The impact of national standards on greywater re-use initiatives

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ABSTRACT

Joint Australia and New Zealand standards are used to assess the performance of household products such as shower roses, washing machines and toilet cisterns for domestic water use. Other standards are used to judge the performance of clothes washing machines against a surrogate-detergent and a particular quality of input water. Based upon these standards, both governments issue water star ratings and consumer organisations rank performance testing.

While some guidance may be seen as better than none, limits imposed by standard criteria need to be current and transparent, and lead to an improvement in societal outcomes with respect to greywater reuse. Therein lies the dilemma - how do we use well researched criteria based upon current expectations using readily available inputs normally be available to all consumers. Can we have an 'average' greywater quality from a household appliance?

This paper examines several current, although progressively out-dated, versions of joint Australia and New Zealand standards used in greywater assessments of water quality and quantity from household appliance. The domestic clothes washing machine is central to greywater reuse or recycling and several standards are used to predict water use and likely performance outcomes. These standards either lead to the pursuit of unrealistic goals, or poorly reflect performance in everyday household use. Examples will show that the standards are following rather than leading initiatives in greywater issues.

KEYWORDS Greywater; laundry detergents; washing machines; water hardness

INTRODUCTION

Various industries are guided by appropriate national and/or industry Standards. These documents, prepared by volunteer committees with interest in the field, are usually prescribed as "best practice". In many cases, the Standards have the acceptance of Governments and, in the case of legal disputes, courts uphold performance 'according to the standard' as the ultimate measure of a competent outcome. Whether these standards truly represent 'best practice' is often questioned by professionals working to secure sustainable water and wastewater efficiencies. The treatment and re-use of domestic greywater is one area where the numerous standards that apply to wastewater generation have proliferated in useful as well as useless directions.

Household greywater, for this paper, is taken to be only the wastewater generated from the laundry, bath/shower and handbasins. The organic and oily content of kitchen wastewater eliminates that source as suitable greywater. Malawaraarachichi (2011) suggests that kitchen wastewater is an unacceptable greywater in many Australian States, unless that greywater receives full treatment. In New Zealand, Tauranga Council is one that excludes kitchen wastewater from the greywater stream, others are likely to have similar separations.

The domestic greywater is, therefore, connected with the use of ‘approved’ washing machines, star rated shower roses, and water delivery systems (pressure and flow) in more recently constructed dwellings. Houses, older than 15 years, usually have fixtures that fail current water use standards making the estimation of greywater volumes more difficult to ‘average’ over a community. Poor water efficiency plagues older homes and appliances.

This paper sets out to clarify some issues around the use of standards and guidelines to both promote and demote the water efficiency of greywater re-use.

RESULTS AND DISCUSSION

Legal acceptance of standards

It is the prerogative of all levels of government to make laws, regulations and by-laws as ‘they’ see fit, irrespective of whether the law abides by the laws of physics, chemistry or any natural system. Governments have made laws for the regulation of greywater, often for reasons not related to water efficiency or to ultimate land application, but to minimise drawdown on limited water storage and treatment facilities supplying urban areas. Are these uses more about political outcomes or true water conservation? Unfortunately, these same laws apply to allotments or sections that have sufficient land to adequately treat any domestic wastewater and capture rainwater for collection and use for domestic purposes.

Following from government legislation is the plethora of guidelines that arise from various departments and local authorities, often one quoting the other as a reliable source rather than seeking primary data on water use, input water quality, typical chemical additions to water during use in the home, or the potential impacts that greywater may have on plants and soils. Often guidelines concentrate on a ‘perceived’ microbiological status of the greywater. This paper does not reject the possibility that microbial contamination may occur in some shower or bath water, but water from a washing machine (in the absence of soil nappies) may present no microbiological disadvantage for human contact or even surface discharge on lawns and landscaped areas around the home. However, holding greywater for more than 24 hours or surface discharging, except by bucket, is mostly against rules for greywater re-use.

In some jurisdictions, legislation demotes the status of a standard, as occurs in NSW, while promoting internal guidelines prepared without consultation or peer review. The NSW Guidelines (DLG *et al.* 1998) is an example where poorly researched work is portrayed as ‘best practice’ in domestic wastewater treatment and land application, and, because of legislation has to be considered in on-site wastewater management (including greywater).

The “NSW Guidelines for Greywater Re-use” (DEUS 2008) also has legislative powers and calls upon Code of Practice: Plumbing and Drainage (CUPDR 2006). Approval under a “WaterMark” (Standards Australia) is also mandatory for all systems. So, the practice of greywater management becomes more complex with more government agencies able to take a piece of the action, irrespective of the expertise to develop those guidelines. The proliferation of guidelines that contradict others makes sensible greywater management most difficult and expensive. Whether the benefits of significant legislation produce better health and environmental outcome is questionable. Simply treating all-wastes is a more logical solution.

