REGULATION, GUIDELINES AND STANDARDS - IS SCIENCE WINNING?

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ABSTRACT

The plethora of Acts from the Commonwealth and State governments, the proliferation of regulations enacted without parliamentary debate and the guidelines raised under the spectre of informed scientific opinion compete with the Australian Standard (AS/NZS 1547:2000) for on-site wastewater management principles and outcomes.

Many objections have been raised by worthy scientists and wastewater professionals to government guidelines that are not only inappropriate to protect environmental and public health, but may result in outcomes contrary to their legislative objectives. The question to ask is whether the guidelines meet best practice given the scientific knowledge at date of publication, or whether the guidelines are simply reactions to public policy, political debate or advocacy by interested parties.

The courts are at the mercy of legislators and departmental guidelines for so called "scientific fact", and even when expert evidence is to the contrary. Legal opinion of domestic wastewater and scientific knowledge are not even in the same phase. When it comes to domestic wastewater, unfortunately, advocacy is not about being right, rather about winning. Being right on guidelines in a literal sense is what counts, never mind the environmental impact.

It is not uncommon for consultants advising on on-site wastewater management to assume that either [i] a literal and uncritical adherence to such guidelines and standards insure their work is sound and ought to be accepted by the responsible authorities without qualms, or [ii] unless they do so, their reports will be rejected.

This paper examines some State regulations and guidelines for domestic wastewater and the current Australian Standard. There is strong evidence that scientific fact and analysis is not even a poor cousin when documents become records of consensus from marginally interested parties. That the Victorian EPA figures strongly in these examples does not mean that similar authorities in the other States are free of similar weaknesses.

1 INTRODUCTION

During site assessments of land capability for on-site wastewater management one frequently runs up to regulations, standards and guidelines that have so grossly simplified the real physical complexity of the issues that many non-specialists think they can carry out the assessment. It also can happen that government officials merely check these assessments to see if all the boxes have been ticked. Reports may be accepted merely because the writer has genu flexed in all the right places, although the report's recommendations may be erroneous or wholly nonsensical. Sadly, objectivity is lost when reports have to go beyond what is necessary to make a sound judgement to approve or reject. In such cases, the paying public rightly questions the credibility of the wastewater profession when they ask "is all of this really necessary?"

Public service departments, noting that there are still many failing on-site systems, may feel compelled to rewrite the guidelines. Committees are set up to carry out this task but many committee members will have little field experience, much less a broad understanding, so new guidelines may lack as much connection with reality as the ones they replace. Broad consultation with other experts, including those who have been critical of the guidelines, should occur as a matter of course, but it is too infrequent. Public participation often occurs after guidelines have been promulgated, not during their preparation.

Unlike the United States Environment Protection Agency's guidelines (USEPA 2002), the Australian guidelines mostly are not referenced to scientific papers in which the technical aspects are adequately discussed and findings are documented. Where this is the case, the user is hindered or prevented from self-education. It can also suggest that the issuing body would prefer to keep it that way to minimise comment from the public. Only their own publications are referred to. The Victorian EPA clearly still clutches desperately to its old safety blanket, and inhibits the uptake of better methods by land capability assessors. We will illustrate this sorry state of affairs with several examples.

1.1 Absence of Scientific Support

The AS/NZS 1547:2000 (the Standard) requires that, as part of the soil examination, an assessment of soil structure is made consistent with the appendix Table 4.1D4 (AS/NZS, 2000 p99). Soil structure is "concerned with the arrangement of all soil particles and may be described in terms of the three characteristics of the grade, class and form of the soil aggregates" (Northcote, 1979). For whatever reason, the Standard simply refers only to the "degree of structure" which is actually the 'grade'. The key observable character of structure is 'form', yet its description is omitted. A complying soil description would omit the most significant characteristic that influences soil permeability as well as a soil description. A key reference is McKenzie and Jacquier (1997) because it graphically demonstrates the limitations of this method even if areal porosity, dispersion index and horizon type are included as explanatory (hence predictive) variables. Although soil structure in the Standard is a "stand in" for permeability, certain regionally important structureless soils nevertheless have good permeability!

The Standard habitually omits reference to technical or scientific literature, but often refers to other Standards as though they have some scientific standing. We think this is a deficiency. At least it could refer to Handbooks and Manuals that do have literature references.

