RESIDENT'S ROLE IN MINIMISING NITROGEN, PHOSPHORUS AND SALT IN DOMESTIC WASTEWATER

R.A. PATTERSON[1]

## ABSTRACT

The fate of nutrients in domestic wastewater systems cannot be left to the environment to assimilate and neutralise while the residents bear no responsibility for the quality and quantity of the waste-water they generate. Other than the quality of the input water, that may be rainwater, treated water from a reticulated supply or groundwater, all other chemicals and solids are the result of activities within the house and, therefore, able to be controlled or modified by changes in individual and household behaviour.

This project reviewed the various chemical inputs to the wastewater stream from the toilet, kitchen, bathroom and laundry and examined various methods for reducing their entry into the wastewater stream. While some approaches required the conscious behaviour of each member of the household, others could be manipulated during the weekly shopping trip and changes in purchasing strategies. The concentrations of nitrogen, phosphorus and salts can be reduced through simple, inexpensive activities. The replacement of sink strainers with micro-strainers, removal of in-sink garbage grinders, collecting and composting of food scraps, and the recycling of cooking oils will reduce the solids and nutrient loading on the primary treatment system.

A review of one hundred laundry detergents, cleaning agents and kitchen products was carried out to rank the contribution each made to the wastewater concentration of nitrogen, phosphorus and salts. Through education of the broader community and the changes to product labelling codes to reflect the environmental benefits of informed choices, much of the excess chemical load can be reduced. Most of the benefits can be gained at no additional cost, at no change of convenience or lifestyle and at significant benefit to the environment, but product manufacturers beware!

**KEYWORDS.** laundry detergents, nitrogen, phosphorus, sodicity, sodium, wastewater chemistry

## Introduction

Emphasis on hydraulic loading of on-site wastewater systems fails to account for nutrient overloading of subsoil or the effects of chemicals, such as sodium, on soil physical properties. Soil hydraulic failure exacerbates nutrient release into the wider environment and necessitates source reduction of nutrients to lower the risk of contamination from occasional hydraulic overloads. In most Australian states, considerably more stringent regulations are now in place for the collection, treatment and land application of domestic wastewater that require the tenants to be more responsible for on-site wastewater management and local authorities more vigilant in their regulatory role. However, there has been a general failure to change the behaviour of the residents through education about methods to improve the quality of wastewater discharged from their premises. This failure is almost universal for on-site systems and most municipal systems alike.

[1] Practising Soil Scientist and Environmental Engineer. Lanfax Laboratories Armidale NSW Australia

Where soils are unable to provide adequate treatment to prevent nitrogen and phosphorus leaving the site and mixing with groundwater or surface water, additional pretreatment is required. These additional works are often a considerable cost to the homeowner and routine maintenance an on-going financial burden. It is time now to consider source reduction of chemicals as part of the holistic approach to wastewater management.

The plethora of regulations, by-laws, design manuals, computer modelling packages, risk analysis assessment and training of professionals mostly by-passes the propagators of the majority of the problems. While professionally sound assessments lead to the design of reliable and low risk systems, these good intentions can be obliterated by any one or a series of ignorant actions within the house. Without being derogatory to the residents, much of their behaviour can be traced back to the 'advertising gurus' who forward sell many of the chemical problems without the requisite warnings of likely effects on on-site systems. Of all the chemicals that end up in the primary treatment tank, whether a septic tank or the first chamber of an aerated wastewater treatment system, these chemicals were once displayed prominently on the supermarket shelves. Although the community may be concerned about the consequences of plastic shopping bags, little if any attention is paid to the supermarket products they transport to the home.

This paper examines a range of common household chemicals in each of the discharges to the domestic wastewater system. While many questions are raised about the consequences of these various chemical loadings, the answers are complex and avoidance or source reductions may be a more preferable option than methods of treating this chemical soup. Technologically complex treatment systems fail to account for the effects of chemicals on the soil environment in much the same way that septic systems cannot cope with soluble compounds. Treatment is not the answer, avoidance and reduction are.

