Guidelines for Auditing Kerbside Waste in Victoria

Leading practice for measuring kerbside waste, recycling and green organics

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Executive Summary

This Guide is intended to be used by councils and their contractors in planning and carrying physical audits of household garbage, recyclables and organics collection services. This Guide is for weight-based physical audits where materials are manually sorted and weighed according to categories of materials types.

The intent of the Guide is to promote greater standardisation of future audits, allowing councils to compare the performance of their waste and recycling management systems over time and with other councils. The Guide has been designed in consultation with councils and waste auditing businesses to develop an audit methodology that cost-effectively produces accurate and useful data and information.

Guidelines for Auditing Kerbside Waste in Victoria
Leading practice for measuring kerbside waste, recycling and green organics.

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The focus of the Guide is on the planning of audits, and using knowledge from audits to refine the methodologies of future audits. The Guide consists of a brief summary document and a number of more extensive Appendices containing additional information and tools for the planning and execution of audits. The proposed audit planning methodology uses the following steps:

Step 1: Define the purpose of the audit

Councils typically commission a second party to conduct bin audits. The Guide provides information about defining the purpose of the audit, setting the audit scope, and developing an audit brief.

Step 2: Classify materials types

Use of a standardised audit classification system will allow more direct comparison of results over time and from different areas, regardless of the auditors used. The guide recommends using a standard system as the framework for audits, but encourages the use of sub-categories to reflect what each individual audit needs to achieve.

Step 3: Determine sample size, audit method and accuracy levels

For typical bin audits conducted over an area with fairly uniform and typical variability in the waste stream, the following samples sizes are recommended:

- General garbage composition audit = 125 – 250 premises
- Recycling bin audit = 125 – 250 premises
- Garden organics bin = 50 – 125 premises

A statistical modelling tool accompanying this Guide has been developed to help councils to estimate the size of the sample they need to be confident in audit results. It is recommended that where budget is constrained it is better to limit the number of items audited rather than reduce sample size to the point where accuracy is poor.

Step 4: Consider the areas to be audited, and the appropriate audit type

The accuracy of audits will depend on how well the sample taken matches the wider population's waste. This is typically achieved by randomly selecting a big enough population to be representative of the wider population. In municipalities with significant variation in land use, housing types, and socio-economic populations, stratified sampling is recommended to specifically audit representative areas that differ. The Guide provides a recommended technique for selecting random populations using a randomised grid selection technique to select areas to audit.

Step 5: Consider seasonal and other variability

Records of the tonnes of waste collection over the year can be used to identify variations and periods where 'average' quantities of materials are typically collected. Knowledge about the nature of variability can also be valuable, and secondary audits conducted during periods of seasonal variation may be useful. It is recommended that unless the intent of the audit is to test for seasonal variability or the average composition of the organics stream, the best months to conduct green waste audits are generally the autumn months of March, April and May of any given year, when the amount of garden organics most closely matches the annual average. This will depend on weather conditions in the weeks preceding the audit. Audit data should be checked for discrepancies with records of quantities of materials collected from the wider community annually and during the audit period.

Step 6: Select sample populations. The following method is recommended:

1. Map the area or areas to be sampled.
2. Superimpose a grid over areas to be sampled and allocate numbers to each cell in the grid.
3. Use randomised grid sampling to select cells to be sampled. Select at least 5 grid cells to audit.
4. Allocate numbers to all streets within the selected grids.
5. Use randomised number sets to select streets to be audited. Audit at least 5 streets per grid.
6. Use randomised number sets (between 1 and 10) to allocate premises from the corner of the street to be sampled to commence auditing.
7. For streets with more than 50 households, select every 5th household from the starting premises and collect at least 5 premises per street.
8. For streets with less than 50 households, select every 2nd households until the required number of samples are taken (at least 5 for garbage and recycling, at least 1 for green organics).

Where stratified sampling is to be used:

- Randomised grid selection can be used if the stratification is based on geographic area (e.g. stratified sampling of higher density/terrace housing separate to areas with mainly lower density dwellings)
- If the stratification is according to housing type (e.g. Multi-Unit dwellings or MUDs) dispersed through the rest of the population, address lists will be needed. Numbers should be allocated to the addresses, and then random number sets used to select the sample population.

Step 7: Determine bin collection and field data collection protocols

Due to significant OH&S, privacy and efficiency advantages, this Guide recommends that for standard composition audits, aggregated samples should be collected by mechanical-lift vehicles.

This implies separate collection of each of the garbage, recyclables and/or organics services being audited, but with aggregation of collected samples. This allows assessment of variation in the quantities and composition of materials collected per household.

Step 8: Consider limitations to selected sample populations

Although the intent of the random selection process is to gain a representative sample, local knowledge can be used to assess whether the sample chosen may not be representative. Particular areas or types of premises may be over represented in the random sample. If it is felt that this may be the case, then additional sample areas, streets and premises should be added to the audit until it is felt that the sample is representative of the wider population.

Step 9: Consider OH&S and working conditions

It is vitally important that audits methodologies are designed and carried out with consideration of health and safety issues. All sampling methods used in the State of Victoria must comply with Work Safe Workplace Laws and Handbooks

- "Safe Collection of Hard Waste" and
- "Occupational Health and Safety Guidelines for the Collection, Transport and Unloading of Non-Hazardous Waste and Recyclable Materials".