Primary sources of data

The referencing of guidelines or standards as an authoritative source of data is poor science. Only original research should be quoted as valid. Where guidelines from one department or agency simply quote from others' guidelines without checking the original source of data is fraught with disaster for the practitioner. Errors tend to accumulate such that where nitrogen can be readily assimilated by plants at 500 kg/ha, a typographic error manifests are 200 kg/ha and this value is then accepted, without dispute, by another agency. Even more sinister is the act of conservatism: the value in one guideline will be halved by another; and further reduced by a third without any reference to the context in which the original value was selected. There are numerous examples of reduction in loading rates in the NSW Guidelines that are simply conservative values from guidelines. A notable example is the total nitrogen loading for land application areas of 25 $mg/m^2.d$, amounting to 91.3 kg N/ha.yr. Such a low nitrogen application, with irrigation, suggests the plants are likely to show nitrogen deficiencies and vegetation production will be limited. This outcome is the opposite to the desirable.

Water efficiency rating scheme

The major source of greywater is the laundry. Depending upon the source and date of primary information, the laundry generates about 25% of a household's daily water use, as estimation of the use of modern clothes washing machines is neither easy nor straightforward. During the last decade, some governments have offered rebates for households changing over from high water use top loading washing machines (average 120 l/wash) to water miserly front loading washing machines (50 L/wash) (Patterson 2006) on the premise that the changes across a wider community would relieve stressed water supplies. The current star ratings have been in place under the Water Efficiency Labelling and Standards (WELS) schemes in both Australia and New Zealand, under various legislation, since 2005 for new washing machines. Possibly driven by increased purchases of front loading washing machines, encouraged by rebates, these machines have decreased from an average of A$1100 in 2005 to around A$750 in 2011 although the range is highly variable with make, model and load capacity.

The effect of increasing water efficiency in front loader washing machines has been matched by some manufacturers of top loading washing machines now satisfying the 4-star rating. In 2010, there were 223 models of 4-4.5 star rated front loaders but only 21 models of 4-star rated top loaders on the WELS website (www.waterrating.gov.au). From 2005 to 2010, the increase in Australian households using a front loading washing machine increased from 13% to 20%, with a decreasing number of loads of washing per week (ABS 2010), suggesting a more conservative approach to washing, rather than less dirty clothes. In the same document, the trend was for over 75% of washing to take place in cold water and 20% in warm water. Thus, the impact on greywater is one where heat is not a consideration. The use of cold rather than hot water is one of energy saving. The manufacturers of laundry detergents are changing the formulations to make the detergents more active in cold water; however, enzymes require a temperature of at least 30^{o}C to be activated.

For whatever reason, the WELS website has considerably 'dumbed-down' the information available to the public, removing the country of origin of the models, eliminating data on the time for each 'normal' wash and failing to reveal the wash to rinse component of the washing machine. Thus, the public cannot make an informed choice to meet its individual needs. Thus star ratings have become a more sales-pitched approach, whether rightly or wrongly.

Star rating of washing machines

A Regulatory Impact Statement was prepared to address water efficiency standards for clothes washing machines (George Wilkenfeld & Assoc. 2008). An objective was to "reduce the environmental impacts of water use and disposal, below what they are otherwise projected to be". Other than provide cost benefit analysis, this report simply defaulted to the water use rating of AS/NZS 6400:2005.

The legislative requirement in Australia and New Zealand is that only washing machines that carry a current WELS star rating can be sold. This star rating is based upon meeting AS/NZS 6400:2005 for which the 4-star washing machine uses less than 8.7 – 10.3 L/kg load capacity. It is perhaps bemusing to the householder that washing machines are rated in kilograms capacity when clothes are not weighed prior to washing but rather loaded to an 'expected capacity' based upon bulk. The author has not been able to determine the source from which the Standard derived this range for 4-star rating, particularly when large commercial 'state-of-art' washing machines that recycle wash water use 13 L/kg.

The question that arises from the ranges used in AS/NZS 6400 is that perhaps there is too much concentration on reduction in water capacity overall, rather than an effort to maximise wash and rinse performance with reasonable quantities. Unfortunately, there are no data to show the wash cycle volume or the rinse cycle volume, and of two major manufactures contact, none was able to shed light on the wash/rinse cycle volumes of their machines.

Washing machine efficiency

Since 2006, all washing machines have been required to meet a performance standard for washing and rinse. Prior approvals were only for wash performance. Unfortunately, AS/NZS 2040.1:2005 is based upon unrealistic and out-dated assumptions. Firstly, the performance is conducted using a water hardness (45 mg/L as $CaCO_3$) that is softer than many municipal water supplies, although harder than rainwater (<10 mg/L as $CaCO_3$). Thus, the performance of 'builders' in the laundry detergent is either limited by the amount of detergent used, or far in excess of what is required for rainwater input.

