WASTE MINIMISATION PERFORMANCE MONITORING : AN AUSTRALIAN PERSPECTIVE*

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1 INTRODUCTION

1.1 The Need for Waste Minimisation Performance Monitoring in Australia

A series of Conventions, Regulations and policies in Australia relating to waste management require the collection and reporting of solid and hazardous waste generation data at the international, national, regional and firm level. At the international level, Australia has an obligation to collect and report waste data in accordance with OECD Council decision C(90)178/FINAL of 31st January, 1991 and the Agenda 21 recommendations (UNCED, 1992) .

At the National and State level, governments as well as industry umbrella groups have established policies that require the monitoring and reporting of waste generation. Government policies include :

- The National Waste Minimisation and Recycling Strategy, which includes a target of reducing the quantity of waste (on a per capita basis) being disposed to landfill by 50% of 1990 levels by yr 2000.
- The national Kerbside Recycling Strategy, which includes recycling targets for particular materials by 1995
- The Intergovernmental Agreement on the Environment (February 1992) signed by Commonwealth, State and Local Government clarifies their roles and responsibilities and provides a mechanism for a cooperative national approach to the environment.
- The ANZECC National Packaging Guidelines set targets of reducing packaging waste requiring disposal by 50kg per capita (approximately 5% p.a.) of the amount sent for disposal in 1991.

Industry umbrella groups have also developed policies to guide their members in improving environmental performance. Many of these include requirements for waste generation data collection and monitoring, often associated with the setting of benchmarks and the monitoring of their achievement. Examples include the Australian Manufacturing Council's Best Practice Environmental Management and the Australian Chemical Industry Council's Responsible Care program.

1.2 The Australian Waste Database (AWD)

It can be seen from the brief review in Section 1.1 that there is a wide spectrum of requirements for the collection and reporting of information on waste generation and management in Australia; similar requirements no doubt exist in many other countries. The danger in Australia, and internationally, is that, through a lack of coordination and standards, information will be collected in forms that do not facilitate aggregation and comparison across industry sectors, nor across State and National borders.

The Australian Waste Database (AWD) project was initiated by the CRC for Waste Management and Pollution Control Ltd and the EPA of Australia to establish a database on waste generation in Australia which can be used by State and Federal environmental and waste management agencies, and other interested organisations, to set and monitor the achievement of national waste minimisation targets.

To achieve this aim, the following objectives will need to be met:

(a) Review and establish nationally agreed classification systems for various groups.
(b) Establish a protocol for sampling and characterising urban solid wastes.
(c) Establish a national waste generation database to provide fundamental information on the generation of different types of waste (urban solid waste and manifested hazardous waste) by region and in relation to relevant parameters.

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1.3 Scope of this paper

In this paper, the authors want to address some difficult and fundamental questions relating to the need for national waste databases (ie waste minimisation performance monitoring) and the extent to which they can be used for improved regional environmental management. The questions are :

- Is it useful to set waste minimisation targets ? ie have we asked the right question ?
- What issues need to be addressed in establishing individual numerical targets for waste streams and materials in waste streams ?
- What methods can be used to collect and manage waste generation data ?

Detailed descriptions of the manner in which the AWD will collect and manage waste data are provided in reports produced by the project and are available from the authors on request. General issues and approaches only are covered in this paper. The paper concludes with some suggestions for ISWA involvement in coordinating possible international activities in the field of waste information standardisation.

2 WASTE MINIMISATION TARGETS

2.1 Targets in General

2.1.1 Advantages in setting targets

The importance and prime advantage of setting targets for waste minimisation has been that they focus the attention of the various players involved, and move the management of wastes in the preferred direction. The 'reduce by half by Yr 2000' phrase is easy to remember and challenging enough to cause organisations to drastically re-evaluate their material use/waste generation. This is what is required; marginal improvements, while important, may not be enough to achieve the desired ends. The remainder of this review *is* concerned with a critique of the setting and monitoring of actual targets, but this general comment should be remembered to provide a proper perspective on the issues discussed.

It is also important that resources spent on collection of data do not exceed the potential benefits of such collection. Targets should be set covering the % of population covered directly by data collection procedures, and an appropriate range of communities and industries from which data is collected.