## CHEMICAL INPUTS TO DOMESTIC WASTEWATER

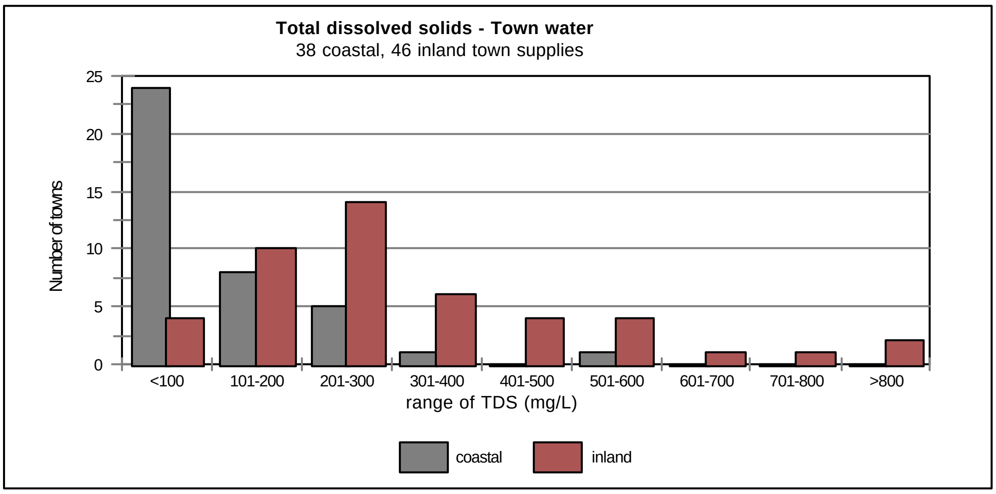
### The Clean Water Source

An often overlooked source of chemical input is the potable water resource available to the house. Whether the supply is from rainwater collected on rooftop areas and stored in plastic, concrete or galvanised tanks, from reticulated town water supplies or groundwater resources, each has the potential to input a variety of chemicals, some of which may impinge upon the soil's physical properties. Rainwater is often the most chemically clean if electrical conductivity (EC) is used as a measure of total dissolved solids (TDS). It is assumed that during storage, solids from roof top and atmosphere will settle to the bottom of the tank and sparkling clean water will be pumped to the house for consumption. Rainwater typically is <10 mg/L TDS but its impact on fluctuations of wastewater quality may be considerable. It is often more convenient to discuss TDS with the general public, and APHA (1995) provides a range of conversions of EC to TDS[2], while Rayment & Higginson (1992) suggest a single factor (680), 0.1 dS/m becomes 68 mg/L TDS.

The reticulated potable water supply also varies with catchment characteristics, and the impact of the town water supply on the overall chemistry of the domestic wastewater may be significant. Figure 1 shows the variation in total dissolved solids for 39 coastal and 46 inland towns in eastern Australia. The inland regions, away from the influence of the Pacific Ocean, have high TDS because of the lower rainfall compared to coastal areas and the higher salt content due to evaporation on the catchment that brings groundwater salts to the surface. The immediate difference is that the TDS of the effluent will reflect the TDS of the potable water supply. If these salts are dominated by sodium, the effect on the soil's structural stability may be severe even before the addition of chemicals from internal uses.

[2] To convert EC to TDS, multiply EC in dS/m by 680 (range 550 – 900), answer in mg/L TDS

Groundwater from springs, wells or bores is generally used to supplement rainwater supplies during dry periods, especially when the water is hard (high calcium and magnesium) or has high sulphur content. The quality of groundwater varies considerably, depending upon the geology of the aquifer from which it is sourced. From data collected by Patterson (1994 and 2001) for 98 groundwater samples, the basalt aquifers generally had TDS in the range of 220 to 2650 mg/L



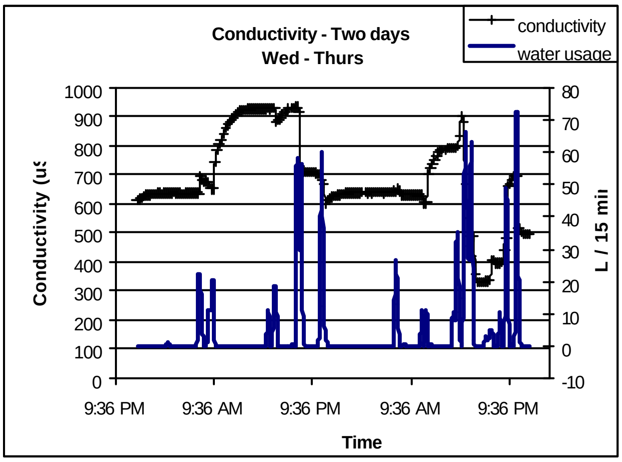

(median 982 mg/L). High levels were due to the calcium and magnesium, while sodium is generally low. Granite aquifers ranged from 135 to 1870 mg/L (median 860 mg/L) TDS with sodium variable according to the type and abundance of feldspars present in the parent rock. Sediments were also highly variable in TDS at 34 to 2418 mg/L (median 360 mg/L). It would be unreasonable to simply assume the quality of groundwater without analysing the specific water that will be used in the home as a supplement for rainwater or town water. Thus, the quality of wastewater will be the cumulative effect of the input water quality and the effects of chemical use within the home.

