Sanitary waste disposal via the solid waste route is definitely more sustainable than flushing

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Introduction

The disposal of domestic sanitary solids using the WC as a 'rubbish bin' is habitual in the UK and stems from the historical link associating health risks with human waste (hygiene). Recent concerns about excessive water use for WC flushing (7.5 or 9 litres), and the downstream costs of dealing with these solids have forced a re-appraisal to be made of this method of disposal, and a UK 'bag-it-and-bin-it' campaign, sponsored by the water industry has been underway for more than 3 years. The project described here has considered in detail one element of the water supply and disposal system: that which relates to the use of water as a carrier to dispose of the large textiles, plastics and paper items (domestic sanitary waste), commonly introduced into the water closet (WC). Of most significance for the waterborne disposal route are female sanitary hygiene items, which are those most commonly flushed. In the UK for example, some 2.5 million tampons, 1.4 million sanitary towels and 700,000 panty liners are flushed every day. Of concern is the increase in the amount of plastic being used in these items and changes in public usage patterns, shifting to using more of the plastic based products. Whilst pressure can be applied to manufacturers to develop fully biodegradable forms of these products, and to use less plastic, the current nature of the items means that the numbers and weights being disposed are unlikely to reduce in the foreseeable future, even with government and other minimisation initiatives. Hence the best way of managing this waste needs to be determined for now and for a long time into the future. Thus the relative sustainability of continuing to dispose of sanitary items via the WC compared with the obvious alternative, the solid waste stream, has been examined in the project. Hence a detailed, multi-disciplinary scientific study, funded by EPSRC, the Scottish Water Authorities and others, has been carried out over this same period to look holistically at the economic, technical, social and environmental aspects of the problem of disposal of sanitary solids via either the WC or the solid waste routes. Using four test catchments in Scotland, the study has defined appropriate sustainability indicators, examined the effects on wastewater systems and the cost benefits and public's attitude and willingness to change habits. Health and legal aspects were also reviewed in the study.

The approach used in the study has broader implications for wastewater planning, as for the first time, it incorporates a rigorous assessment of 'sustainability' within the context of a real problem and hence provides an exemplar for those in the water industry tackling other issues which include 'sustainability'.

Sustainability and Indicators

What sustainability means is still unclear, and many publications use the word in a vague and generalistic way. The definition of sustainability is complex and applies to all aspects of human endeavour, together with the maintenance of natural systems, and also depends upon the perspective of the questioner. Sustainability and 'sustainable development' are often confused and mean different things (Van Dieren, 1995). Nowadays use of the word 'sustainable' to promote developments based on sound engineering principles (with today's knowledge) is almost endemic, and frequently coupled with the other misused word 'optimum' to justify what is really a traditional solution. This has devalued the use of the term 'sustainable' (e.g. Carroll & Turpin, 1997). Others state that 'sustainable development' is an oxymoron (Torgersen, 1995) largely because of the anthropogenic perspective. Perhaps the most useful definition relates to people: *'...the critical requirement for sustainable development ..is to build capacity in the **ability** of people*

*and their representative organisations to **sustain** lifestyles which are compatible with continued environmental integrity'* (Selman, 1996). The tripartite elements traditionally used to assess relative sustainability are: social; economic and environmental (Figure 1). There are also problems with indicators of sustainability (used to assess whether a system is becoming more or less so..). Various approaches are in use to 'quantify' sustainability, usually based on some form of indicators: ecological; economic; socio-political, (Hatcher, 1996, Moffatt, 1996, Serageldin, 1993). It is clear that the role of indicators must be dynamic, i.e. continually reviewed within the context and growing knowledge of the understanding of the system processes and interactions.

Figure 1 The tripartite elements of sustainability as applied to sanitary waste issues

In this project, the problem of defining which of the two disposal systems was the *most* sustainable, necessitated the use of indicators, despite their limitations (Ashley et al, 1999). A number of indicator options were considered based on UK government indicators (e.g. DoE, 1996, DETR, 1998), and candidate recommendations for water systems (Parkinson & Butler, 1997).
The latter consider five main indicators relevant to sustainable wastewater systems:

- Loss of nutrients from land-based cycles to the aquatic environment
- Fresh water resources expressed as change in quantity and quality.
- Use of renewable energy and material resources
- Economic cost
- Water Re-use

Any attempts to define 'sustainability' without reference to the three areas in Figure 1, and without the use of well thought out indicators, is thus futile. For example, a recent draft report proposing a set of indicators for the UK water industry (ERM, 1998) concentrates on so-called '*environmental*' sustainability, a focus which is at odds with current approaches which advocate the use of combined indicators spanning the tripartite elements (Figure 1). The proposed UK water industry indicators are focussed on what is perceived to be a single industry and hence deficient.