Secondly, the detergents chosen for the performance test does not reflect the laundry detergents currently available to the consumer. AS/NZS 2040 requires a phosphorus level of 8.7 g P/wash for a 6 kg capacity washing machine. Research published by Lanfax Laboratories (www.lanfaxlabs.com.au) indicates that the 2011 test results show that the range of phosphorus in powder detergents was from <0.01 to 2.95 g/wash for front loaders, and <0.01 to 4.38 g/wash for top loaders. These rates are significantly less than the Standard's rate, leading to the conclusion that the performance test may exceed the consumers' outcomes.

Thirdly, the quantity of detergent required for the performance test was 75 g/wash for a 6 kg front loader and 114 g for a top loader of the same capacity. The 2011 results show that the average rate was 47.5 g for a front loader and 48 g for a top loader, half that of the Standard. The Standard is inconsistent with the modern trend in powder laundry detergents. The Standard has no performance test applicable to liquid laundry detergents, and cannot be purported to be a valid Standard for use in assessing domestic clothes washing machines. Thus, what happens in the performance testing does not reflect what really happens in the home, and that greywater quality may vary significantly with machine type, water hardness and choice of a liquid or a powder detergent.

Greywater variability

While some researchers have attempted to prepare a 'simulated' greywater composed of laundry detergent, toothpaste, shampoos and soaps to reflect the daily output from a single domestic home (Tjandraatmadja *et al* 2008), the reality of greywater discharge varies significantly with time of day and day of the week, and the affluence of the household. Since, by legislation, greywater cannot be stored, one must deal with volumes of washing machine water and showers water separately, and small volumes from handbasins may be mixed with either of the larger volumes. How does one model the impact of laundry chemistry on one application and shower water on the next? Can one be detrimental to the activity of another?

Laundry detergents

The range of laundry detergents has changed significantly since the author first analysed the common supermarket range of detergents in 1988. Detergent use in 2012 is significantly lower than in 1988; powders are now mostly ultra-concentrated (less than 0.8 g/L in the wash volume); and liquids are also concentrated (1.8 g/L). Thus, greywater is less contaminated by chemical additives than previously, particularly the 'fillers' that were common standard powder detergents prior to 2009. Manufacturers of modern detergents recognise the need to limit phosphorus and sodium as these are potential contaminants of water and soil. Today, over 75% the supermarket bands of laundry detergents have less than 1 g P/wash and less than 20 g Na/wash. Cheaper laundry detergents are usually less environmentally suitable for greywater discharges, while detergents for front loaders often have higher phosphorus levels.

Biodegradability is not a significant issue with greywater re-use because only small contributions of organic material are present. The more significant factor is the inorganic chemical load, which by definition cannot be biodegradable, but more likely to have an effect on plants and soil. The increase in sodium adsorption ratio may be a real issue on sensitive soils.

Water Quality

Input water quality varies from rainwater (low electrical conductivity, soft), highly variable surface waters to reticulated supplies where additional salts are added to adequately treat the water for total alkalinity and pH adjustment. For an 'average greywater' assumption, there must be some recognition of the highly variable impact the quality of the water will have upon the ultimate greywater where the input water is further 'contaminated' with the chemicals used in the home. One neglects the input water quality at their peril.

Greywater treatment systems

AS/NZS 1546.3:2001 is available for the secondary treatment of wastewater. Where legislation requires that greywater undergo 'full treatment' prior to re-use, the treatment system is often the aerated wastewater treatment system (AWTS), irrespective of how the greywater compares with the wastewater for which the operation of the AWTS was certified. With significantly reduced nitrogen load and biochemical oxygen demand (BOD), operation of an AWTS as a greywater treatment system has to be suspect as a microbially immature treatment plant, since the majority of biodegradable material in an all-waste system comes from the toilet and the kitchen. For greywater treatment, the soil has a greater function and capacity for assimilating the water, the chemicals and the bacteriological properties.

CONCLUSIONS

Greywater re-use is a legitimate use of a valuable resource, provided environmental and health considerations are met. Whether the discharge is 'approved' or 'regulated' depends entirely upon local jurisdictions. In Australia, no commonly acceptable principles or models exist for directing greywater to landscaped areas. In New Zealand, the activity is no less confused by local rules. While various jurisdictions have the authority to choose principles, objectives, policy and guidelines to suit unique area, greater advancement would be gained by an overall, scientifically based approach to greywater reuse, with correlation of data with policy.

It is the author's opinion that the development of standards in the hands of volunteer committees is rather unwieldy and ineffectual. The standard often develops from an association with the 'topic' rather than experience with research and development of that 'topic' as shown by the two standards that apply to performance ratings for washing machines.

Clearly, the development of greywater guidelines involves more than simply 'picking the eyes' out of other guidelines or departmental documents and rehashing as locally specific and therefore worthy of legislative support. Conservatism is probably an excuse for not knowing!

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