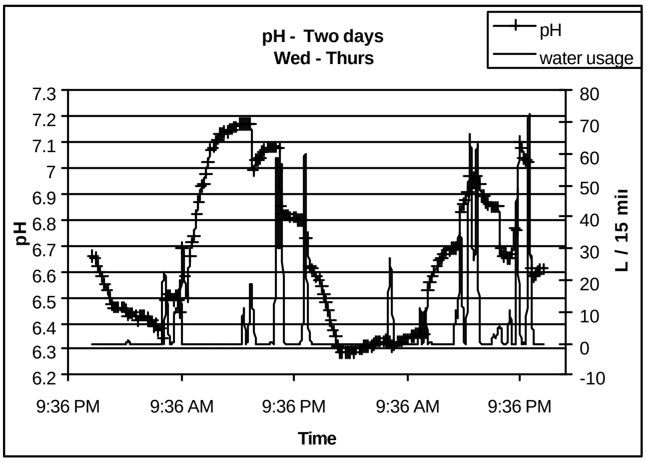
**Figure 1. Frequency distribution of hardness in town water supplies.**

## Water Conservation

Water conservation without a proportional reduction in the use of chemicals, particularly those that have a detrimental impact on soil structural stability and plant growth (such as sodium) may be as great an environmental problem as excessive use of water. For example, replacement of a top loading washing machine using 160 L water per wash with a front loading washing machine using 80 L per wash will have no impact upon chemical loads unless the laundry detergent is also reduced by 50%. In an examination of several major brands of laundry detergents, the recommended quantities of powders and liquids were the same for a front loader compared to a top loading washing machines, thus the potential negative impact of water conservation is greater with front loading washing machines than top loaders due to the higher concentration of salts and higher pH. Details are provided under Laundry Chemicals, and in Table 3.

In a recent project, Patterson (2003) monitored a number of septic tanks at 15 minute intervals over 14 days for pH, EC, redox and temperature. Figure 2 shows the water use for each interval for two days: on Day 1 normal household activities included toilet flushing, kitchen duties and personal ablutions generating 350 L wastewater; and Day 2 a load of washing was done at 3 pm and the dishwasher activated at 6.30 pm and normal personal ablutions making 506 L wastewater.




**Figures 2a and 2b. Daily water use for household of three adults, washing and non-washing days**

The quantity of water passing to the septic tank is highly variable and arrives in discrete doses as shown in Figure 2, rather than in a constant stream, thus changes to the effluent chemistry may be extreme rather than gradual. Figure 2a shows the 15-minute changes to EC from chemicals used within the house, including the effect of large volumes of relatively low EC rainwater. Figure 2b shows the changes to pH as a result of the same activities, chemical inputs causing the increases and relatively clean volumes of rainwater lowering pH. At any one time, a sample taken from the septic tank may not be representative of the long-term average quality of the effluent.

Other water conservation practices such as low-flow shower-heads, and 6/3 L flush toilets may have the reverse effect of increasing concentrations, although having no effect upon total loads. However, lower water use means that the effluent cannot be spread as widely should it contain elements that need broadcasting over large areas to dissipate a negative impact on soil or plants.

Environmental considerations of effective water conservation need to be balanced against a concomitant reduction in chemical use within the home.

## Chemicals in the Kitchen

The chemical load added to the wastewater stream from the kitchen comes from two sources: the preparation of food and the chemicals used for dishwashing and other cleaning chores. A perusal of any kitchen cupboard will reveal the range of cleaning products widely used in everyday activities within the home, many marked ***toxic, keep out of reach of children, if swallowed seek medical advice, highly flammable*** and other warnings of their hazardous contents. While strong acids and strong alkalis are not uncommon as drain cleaners, oven cleaners and metal brighteners, other common products may also have a pH outside the range of 6-8 that is considered safe for humans. In Australia, there is no “Safe in Septics” guidance for manufacturers or consumers, hence the unregulated sale and purchase of many products that are likely to interfere with the effective operation of a septic tank or the soil around the leach drain. With no guidance, consumers are at the mercy of clever advertising and the interactions of all these chemicals would confuse the most experienced chemists. To suggest that dilution cures many of the hazards is simply ignoring the problem as many of the chemicals are based upon sodium, because sodium salts are highly soluble, yet sodium is detrimental to both soil structural stability and plant osmotic potential.