The NSW Department of Environment (now Department of Environment and Climate Change) in its 2004 "Environmental Guidelines: Use of effluent by irrigation" states that an Emerson Aggregate Test (EAT) 'of 8 means that the soil is so stable that it cannot be penetrated by plant roots', without reference to published data. In fact, it is towards a Class 8 soil (no slaking, no swelling, no dispersion (Emerson, 1967)) that all agriculturalists, irrigators, and home gardeners strive. An appropriately qualified soil scientist should have refereed these guidelines.

We believe peer reviews of guidelines and standards, rather than review by the relevant committees, have not had a place in recent years. Consequently the documents contain simple mistakes, misunderstandings and non-referenced hypotheses that are often accepted as fact. While courts may be well equipped to handle legal argument, the calibre of the legal fraternity to handle scientific argument is less than ideal which can easily lead to environmental disaster.

1.2 Large Volume Dispersal on Small Area

At an upmarket seaside township on the Mornington Peninsula, Victoria, it was proposed to build three two-bedroom apartments as a second storey over a small restaurant. The restaurant was equipped with an aerated wastewater treatment system (AWTS) and already discharging its treated effluent in the stormwater system as there was no space for on-site disposal.

The total land area of the site is approximately 1000 m^2. The present building occupies approximately 300 m^2 of the area and the car parking takes up another 308 m^2. Only about 123 m^2 of land on the more or less undisturbed rear of the block is available as a potential disposal area for domestic effluent. This potential disposal area is located on higher land separated from the car park by a cut of approximately 2 m in height. It has a significant slope towards the car park. The soil profile consisted of 0.6 m of recent dune sand over a sloping base of heavy, sodic clay, which both consultants involved in the assessment classified as "impermeable". The base of the car park was in that clay. Consultant A. has accreditation with the National Association of Testing Authorities (NATA) for percolation testing and Consultant B was a Certified Practising Engineer (CPEng).

Percolation rates in the well-sorted dune sand cover soil were very high (1416 mm/h and 1124 mm/h in two out of four tests in the sand). To reduce these values to more acceptable values as per the Victorian Code of Practice (EPA, 2003), they were averaged with three results from the clay soil in the parking lot (each with 4 mm/h). This then resulted in a usable "site percolation rate" of 217 mm/h.

Following the Code consultant A was now able to recommend disposal of 900 L/day at a rate of 7.3 mm/day on 123 m^2 of land. Presto, problem solved!

In a follow-up phase, consultant B backed up consultant A's report wholeheartedly and the Council had to accept both reports as adequate. After all, the percolation tests for the land capability assessment had apparently been done exactly as prescribed and there were no calculation errors.

Any scientist worth his or her salt would easily have realised that the water storage capacity of 123 m^2 of sand of 0.6 m thickness, would be completely filled with effluent in a short time:

Volume of sand in 123m^2 x 0.6m	=	73.8 m^3
At 50% void space the water storage capacity	=	36.9 m^3
Which would be filled in 36.9 m^3 / (0.9 m^3/day)	=	41 days

Effluent would weep out the cut face almost as fast as it was applied well before this time. Neither NATA Accreditation nor CPEng credentials guaranteed any professionalism or ethics in this case. So how is the Council to know sustainable from disastrous?

1.3 Managing Environmental Risks

Requiring reserve areas became fashionable when in the past the lack of space in the garden rather than the quality of the soil was the determinant for the sizing of the disposal field so that trenches were overloaded, especially when tanks were not routinely desludged. To overcome this problem it was thought by many regulatory authorities that a reserve area for trenches was necessary as a failing field usually could not be rehabilitated. Now, in the case of disposal by means of irrigation, the risk of field failure is very much smaller and, if ever necessary, rehabilitation is easy. Therefore, there is no need to require reserve fields in every case and for every method of disposal by way of automatic response.

Groundwater quality ought to be considered in an LCA, but assessing risks to groundwater must not be based on unrealistic premises or assumptions that only nutrients and microbial pollutants are important. Domestic wastewater may contain many other kinds of pollutants such as those from detergents, medication and salts that may be flushed down the septic tank and survive. The LCA procedures in several States tend to be blind to these other contaminants, particularly from greywater.