The indicators developed for this project are shown in Table 1. These apply only to catchments where the proportion of private septic tanks is low. Where householders have these, then they have more of a direct responsibility for disposal and the effects of their sanitary waste, at least in principle. The component indicators have been selected as constituent representatives of the three areas of economics, environment and social factors. The driving perspective overall is the changes in the technical operation of the two alternative systems, principally the numbers (mass of material) switched from one route to the other, which is effected directly by public behaviour. Consideration was also given to system energy changes, but it was concluded that these were not significantly different between the two disposal routes, and in any case required a detailed life cycle analysis to be undertaken; an activity not part of the original project, but now being undertaken as part of an extended project (Ashley et al, 1997, Ashley et al, 1999).

ECONOMIC	ENVIRONMENTAL	SOCIAL
C1. NUMBER OF SANITARY WASTE ITEMS FLUSHED		

E1. Cost-benefit : waterborne disposal route (££PV/cap) E2. Cost-benefit : solid waste disposal route (££PV/cap)	EN1. Aesthetic : numbers of sanitary waste items on beaches/riverbanks (items) EN2. Environmental evaluation (public willingness to pay for sanitary waste free beaches/watercourses) (££/cap)	S1. Public willingness to change from WC to solid waste disposal. (Number willing to change / Population currently flushing) S2. Actual change in disposal habits. (Number flushing / Original population flushing)
Beneficial results are if the difference (E1-E2) is cost saving to society	Beneficial results occur from a reduction in numbers and public willingness to pay	Beneficial results occur as S1 tends to unity (per year); i.e. all of those residually flushing, would be willing to change. And as S2 tends to zero (no flushers).

Table 1 - Indicators used in this project

The economic indicators E1 and E2 deal with direct costs; the direct cost-benefits in terms of present worth for the two alternative disposal routes, for operational and capital investment costs. Where E1 exceeds E2, then there is a net cost-benefit in direct monetary terms. The two indicators have not been combined (E1-E2) for two reasons. The precise boundary as to whether the aggregated indicators show increasing or decreasing sustainability, is open to judgement due to the uncertainty in the estimates of costs. For example, where E1 is larger than E2 by a small amount, then judgement as to how precise the estimates of costs are will be required in order to decide whether the difference gives a good indication of enhanced sustainability. Secondly, the indicators in the proposed form may also be used to compare different scenarios other than just a switch from the waterborne to the solid waste route.

Although there are known limitations to the approach, representative economics, in the form of Contingent Valuation also provides the EN2 indicator of environmental factors in terms of the willingness of the public to pay to prevent sanitary waste being seen on beaches and along the banks of watercourses. This is linked to the indicator for the actual presence of sanitary items on beaches EN1, which ideally should decline to zero. EN2 may either increase, decrease or remain the same, and it is expected that as sanitary item presence on banks and beaches declines the public may become less willing to pay to deal with the problem. Thus indicator E2 should be assessed only in conjunction with indicator EN1. In general, however, a positive value is beneficial. This is an example of a dynamic indicator (Ashley et al, 1999).

The social indicators S1 and S2, relate only to the public's behaviour with respect to what use they make of the WC for disposing of sanitary waste. If alternative scenarios are envisaged in which, for example, domestic plumbing precludes the introduction of these items into the WC, then these indicators may require modification or to be complemented by others to include the rate of installation of alternative systems, provided these had been shown to be *more* sustainable. Nonetheless the overriding indicator C1 would still be relevant as the introduction of sanitary solids into wastewater systems is not expected to be the *most* sustainable way of dealing with these items.

When considering the waterborne vs the solid waste disposal route, S1 and S2 have been selected deliberately to incorporate what the public claim they would be willing to do (habit change), and what they actually do. S1 is based on the willingness to change of only those who continue to flush, whereas S2 compares these continuing flushers with the total original

population of flushers within a given area. These two indicators are important for assessing the effectiveness of recurrent public attitude change campaigns, and also indicate whether additional campaigns should be run. In order to relate these to the campaigns, temporal criteria must be specified.

The indicators may be combined so that a single aggregated indicator is formulated: C1 - in this case represents all of the others in aggregate, as flushing sanitary solids has been shown in the study to be *less* sustainable than disposing of them via the solid waste route: The numbers or masses of sanitary solids being flushed - ideally this indicator should ultimately fall to zero.