As an example, four brands of dishwashing detergents were each mixed at the manufacturer’s recommended rate with a volume of water equivalent to the volume used in a complete washing cycle (30L) and analysed for various parameters (Table 1). It is obvious that the pH of each automatic dishwasher detergent is *hazardous* while the levels of phosphorus in two are very high, and the three powders are high in sodium.

**Table 1. Comparison of automatic dishwashing powders and hand dishwashing liquid.**

| Brand | type | pH | EC (dS/m) | P (mg/L) | Na (mg/L) |
|---|---|---|---|---|---|
| auto dishwashing 1 | powder | 11.6 | 1.260 | 41 | 220 |
| auto dishwashing 2 | powder | 10.9 | 1.850 | 89 | 440 |
| auto dishwashing 3 | powder | 10.9 | 1.450 | 0.17 | 376 |
| hand dishwashing | liquid | 5.8 | 0.048 | 0.11 | 15 |

The potential effects of these wastewater qualities on the soil will determine whether discharge of greywater from the kitchen directly to the soil is a reasonable approach. Among the brands studied, only the hand-dishwashing detergent would be acceptable for soil dispersal. The other products have too high salinity and sodicity values and can be classified as hazardous.

Some of the other chemicals in general use include borax (boric acid) as a cleaning agent to dissolve grease, act as a mild antiseptic and remove odours. While boron is a micronutrient, its availability in soil is reduced with increasing pH and is lowest between pH 7 and 9 (Brady, 1990). The alkaline cleaning agents may increase boron deficiency in plants rather than solve a deficiency. Other nutrients are also affected by the increasing alkalinity from detergents.

Many of the products used in the kitchen are poorly labelled and often give no indication as to the chemical constituents they contain. For example, a general anti-bacterial cleaner Pine-O-Cleen™ states that its active ingredient is benzalkonium chloride 0.1% w/w. That means that 999 mL of each litre of Pine-O-Cleen™ is a mixture of undisclosed chemicals. What is the effect of these undisclosed chemicals on persons or the wastewater treatment system? A rust and scale remover CLR™ has 41.4 g/L sulphamic acid (a very strong acid) but the label does not identify the chemicals in the other 958.8 g/L of the liquid contents.

Unfortunately, it is not possible for an environmentally conscious resident to remain well informed about the chemicals that are in general use around the home and, therefore, the impact on the septic tank's contents is almost impossible to predict, even to the extent of introducing hazardous substances or hazardous mixtures into the wastewater.

Foodscraps in the Kitchen

When vegetables are washed, peeled, diced or otherwise prepared for the family meal, scraps and small pieces are flushed down the sink. After vegetables have been cooked, the unwanted cooking water that contains many of the inorganic and organic chemicals from the vegetables is mostly disposed of down the sink, perhaps only in winter is some used in soups. These chemicals add to the concoction of other chemicals in the septic tank. While these additions are highly variable, minor alternative practices can prevent many of the scraps entering the system. Retro-fitting a small sieve (less than $2) into the sink to replace the standard series of 12 mm holes can provide better separation at source. The food scraps and organic wastes are better dealt with as compost inputs rather than wastewater additives. Garbage grinders should be banned from all systems, both on-site and municipal, because they divert an easily compostable waste into a difficult wastewater treatment exercise, adding excessive organic load to the system that can be removed at source.

Table 2 provides a range of values of nitrogen, phosphorus and salts in common vegetables. Of interest is the high nitrate content of the green leafy vegetables, a contradiction to the concern over nitrate in drinking water limited to 10 mg N/L. The reduction of nitrogen and phosphorus in domestic wastewater can, therefore, be achieved by preventing food scraps from entering the system, providing better separation during food preparation and better removal of food residues from plates before dishwashing. These scraps are ideal inputs to compost bins or worm farms.