2.1.2 The context in which targets are set

The various targets on total waste stream quantities being disposed, reductions in the quantity of certain goods (packaging) in the waste stream, and increases in recycling rates of certain materials all generally aim to increase waste minimisation, which is at the top of the preferred hierarchy of waste management, now a principle adopted by most Australian State environmental authorities.

Waste minimisation can be seen as one of the principles to assist in the achievement of sustainable development in the field of waste management; and sustainable waste management could be defined as control (minimisation, treatment and disposal) of emissions to within environmental protection limits and an appropriate contribution to conservation of resources (Brunner & Baccini, 1992). A recent international workshop on Materials Management and Regional Sustainability (Brunner & Baccini, 1994) concluded that in order to do this in a sustainable way (ie, indefinitely into the future), we must go beyond managing waste materials as a separate system, and move towards managing materials as a whole in regions.

When we have an understanding of the material flows in a region we know which input goods are significant, where the stocks of certain materials are accumulating (for possible future disposal as waste or as a resource), and where both current *and future* waste emissions will arise under different materials management scenarios. We can then design materials management systems to most efficiently satisfy the dual objectives of controlling emissions and conserving resources. We might then be able to *derive* (rational) waste minimisation targets for specific materials and (rational) waste reduction % to landfill disposal, because this is what is required by the sustainable development criteria of emission limits and resource conservation.

With landfill prices in Australia ranging from US$5 - 30 / t for urban solid waste, it is difficult to argue that there is a scarcity of the resource "landfill space". It would appear, therefore, that waste reduction to landfill and material specific recycling targets are, or should be, set on the basis of the sustainable waste management objectives of resource conservation and the potential for certain materials in certain quantities to cause unacceptable emission levels.

Concentration of monitoring resources on ambient environmental quality and waste outputs will only provide a (very good) understanding of the problem after it has manifested itself in the monitoring data. Authorities and institutions then need to *react* to remediate the now identified problem, and to change the system so that the problem does not continue to occur. Experience has shown that this may take 30 years in the case of problems that can be remediated (Phosphorus eutrophication of lakes for example), while in cases such as ozone depletion, remediation may not be possible. Therefore monitoring and target setting at the waste/output end of the materials management system is not enough. Indeed, because of the inherent difficulties associated with measuring all the attributes of waste (Section 2.1.3), a strong argument can be made for only measuring the core *material*, stripped of the messy higher levels of meaning, for which our measuring instruments are sorely deficient.

2.1.3 Inherent difficulties associated with defining "waste"

Solid Waste is defined as a material which has negative value to its owner in a particular place and time. This means that the one material (eg scrap tyres) :

- may be a waste to a particular owner now, but be a resource to the same owner in the future,
- may be a waste to one owner, but be a resource to other owners in different locations and/or times.

Solid waste is more than just a material that can be measured by scientific means alone; it also has attributes of economic value which are dependent on the location of the material in space and time. Additional attributes of solid wastes are acquired through their political/institutional setting; for example, the management of solid waste is influenced by the type of institution (private, local government, state government) given responsibility for it beyond the owner. Thompson (1994) argues that wastes also acquire meaning through their cultural context - the one material can evoke very different psychological reactions from people in different cultures. These different levels of meaning associated with solid waste make measuring and recording it, and undertaking inter-regional comparisons, a complex exercise.

There needs to be an efficient allocation of resources to monitoring all parts of our materials usage, not just materials when they become wastes, so that the best data for proactive environmental management can be obtained. This may take some time, and in the interim the monitoring of waste generation and disposal (and environmental effects) with feedback to waste production processes (industrial and household) should continue so that materials management, of which waste management is a sub system, moves in the preferred direction. This also means that resources would be better spent on establishing regional/country materials accounting systems than on refining waste generation data collection so that errors are reduced from the current +/- 20 - 30 %(?) to say 10 - 15 %, but not 2 - 3 %.

2.2 Specific Targets

In setting waste minimisation targets, such as a reduction by 50 % in waste generation/disposal (?) to landfill, and in setting recycling targets for waste materials; there are some fundamental issues which need to be addressed, namely :

- What is 100% ?Should the base year (1990 in Australia) starting point be the same for all communities, or the (different) 1990 level for each community (the difficulty of knowing the 1990 level is appreciated).