Conclusions from the study

The elements of the study are illustrated in Figure 2. Application of traditional cost-benefit analysis using a 45 year timescale has shown that there are considerable costs savings (about £6000 annually for a 2000 population catchment, and some £120,000 for 60,000 population) likely to arise from even a 50% change in public disposal habits from the waterborne to the solid waste route, savings which would initially be of direct benefit to the Water Utilities and ultimately passed on to customers. There are no legal, institutional or health impediments to promoting a change in public behaviour, and encouraging more binning, nor are there any foreseeable in the future. The increased amounts of materials which would be introduced to the solid waste collection system (circa 0.3% by mass from a 100% change) from a change in disposal habits were found to be negligible compared with the total amount of municipal solid waste currently being collected. As sanitary waste is in any case, ultimately disposed to the same point as municipal solid waste, with sewage screenings going to landfill or incineration, there is likely to be no difference between the ultimate fate of the sanitary solids removed from wastewater systems, and any change which would mean that more of these solids were placed directly into the municipal solid waste stream closer to their point of origin.

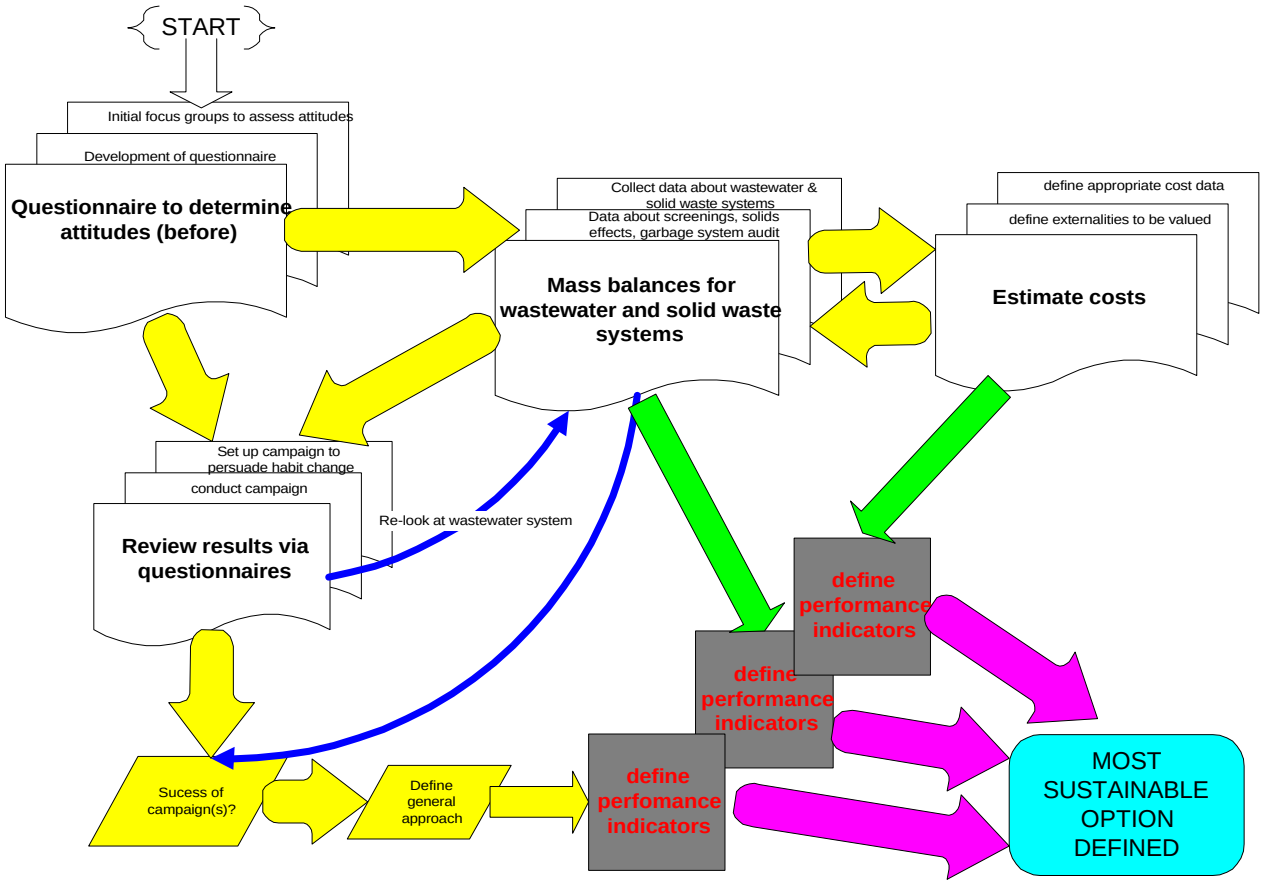

Figure 2 - Study Elements

Direct environmental benefits would also accrue due to a reduction in the numbers of items of Sewage Related Debris (SRD) being discharged from wastewater systems into the environment. Despite recent Directives and Regulations making screening of such discharges mandatory (and now being implemented), current screen technologies are unable to ensure that all such items are prevented from 'escaping' on to beaches or watercourses, prior to their screened removal for controlled disposal. Additional, but less significant benefits would also arise from the reduction in sanitary waste materials eventually being collected in sewage sludge, increasing the subsequent sludge disposal problem.

The project used both qualitative and quantitative surveys, framed around intensive public awareness campaigns in four test areas in Scotland, to establish that a significant number of people would be willing to change their behaviour, and place their sanitary waste into the solid waste route, rather than into the WC. It is expected that a rapid change in behaviour of by least 50% of those currently flushing could be easily realisable by mounting public awareness campaigns. The public also expressed a willingness to pay to ensure that SRD was not seen on beaches and river banks, with an equivalent increase in local taxation of 1 - 1.5%.

It is concluded that it is more sustainable to dispose of sanitary wastes via the solid waste route, and that for the purposes of continuing assessment as to whether there is a move toward greater sustainability within a given area, a single indicator could be used which incorporates a number of sub-indicators, and which is robust enough to allow for uncertainties in their assessment: the numbers of domestic sanitary items being flushed.