**Table 2. Chemical composition of some common vegetables (after Reuter & Robinson, 1997).**

| Vegetable at eating stage | Nitrogen (%-N) | Nitrate mg/N kg | Phosphorus mg P/kg | Sodium mg Na/kg |
|---|---|---|---|---|
| Asparagus | 3.5 – 3.6 | 5000 | 0.16 | 0.01 – 0.26 |
| Green Beans | 3.1 (pods) 4.5 seeds | 4000 | 0.3 | 0.04 – 0.33 |
| Beetroot | 3.5 – 5.0 | | 0.25 – 0.30 | 3 – 10 |
| Broccoli | 5.6 – 6.1 | 6000 – 11000 | 0.8 – 1.1 | |
| Brussels Sprouts | 2.2 – 4.2 | 9000 | 0.26 – 0.45 | 0.1 – 0.2 |
| Carrots | 0.85 – 0.95 | 5000 – 7500 | 0.3 – 0.4 | 0.66 – 4.50 |
| Celery | 4.0 – 5.0 | 9000 | 0.64 – 0.90 | 0.4 – 0.8 |
| Lettuce (head) | 4.0 – 4.5 | 6000 | 0.4 – 0.6 | 0.02 – 0.20 |
| Potato (60 mm tuber) | 5.3 – 6.6 | 10000 – 16000 | 0.37 – 0.45 | 0.04 – 0.1 |
| Tomato | 3.4 – 3.8 | 2900 | 0.7 – 0.75 | 0.4 |

1% = 10 000 mg/kg

L'Hirondel & L'Hirondel (2002) quoted various references showing that in USA 87% of the nitrate of the human diet came from vegetables, compared with 60% for the UK and 78% for France, the remainder coming from water. It is obvious from the data presented in Table 2 that significant amounts of nitrate-N and total N are consumed as part of our normal diet. The effect of 10 mg N/L from about 3 L of water per day human consumption is a minor component of our nitrogen intake. Since 90% of all protein is excreted in urine and 10% in faeces, eventually all the nitrogen consumed in food will end in the wastewater. However, it is unlikely that reduction in nitrogen or phosphorus in wastewater can be achieved from changes to diet, and this paper does not advocate a change from a diet with an adequate level of protein and vegetables.

Other dietary sources of nitrogen, phosphorus and salt also result in significant input to the wastewater system. Food acid 380 (phosphoric acid) is noted on the label of Coca-Cola™ while phosphates are widely used as emulsifiers in the preparation of processed foods. Nitrates and particularly ammonium salts are used as acidity regulators, thickeners and stabilisers. Preventing offcuts, scraps and crumbs of food entering the wastewater is a positive approach.

Greases and Oils

Fats, oils and some waxes are natural esters of long-chain organic acids. Although they do not contribute either nitrogen or phosphorus to the wastewater, they are often associated with the residues from cooking vegetables that do contain nitrogen and/or phosphorus.

Modern cooking oils are derivatives of vegetable products, replacing the solid fats and lards derived from animals. Peanut, cotton seed, olive, and safflower oils are liquids at normal ambient temperatures and their removal as a solidified skin on the surface of wastewater cannot be accomplished in the same way that animal greases solidify at normal air temperatures. Grease traps are mostly ineffective for a domestic dwelling. Modern dishwashing detergents retain the grease and oil in a miscible form that will pass through a conventional grease trap with very little removal. With a knowledge of this behaviour of oils, the residents must divert waste oil to compost or other organic waste recycling rather than deposition in the wastewater stream.

The Bathroom Solutions

Other than the residues of perspiration and other bodily excreted products, any cosmetic, deodorant, talcum powder or other personal products will also enter the wastewater stream during showering or bathing. Some of these products will also be washed from clothes.

Hair, skin, and sweat are protein rich organics that add to the nitrogen input to the wastewater stream, however, other than preventing hair from entering the drainage system these contributions to the overall nitrogen load are small.

Various chemicals find their way into the bathroom through not only the products we use in the bath, shower or handbasin, but also the products used for personal hygiene and beautification. One anti-dandruff product readily available is Selsun™ which has a selenium salt as its active ingredient. Selenium is a hazardous element, yet its use as a general product is not regulated.

A label on sorbelene lotion (a body moisturiser and cleanser) stated its ingredients as: *De-ionised water, glycerine, sorbitol, light mineral oil, cetyl stearyl alcohol, stearic acid, triethanolamine, wheat germ oil, cetamacrogol, imidazolidinyl urea, methyl paraben, tetrasodium EDTA and paracresol.* It is beyond the realms of ordinary citizens to even pronounce many of these chemicals let alone understand what effect they may have on the wastewater, particularly when used in conjunction with other chemicals.