The NSW "Environment and Health Protection Guidelines" (DLG, 1998) set buffer distances for separating effluent disposal areas from property boundaries, buildings, swimming pools, drinking water wells and drainage lines. That 'the values given are recommended maximum, based upon ideal site and soil conditions' invites the question "What are ideal site and soil conditions?" With no references against which to gauge how closely our site conditions resemble the 'ideal site and soil conditions' so the differences in risk cannot be made. Is '100 m from permanent surface waters' critical when it can be shown that domestic stock roam through the 'permanent surface waters'? While the guidelines are purporting to be advocating 'performance assessment' these buffer distances are not only prescriptive but lack any scientific basis, or else they would be referenced. And should not buffer distances, by very definition, be based on a series of site dependent criteria that will vary from one site to the next? The same questions can be asked in Victoria.

LCA procedures ought to be far more specific and oriented towards the likely methods of effluent treatment and disposal and the nature of the wider receiving environment.

1.4 Participation and Training in Technical courses

The Centre for Environmental Training (CET) regularly conducts courses in various aspects of on-site wastewater management at venues throughout Australia and New Zealand. Other organisations also offer occasional training in the field. Table 1 summarises the numbers and associations of CET course attendees for the period 1994-2007. The major groups of attendees are from Local Government and the private sector (consultants, plumbers, maintenance technicians etc). By comparison, far too few State Government agency staff enrol for these courses. Many of the State Government agency staff who have completed the course are from organisations that do not have a prime regulatory responsibility for on-site wastewater (National Parks, Agriculture, Roads & Traffic Authority etc). We do not know why so very few staff of regulating authorities have attended these courses. Participation would yield great benefits in bringing them together with the technical experts in the field.

Table 1. Numbers of attendees and their association

Total attendees 1994-2007	2817				86% Aus		14% NZ	
Affiliation details available	1634							
Federal Government Agencies	3							
State Government Agencies	94				7%			
Local Government	839				51%			
Private Sector / Academic Institutions	698				42%			
	NSW	VIC	WA	QLD	TAS	SA	NT	ACT
Australian attendees by State	104.6	245	82	98	49	49	49	16
State Government Agency staff	55	3	10	1	2	5	16	2
State Government Agency responsible for On-site Wastewater Regulations	5	1	3	1	1	4	15	2

Fortunately, the environmental health profession, however, both at State Government level in some States and Territories and particularly at Local Government level in the other States, maintains a much stronger involvement in the discipline.

1.5 The Percolation Test: A Safety Blanket for the Victorian EPA?

The percolation test, which operates as a falling head test method in an unlined auger hole in the soil, lacks a proper scientific and mathematical basis as a test. Worse, it lacks any local correlation with the performance of effluent disposal trenches or effluent irrigation fields, so is useless as a predictor. It originated as an *ad hoc* method, developed by Henry Ryon in New York State in the 1920s, who plotted the rate of fall of the water surface in a 300 x 300 mm square hole, against the long-term functioning or failing of disposal fields using absorption trench systems and found a very rough relationship. As this method is one that is 100% empirical, nothing in the test parameters can be changed without losing its predictive ability. Ryon's test found its way into the U.S. Public Health Service Manual of Septic Tank Practice in the fifties and lastly in 1967. The test was copied by the Victorian Department of Health and in use until at least 1975. Presumably it was copied also in other States; certainly NSW followed the same requirement until 1998.

In Ryon's time, the unsaturated flow through soils was hardly understood. The manner in which the percolation test was used shows that people predominantly believed that the water only flowed vertically down through the bottom of the hole, so that the shape and size of the wetted area in the hole was irrelevant. Consequently, the Victorian Department of Health (1975) just asked the tester to "dig a hole" and put 150 mm of water in it and measure how long it takes for the water level in the hole to drop 25 mm. From this it recommended the disposal rate per square metre of trench bottom.

When the Victorian EPA took over the responsibility for septic tank systems, it also took over the percolation test. In 1975, the EPA's Planning and Research Branch undertook the one and only serious appraisal of the percolation test in its history in Victoria, and standardized the hole diameter at about 30 cm, its shape as cylindrical (10 inch auger), its depth at 50 cm or less based on proposed depth of trench, and a beginning water level in the hole at 30 cm above the base, but test results were not correlated with the performance of operating effluent disposal fields.