- How is recycling % defined ?Difficulties associated with setting recycling targets for waste materials include :

    - how should/can waste reduction through light weighting and reuse be included in these targets.
    - how can imports and exports be accounted for; both between regions in Australia and between Australia and overseas.

- Are all means to the end of reducing waste generation/disposal equally preferred, or do some have priority and perhaps some should not be counted at all. For instance, how should the following be treated:

  - waste reduction associated with economic recessions,
  - incineration to reduce waste to landfill, with and without energy recovery, with and without metal recovery,
  - recycling activities which consume more energy and materials than are "saved",
  - waste reduction per head by increasing people per household, or vice versa (it may be that households are more significant than people as a unit of waste production for some waste streams and material types).

2.3 Accuracy of Data

The current poor reliability of waste data in Australia arises from a number of factors (Moore et al, 1993); in summary :

- The lack of a consistent solid waste classification system, leading to uncertainty over what is included or excluded in apparently similar waste streams.
- The different methods used to measure the quantity of waste arising, leading to different levels of confidence in the accuracy of the data
- The purpose for which the data is being collected, leading to bias.

The Australian Waste Database project should lead to direct and early improvement in the first two sources of error, and it is hoped will indirectly influence the third source of error in the medium term, through information feedback having a positive influence on data collection procedures.

3 DATA SOURCES

3.1 General Approaches

There are a range of methods that have been, and are currently being, developed to obtain information on waste generation, disposal and recycling rates. There is no one best method for collecting information on waste generation rates, and where possible (including regard for the resources available), the principle of data redundancy should be built into the study; i.e., a number of different approaches to determining the one result should be attempted in order to improve the confidence in that result and the understanding of the system being analysed. Reliance on single methods can often mask significant omissions because of bias inherent in the method.[1]

The AWD project will document in some detail the variety of approaches that are being developed. A summary of the main methods currently available is provided in the remainder of this section.

3.1.1 Waste generation and disposal quantities :

Waste stream arisings and disposal quantities (t of waste stream/region and month or year) may be determined by :

- Directly weighing (or inferring weight by counting trucks with assumed waste weights) waste from identified sources at the gatehouse of waste treatment and disposal facilities. Records kept by the operator of the landfill may then be accessed by :

[1] This principle of preferred data redundancy should not be confused with the need to **avoid** data entry redundancy in the establishment of a database using one of the methods - double entry of data leads to increased sources of error which should be avoided.

- Undertaking a questionnaire survey[2] of the whole sample population of :

    - waste generators, who have contracts with the disposal facility
    - waste regulators at the State level, who receive data associated with Regulations
    - owners of waste landfills and treatment facilities.

- Indirectly accessing the databases now being established by each State authority responsible for regulating waste management.
- Selectively sampling a small representative number of facilities and/or councils, possibly in conjunction with Australian Bureau of Statistics (ABS) regular surveys.
- Reviewing Waste Management Plans prepared by Councils and regions.

♦ Materials balance techniques, whereby information on the import of goods and materials into a region, their use within the region, and export from the region is used to build a model of the storage of materials and production of wastes in the region. The model can only be made as fine as the statistical data will allow, and so the system boundary is often that of the country.

3.1.2 Waste composition

Composition of the various waste streams can be assessed by one or a combination of the following methods (Brunner and Ernst, 1986) :

♦ **Direct sampling and sorting studies**, using a variety of sampling approaches (at the point of generation, at transfer stations, incinerators and landfills). The techniques for the domestic waste stream are becoming better defined, but there is still much development work to be done for Other Domestic, Other Council, Commercial and Industrial, and Building and Demolition waste streams. These studies can only report on the material types in the waste stream, and some of the dominant elements, such as carbon and nitrogen. The method is not well suited to trace element analysis.

♦ **Market analysis, or regional materials balance models**, to provide estimates of materials (such as paper, plastic) that would be expected to report to the waste streams. The total waste generation calculated by this method, as described above, is determined by summing all the material types in the waste streams. The method involves the identification of significant processes in the regional materials management system, identification of the flow of significant goods, and then the materials balance of the system from knowledge of the material composition of the goods and the transfer coefficients of materials through processes (Baccini & Brunner, 1991).