A brand of toothpaste has an active ingredient of 0.76% w/w sodium monofluorophosphate. What is the other 99.24% that we regularly trust with the inside of our mouth? The active ingredient of an anti-rash talcum powder is 250 mg/g (25%) zinc oxide. What is the effect of this metal in the wastewater?

These simple questions about the suitability of many of the products we so willingly purchase, use and then wash into the wastewater system need to be answered whether for an on-site system or a municipal treatment works.

## Laundry Chemicals

As discussed under water conservation, there was no reduction in the amount of detergent recommended for four major brands when the smaller water volume of a front loading washing machine is used. Table 3 shows the four brands and the recommended dose for those brands. Packaging within each brand of liquid was identical (containers same shape with same size lid that doubles as the measuring device), only the label differed indicating its suited machine type. In the last two years there has been a move towards packaging for either top loaders or front loaders with the details on the pack rarely giving doses to both types. There is often a recommended 50% increase in dose from normal loads to large loads and hard water. Obviously the consumer has some knowledge of these terms, and expected to adjust chemical use accordingly.

The terms *biodegradable*, *low phosphorus* and *safe in septics* are common advertising terms used to encourage purchase by the conservation minded. Unfortunately many of these statements fail to draw one's attention to the high pH, high EC and sodicity of the powders. True, many of the products will not adversely affect the operation of a septic tank, the effect being most pronounced in the receiving soil.

**Table 3. Comparison of amounts of detergent for top and front loading washing machines.**

| Brand of detergent | Machine type | Normal loads | Large loads/hard water |
|---|---|---|---|
| Omo High performance concentrated powder | top loading | 1 scoop | 1 ½ scoops |
| Omo Matic concentrated powder | front loading | 1 scoop | 1 ½ scoops |
| Omo High performance powder | top loading | ¾ cup | 1 ¼ cups |
| Omo Matic powder | front loading | ¾ cup | 1 ¼ cups |
| Dynamo Liquid | top loading | 100 mL cap | 1 ½ caps |
| Dynamo Matic Liquid | front loading | 100 mL cap | 1 ½ caps |
| Omo High Performance Liquid | top loading | 90 mL cap | 1 ½ caps |
| Omo Matic liquid | front loading | 90 mL cap | 1 ½ caps |

It can be seen from Table 3 that the lower volume of water for the front loader will result in a higher concentration of salts in the wastewater and where both sodium and phosphorus are present, these elements will be in higher concentrations. Sodium in higher concentrations is likely to have a serious negative impact upon the soil and reuse of laundry greywater from a front loader could not be recommended. Other considerations of pH and sodium adsorption ratio (SAR) have yet to be determined for the latest products.

Liquid bleaches based upon 40 g/L available chlorine as sodium hypochlorite (NaOCl) are slowly being replaced by powder bleaches based upon 15-32% W/W sodium perborate ($NaBO_3.4H_2O$). The exact proportion of active ingredients varies with price, the lower priced bleaches containing less active agent. Advertising on the packaging, such as "*reduces germs on contact by 99.9%*' and "*safe in septic tanks*" are obviously in conflict. The question which needs to be asked "What are the other ingredients in these products?" and how do they impinge upon the chemical load. The potential for a bleach to 'kill-off' beneficial bacteria is high. A liquid bleach (Marvo-Linn™) at the recommended dose of 2/3 cup (165 mL) for a top loading is equivalent to 3.3 mg/L available chlorine, well in excess of what is required to maintain water at a drinking water standard.