The 1990 Victorian Code of Practice for Septic Tanks adopted this old-fashioned test method at the strong urging by the Health Department and the EPA. However, the Code also had a reference to the proper constant head method. This Code had an empirical effluent disposal field-sizing diagram, which could be used with both test method results. It was based on limited data for thirteen existing septic tank absorption systems east, north and west of Melbourne described in Brouwer's doctoral thesis (Brouwer, 1982). The 1990 EPA Septic Tank Code of Practice employed a test hole diameter of 10 cm (4-inch auger) and an initial water level of 15 cm above the base, Under the flag of the "Best Practice Environmental Management Series" the 1990 Code was reviewed and in 1996 the test procedure changed the starting depth of water from 15 cm to 25 cm. The effect of changing the initial depth of water of the sizing diagram was not taken into account. The unintended effect was that now the percolation test results became very much more generous to the developer, especially for low percolation marginal soils. If the reviewing Committee had understood the basis of the sizing diagram (Kessler and Oosterbaan, 1974, referred to in the 1990 Code) and recalculated the sizing diagram it would have avoided this unnecessary mistake. Change the geometry of the test and one changes the relationship between percolation rate and soil permeability.

$$K_{sat} = 1.15\, r \left[\frac{\log(h(t1) + r/2) - \log(h(tn) + r/2)}{(tn - t1)} \right] \qquad \text{Equation 1}$$

Where h(t1) = water level in hole at beginning time t1
h(tn) = water level in hole after selected interval of time at time tn
r = radius of the test hole
1.15 = conversion factor from e-based log to 10-based log
(h(t1) – h(tn)) / (tn – t1) = percolation rate
(Only for that period of testing when the water level drops at a stable rate)

Also, at an unknown date, the Victorian EPA registered its percolation test with NATA. This enabled some consulting companies (five in 1997) to become accredited to carry out this test. Judging by copies of their LCA reports, two of these consulting companies routinely did not follow the exact procedure in terms of initial depth of water. They thought that the required depth of water above the base of the hole meant the depth of the water surface to the surface of the soil. This misuse of the NATA registered test method and its lack of any science was communicated by one of us to NATA in 1997-98 and again later in 2000, but unfortunately failed altogether to make any impact.

Patterson (1994) showed that it required more than 18 tests to derive at minimum of a ± 50% variation (100% variability) in measured permeability. Such replications could not be done without striking natural soil variability influences, nor could such replication be practical. It is known that some consultants take three measurements, disregard the extreme and average the other two. In this manner they produce just a guess, nothing else. Now replace the clean water with effluent and percolation rates are significantly reduced in relation to sodium adsorption ratio of the effluent (Patterson, 1994).

In 2001 the Victorian EPA's Publication 746 on assessing land capability used the term "soil permeability" referring to an important soil property. Its use appears throughout the document including in the land capability-rating Table. It was defined as shown in italics below.

***Permeability** is the term used to describe the rate at which water moves through a soil profile. Soils should be able to take water loadings at a rate that allows time for adequate remediation of domestic wastewater. Fast permeability rates will not allow for adequate remediation, slow rates may give rise to soil waterlogging. <u>The EPA endorses no particular permeability test, although a procedure in which the hydraulic head remains constant throughout the test is recommended.</u>*

Note the underlined sentence (our underlining). As if there is a plethora of *in-situ* methods for measuring saturated hydraulic conductivity (Ksat) in unsaturated soil and all are almost equally valid. In reality there is just the one *in-situ* constant head method for an unlined test hole, but one wouldn't know if one doesn't read the literature. Note also that the rate of water movement through the soil apparently has no relationship to the hydraulic gradient, because there is no mention of it. Darcy's Law of 1875 is the relevant physical law for flow of water in soils, but one can go too far in dumbing down the text of a guideline to suit the layperson.

In 2003, Publication 746 was re-issued as Publication 746.1. The paragraph in the 2001 version regarding which test method might be endorsed and that a constant head method was to be preferred was wholly removed, and the LCA Rating Table was cleansed of the word "permeability". Publication 746.1 has gone back to the seemingly safe old "percolation rate". The EPA NATA-registered percolation test procedure shows that neither EPA nor NATA understood the test method is an "above-the-water-table-test" and cannot be carried out when the soil is saturated or even when saturation occurs close to the base of the test hole (McKenzie *et al.* 2002, Chapter 9.7.5). There is, furthermore, no warning that in highly dispersive soils the testing fluid should not be plain water, but 0.01 Molar $CaCl_2$ solution (McKenzie *et al.* 2002, Chapter 9.76). Patterson (1994) showed that for even small changes in sodium adsorption ratio (SAR) of the effluent, statistically significant loss of soil permeability could occur on many soils considered 'ideal soils' with high measured permeability when using drinking water. That the tests be done with clean water neglects the varying quality of tap water (drinking water quality) across the country and ignores the benefit of using effluent or similar manufactured testing water in place of drinking water. Publication 746.1 and other EPA guidelines inhibit the uptake of better methods by land capability assessors.