♦ **Waste treatment process materials balances**, using existing facilities such as incinerators and composting plants as "instruments' to analyse the waste stream being processed into its component elements (C, P, Cl, Hg, Pb, Fe, Al etc). Brunner et al (1986) have analysed the composition of the products of waste incineration plants in order to derive the transfer coefficients (partition coefficients) for a range of elements in solid waste streams. Once transfer coefficients are established for a particular facility, it is then only necessary to sample one product (eg fly ash) in order to derive the composition of the raw waste for selected elements.

All three methods have particular advantages and disadvantages, and the method providing the most reliable answers within resource constraints, for the particular question being asked, needs to be employed.

3.2 Sources of Data

Studies undertaken in Australia to date rely on questionnaire survey methods of various bodies. This section has attempted to outline the full scope of waste (and materials) data collection possibilities, and has indicated the techniques that have been used in these survey based approaches and the approach that the AWD will take.

[2] "Questionnaire survey" is used throughout this report to mean a procedure where standardised questions are sent to a sample population, and all involved in the survey are followed up by means of an interview to ensure that the questions are not misinterpreted, and that some understanding of the basis for the data provided is gained by the surveyor. It is much more than a simple mail out of questions and collation of responses.

"Survey fatigue" of the data suppliers and the considerable resource input by the surveyors, means that these questionnaire techniques on a broad scale should not continue into the future. Hence the need for the approach being developed by the AWD, whereby existing data collection processes will be standardised and coordinated at a National level. Supplementary surveys of samples of some of the various statistical populations may need to be instituted, and ongoing surveys of recycling material users will be necessary.

Table 1 presents a summary of the various data sources and the use of these sources by the AWD. This should provide a useful basis for discussion on the data collection methods that should be used, and may explain why the information from various sources will inevitably have some differences.

Table 1 : Application of Material Data Collection Techniques to Various Material Parameters

\ Material Technique \ Type	Materials Balance of Regions (1)	Regional Urban Solid Waste Stream Quantities	Regional Recycle Quantities	National Recycle Quantity	Composition of Urban Solid Waste Streams
UNITS	t material type/region + year	t waste stream/region + (month or year)	kg material type/person + region +(year or month)	% of recycled material in goods	material type as a % of waste stream, by weight. kg material type/person + week
MFA of processes	* (4)				AWD
MFA of regional systems	*	*	*	*	
Survey whole statistical Population				AWD	
Survey sample of statistical Population.	*	[AWD] (2)	[AWD]		
Access existing Regulatory databases		AWD	AWD		
Access Regional Waste Management Plans		(AWD) (3)	(AWD)		AWD
Direct Sampling and sorting studies by various					AWD

Notes :

(1) In practice, the MFA (Materials Flux Analysis) technique considers using any and all sources of data, with data redundancy preferred where possible.
(2) To be included in AWD if undertaken by , for instance the ABS.
(3) To be included in AWD if State authorities require Waste Management Plans and aggregate data in a form suitable for the AWD.
(4) * means technique is applicable, but not part of scope of AWD.

4 CONCLUSIONS

In designing regional and national waste data collection systems for waste minimisation performance monitoring, the inherent difficulties associated with measuring waste must be recognised and addressed. Ad hoc and on-going questionnaire surveys are unlikely to yield reliable results because of "survey fatigue", and therefore alternative mechanisms which have other inherent needs and benefits (such as the collection of levy revenue which is subject to financial audits and laws governing fraud) should be utilised.

In the medium term, the difficulties associated with measuring waste, and the reactive environmental policy response that waste monitoring produces, can only be overcome through comprehensive systems of regional materials accounting. Knowledge of our use and misuse of materials in all their life stages, rather than only when they are raw materials and when they are wastes, is necessary for proactive environmental management policy development.

In the short term, the demands for national waste monitoring by international agreements and conventions requires the development of international waste management reporting standards so that comparisons between countries can be better made. Currently this is hardly possible because of the plethora of waste terms and definitions, and because of the region specific higher levels of meaning associated with waste materials. Such standardisation of reporting of waste materials should keep in mind the use of the data for future regional materials accounting purposes.

ISWA is in a unique position to be able to initiate and steer the development of appropriate international reporting conventions in the field of waste management, and the authors commend this worthwhile task to the ISWA executive.

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