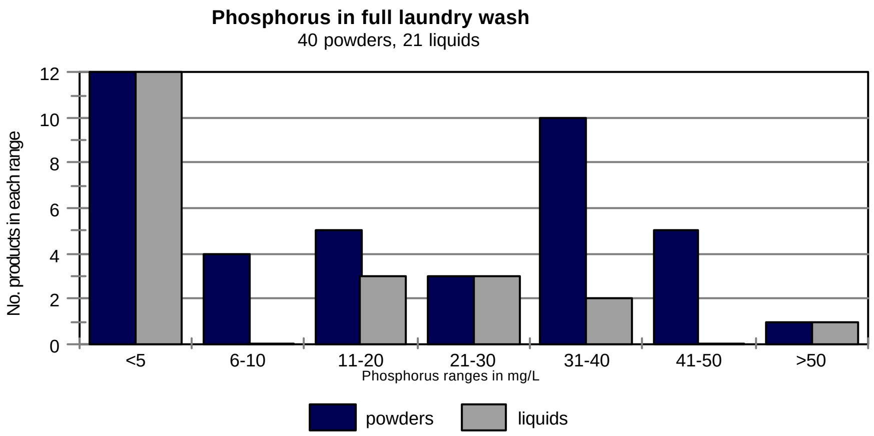



**Figure 3. Frequency of phosphorus concentration in powder and liquid laundry detergents for full 160 L load.**

The proportion of phosphorus in laundry detergents compared with that in food may be significant although there is a shift towards detergents with very low levels of phosphorus, appropriately marked "*NP*" for no added phosphorus. The major green label "*P*" which denotes a level of phosphorus that meets an industry standard can be confusing since the range of phosphorus in these detergents can range up to an equivalent of 50 mg P/L in a top loading washing load (Patterson, 2001). Figure 3 shows the frequency distribution of phosphorus in a full wash load (150 L) for a range of powders and liquids. It is clear that the powders have a higher range of phosphorus than for liquids. Where there are environmental considerations as to maintaining a low phosphorus concentration in the effluent, one should choose the 'NP' label. However, there is no labelling that indicates the quantities of sodium in the detergents.

Sodium in detergents is used because many of the salts used in laundry detergents – sodium carbonate (washing soda), sodium silicate, and sodium tripolyphosphate are highly soluble and can be manufactured more cheaply from sodium hydroxide than potassium hydroxide. Since sodium can have a serious effect upon reducing soil permeability as well as being toxic to plants, its excessive use in detergents should be restricted, preferably replaced with potassium salts. Unfortunately, sodium sulphate is used as a 'filler' or 'manufacturing agent' to coin the manufacturers' nomenclature, taking no part in the washing action and only raising the sodium adsorption ratio of the washing machine's discharge water. Sodium sulphate gives sodium and sulphate ions in water, significantly increasing the EC and providing unnecessary sulphate ions.

Figure 4 shows the salinity levels as EC (all salts) for the 40 powders and 21 liquids tested by Patterson (2001). High salinity in the detergents is consistent with high sodicity, hence standard laundry powders are potentially more detrimental to soil structural loss and plant toxicity than liquid detergents. Liquids have the lowest salinity while concentrated powders have less filler than standard detergents, therefore, a lower salinity.

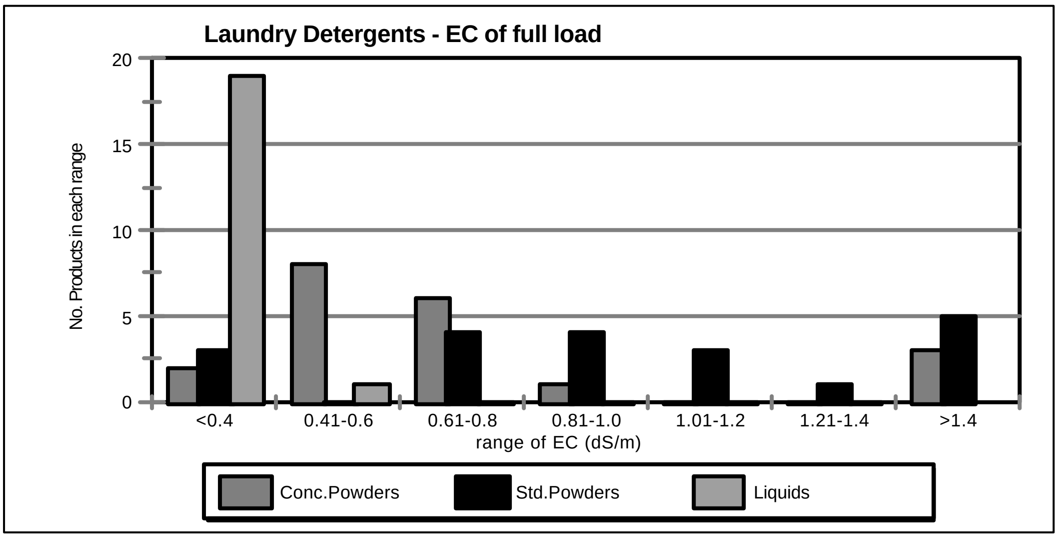



**Figure 4. Frequency distribution of salinity values for powder and liquid detergents**

The nitrogen content of laundry detergents has not been found at more than trace levels in a range of laundry products analysed. However, sweat and other body fluids washed from clothes have a nitrogen component, albiet small in relation to the water volumes used for washing.