Disappointment with the guidelines for Land Capability Assessors has resulted in the Municipal Association of Victoria developing a Model Land Capability Assessment Report with supporting explanatory notes (Whitehead & Associates 2006) which has been made available to all Councils in Victoria. This document supports a more rigorous scientific assessment of soils and early indications are that Councils requiring this approach are receiving much improved land capability assessments.

There is much room for guidelines and standards to undergo a peer review outside of the committee tasked with their construction. Legal argument at a later stage fails to address the scientific gaps or errors in our current guidelines and it is time for the scientific bent to be returned.

1.6 Greywater Re-use – in Favour but Dead Against

After many years of below average rainfall and even drought in Australia, it is natural that government agencies are turning their attention to better use of water, which includes recycling. The EPA has also jumped on this bandwagon. In 2001 the Victorian EPA published its "Domestic Wastewater Management Series - REUSE OPTIONS FOR HOUSEHOLD WASTEWATER", Publication 812. In 2006, with the drought worse, this was dusted off and republished as Publication 812.2. Its objective is given below, in italics and *verbatim*, with our underlining of the penultimate sentence.

Objective

Households in sewered areas that reuse wastewater on their own premises should do this in a way that sustainably protects human health and the environment, with a risk level equal to (or less) than that associated with discharging to sewer. <u>Water balance calculations indicate that it is not possible to reuse the entire wastewater flow from a household (and hence comply with this objective) on typical urban allotments in Victoria</u>. More detail is provided in 3.3 (in the original document) below.

We will see in Table 2 why the EPA thinks typical urban blocks cannot comply.

Table **2. Indicative irrigation area and winter storage requirements for sites in Victoria**

Location	Assume flow = 1000 L/day		Assume flow = 500 L/day	
	Area (m^2)	Storage (m^3)	Area (m^2)	Storage (m^3)
Marysville	1800	280	900	140
Welshpool/Yarram	1500	260	750	130
South-East Melbourne	1200	240	600	120
Wodonga	1000	240	500	120
Bendigo	810	220	400	110
Werribee	730	220	360	110
Horsham	360	180	180	90
Mildura	260	120	130	60

1. The above irrigation area and storage requirements are indicative requirements, based on containing all wastewater up to the wettest year in 10. They were estimated using the water balance model described in EPA Publication 168, Guidelines for wastewater irrigation. Alternative water balance models may be used, but designers would have to justify their suitability and reliability.

The table is a logical outcome of making the criteria for wastewater irrigation at municipal sewage farms and large industrial wastewater management systems apply to domestic grey water: no effluent must ever reach the groundwater; irrigation is not permitted during "winter"; winter storage is mandatory. Figure 2 shows inputs and outputs of water that are or are not ($\equiv 0$) permissible under the principles of Publication 812.2.

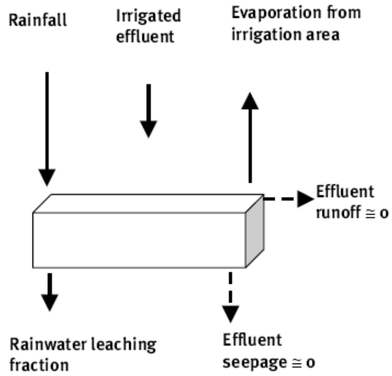

Figure 1. A tank of 220 m^3, just right for a wealthy Bendigo gardening devotee.

Figure 2. EPA's concept of hydrologic cycle (Source: EPA Publication 812.2).

2 CONCLUSIONS

The use of examples to highlight the disparity between the science of wastewater management and the policy and legal framework illustrates the problems that exist in developing an effective land capability assessment, let alone a design for a system that has the potential to work. While States share many policy frameworks, they have copied many poorly referenced statements and ideas.

However, Science is winning ground at a satisfying pace among those who are serious about doing the best they can for the environment by researching, studying and discussing their professional areas of interest in the broad terrain of on-site wastewater management. The Regulators may still live on Mars, although recently in Victoria two senior EPA appointments were made specifically to review the whole area of on-site wastewater management. This is a most promising new start. The Australian and New Zealand Standard for on-site effluent treatment and disposal, which is being revised, could potentially benefit from the new knowledge and would then make State guidelines superfluous. The real question is whether it will take advantage of the opportunity.

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