Whilst appearing to be a relatively straightforward (2 option) study at the outset, it has required the collection of a lot of data, and the harmonious working of a multi-disciplinary team. The results also demonstrated that to determine whether one scenario is more or less sustainable than another requires detailed assessment of the technical, economic, environmental and social systems and context. In addition, the study identified a number of alternative scenario options, and practically, it is proposed that a combination of approaches is taken to make the disposal of sanitary wastes more sustainable:

1. Pressure should be applied to manufacturers to minimise materials and make these more 'environmentally friendly'.
2. Public awareness campaigns should be run to attempt to persuade people to change their habits.
3. The fitting of low flush small diameter outlet WCs/plumbing in new properties should be investigated, as this would both reduce the sanitary waste entering the waterborne system and at the same time reduce water wasted in flushing.

The study reported here relates only to the first 3 years of the work. Whilst the social aspects are reported for all four of the studied catchments, details of the mass balances, economics and cost-benefits have so far been investigated only for the two Dundee catchments. During the next phase of the work (funded by the Scottish Water Authorities) in 1999, analyses will be undertaken for the two other catchments, together with risk assessment. Simultaneously, Life cycle analysis will be completed for the waterborne disposal route and two additional catchments will be studied on the west coast of Scotland, using the methodologies developed in this first stage of the research, and also studying the dispersal of the sanitary solids from sea outfalls. Additional public awareness campaigns will be undertaken in the East of Scotland Water Authority area. The results from these activities are also being used in a new EPSRC/water industry study (WITE initiative, GR/M15545), investigating the development of tools for the water industry to assist decision makers in determining how to assess whether changes are likely to introduce *more* or *less* sustainability. This research is collaborative between UAD, Imperial College of Science, Technology & Medicine, Heriot-Watt University and Coventry University.

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DISCUSSION

Question **Nick Orman** **WRc**

I am interested in you comments on what should and should not be flushed , WRc are involved in some research that suggests that the paper in low flush systems actually helps to keep the top ends of sewer systems clean.

Answer

I am aware of this research as it involves the same research team as ours.

Question **Alan Wisdish** **WS Atkins**

I can see the benefits to the Water Authorities or Water Companies , but what are the benefits to the general public/customers?

Answer

The brief of the project was to find the sustainable solution from two options. We have only shown that flushing is less sustanable. The benefit to the public will be a better environment and a cost saving on water charges.

Question **Mark Bottomley** **Montgomery Watson**

One problem is looking at the model of the Water Industry, the structure of which creates artificial boundaries. How far does this affect your findings and the applicability of sustainable solutions?

Answer

Nobody has properly addressed the sustainable issue which is made worse by PFI and EUWWTD.