Toilet Wastes and Cleaning Aids

One of the most important advances in public health has to be the flush toilet, where human wastes (faeces and urine) are removed from the home and either treated on-site and discharged to land, or treated in a municipal works before discharge. The cultural dietary differences are likely to give different effluent quality with respect to nitrogen and phosphorus while personal and household hygiene will have a different impact upon effluent salinity and sodicity.

Residents need to recognise the toilet as a repository for human wastes and not for unwanted or time expired pharmaceuticals, sanitary napkins, condoms or nappies (diapers). Toilet bowl cleaners based on chlorine bleaches are likely to have similar detrimental impacts as from the laundry.

Water conservation through the use of 6/3 L flush toilets may not provide sufficient water to flush solids down long sewers and the use of additional water for this purpose will override the original intention to limit water use. Plumbing codes may need to be altered to reflect low flush toilets by placing the laundry or shower up-gradient to the toilet so that the larger volumes from the shower and laundry provide a sewer flushing mechanism.

## CONCLUSION

The behaviour of individuals and their pattern of chemical use within the house will be reflected in the quantity and quality of the septic tank effluent. While water conservation may be well practised in the home, a commensurate reduction in chemical use must be observed.

It is unlikely that dietary changes will ever be considered because of any need to reduce nitrogen, phosphorus or salts in the wastewater, irrespective of the environmental or public health risk. Improvements in diet lead to greater intake of nitrogen and phosphorus and should not be discouraged. However, habits that use the wastewater system as a repository for scraps, unwanted pharmaceuticals, food residues and a host of chemicals can be altered for a positive outcome on effluent quality and quantity.

Actions that are required at the household level need to start with better labelling of products on the supermarket shelves so that an informed choice can be made by those residents interested in reducing chemical usage. There is no "*septic safe*" guideline and the term *'safe in septic tanks'* may be true because the deleterious effect occurs in the soil environment. The consumers' choices at present are limited by the ability of any manufacturer to adulterate products with 'fillers' that later reduce soil structural stability and plant vigour. Almost limitless production of chemicals for cleaning that are toxic, hazardous, highly acidic or highly alkaline, or potentially explosive (chlorine bleach with ammonia) or flammable need better regulation at the state level.

While education of householders is critical to implementing reduced chemical use, a better understanding by the regulators of on-site systems must be promulgated in guidelines and information packages. Much has been achieved in recent years in promoting water conservation and reducing phosphorus; a similar approach is required to also limit nitrogen and salts in domestic wastewater. For the on-site wastewater system, the reduction in sodium is more critical than either nitrogen or phosphorus since the latter two elements are plant nutrients.

An increased level of awareness and a conscious change in chemical use in the home is the next stage of advancing the effectiveness of on-site wastewater systems.

## References

1. APHA. 1995. *Standard Methods for the Examination of Water and Wastewater*. 19th Edition. American Public Health Association.

2. Brady, N.C. 1990. *The Nature and Properties of Soils*. Tenth Ed. MacMillan Publishing Company. New York.

3. L'Hirondel, J. and L'Hirondel, J.L. 2002. *Nitrate and Man: Toxic, Harmless or Beneficial*. CABI UK.

4. Patterson, R.A. 1994. On-site treatment and disposal of septic tank effluent. PhD thesis. Departments of Resource Engineering and Agronomy and Soil Science. University of New England. Armidale.

5. Patterson, R.A. 1999. Reuse Initiatives Start in the Supermarket. *NSW Country Convention*. Institution of Engineers Australia. 6-8 August 1999. Northern Group, Institution of Engineers Australia, Armidale.

6. Patterson, R.A. 2001. Wastewater Quality Relationships with Reuse Options *Water Science & Technology*. 1.43 (10):147-154.

7. Patterson, R.A. 2003. Nitrogen in Wastewater and its Role in Constraining On-site Planning. In *Proceedings of On-site '03. Future Directions for On-site Systems*, University of New England, Armidale 30 Sep to 2 Oct 2003. Lanfax Laboratories Armidale pp 313-320.

8. Rayment, G.E. & Higginson, F.R. 1992. *Australian Laboratory Handbook for Soil & Water Chemical Methods*. Inkata Melb.

9. Reuter, D.J. and Robinson, J.B. (Eds) 1988. *Plant Analysis: An Interpretation Manual*. CSIRO Publishing Victoria.

10. Wahlquist, M.L (Ed.). 1986. *Food and Nutrition in Australia*. Methuen Australia.