Step 10: Prepare audit documents and protocols

Councils typically engage second parties to conduct audits. To ensure clarity regarding the audit scope and expectations of what the auditor will deliver, it is recommended that councils prepare audit brief documentation prior to seeking quotes that include:

- A clear statement of the purpose of the brief
- Proposed standardised audit materials classification and proposed data collection forms
- Proposed collection areas and minimum numbers of samples to be collected
- Proposed sampling protocols
- Proposed operating procedures to ensure quality assurance of collected data
- Minimum standards of OH&S management and protocols
- Clauses to protect the privacy of the community
- Clauses to ensure that council retains intellectual property and ownership of all audit data

Once these planning steps are completed, councils can appoint an auditor. Once the auditor is appointed, the methodology can be refined to ensure cost-effective delivery of the brief. Some councils may choose to leave the full development of Steps 3 to 8 above to the appointed auditor, but it is recommended this is done with the close involvement of council personnel to ensure that the methodology meets the council's needs and benefits from the input of local knowledge.

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We would also like to acknowledge the input provided by Pam Keating to waste auditing in Victoria over the past two decades. Pam was a pioneer in waste auditing and worked with the industry to ensure the highest standards in safety and data integrity.

Introduction

This guide provides local governments and private operators with advice on waste auditing methodology to enable them to better analyse the performance of kerbside waste management services. The focus of the guide is weight based physical auditing of kerbside materials.

The guide's main purposes are to:

- Provide a standardised methodology for weight-based audits to obtain composition data about kerbside garbage, recyclables and organics.
- Inform those commissioning and undertaking audits of OH&S and the Duty of Care obligations and requirements.
- Help councils and others who commission audits to better understand the professional waste auditing process.
- Assist councils and contractors to cost-effectively measure the performance of systems.
- Assist those commissioning and undertaking audits to design audits that provide the information and level of accuracy they need.
- Provide general tools for those undertaking audits.
- Provide a methodology that informs users about the accuracy and limitations of audit data in future waste management planning.
- Help councils to continuously improve the performance of kerbside waste and recycling services.

The audit methodology outlined in this guide will allow councils and contractors to directly compare results of previous audits in their own and other areas, allowing benchmarking of performance and monitoring of continual improvement.

The document is not intended as a detailed technical guide for practitioners undertaking audits, although the information provided may assist them in developing their audit methodologies.

Why Audit?	Outlines the key reasons for auditing and factors that need to be considered when commissioning or conducting an audit
Getting Started	Details factors that need to be considered in defining the purpose and scope of an audit, and in deciding on the nature of the audit to be conducted
Audit Design	Provides advice on a standard audit design, detailing where this can be refined to meet specific needs
Commissioning & Conducting an Audit	Provides advice on factors to be considered in commissioning and audit, and the practicalities of undertaking an audit
Reporting & Using Audit results	Outlines some of the uses and limitations of audit results, and suggests ways in which the results of audits can be used to refine future audits

A glossary, appendices and auditing tools are provided to support this guide.

The Guide consists of the following sections:

1 Why audit?

This Guide can improve the consistency and accuracy of audits, providing better information about the performance of different systems used to provide kerbside services.

Audits can help councils to:

- Accurately measure the composition of garbage, recyclables and green organics bins
- Establish waste generation trends
- Plan infrastructure and systems
- Report, review and track resource recovery performance
- Increase opportunities to increase recycling from garbage bins
- Accurately measure contamination rates in recycling and green organics services.
- Calculate the net carbon footprint of waste disposal and resource recovery services
- Calculate potential carbon liabilities related to landfill emissions
- Set and monitor benchmarks and continual improvement targets for waste minimisation and recycling within their community
- Accurately compare own performance over time, and compare with other councils using similar methodologies

2 Getting started

Those commissioning audits need to consider what information they want to obtain, any variability within the areas to be audited, and the practicalities of collecting and measuring samples.

Some key issues and needs to consider when planning and commissioning an audit are:

- What is the purpose of the audit?
- What information is already available from council records and previous audits?
- How much variation in the quantities of materials occurs over the course of a year?
- What are potential sources of variability across the audit area and over the course of the year and how can these be accounted for?
- What budget and resources are available for the audit, and what are the implications for the scope and accuracy of the audit?
- How will sampling be coordinated with regular collection?
- Are there any physical, commercial or other constraints to accessing samples?

- How will privacy and other community concerns be managed?
- What OH&S requirements will be placed on the audit?
- Who needs to be consulted in designing and coordinating the audit?

Appendix A provides further information about getting started.

3 Audit design

This section provides a guide to designing a weight based composition audit. If you are new to auditing it will be critical to refer to the further details provided in *Appendix B*, *Audit Methodology*.

Step 1: Define the purpose of the audit

Councils typically commission a second party to conduct audits. It is vital to clearly state what the audit needs to deliver to meet the minimum auditing requirements in an audit brief.

This Guide provides a recommended standard approach for auditing to measure the composition of kerbside garbage, recyclables and green organics bins. This should provide statistically robust and accurate information about major components of these materials streams, and slightly less accurate information about more lightweight and less common items in these materials streams. The methodology also collects data about: the average weight of materials set out by the sample population during the audit; and household participation and set out rates. If you require more or even less detailed information from your audit, you may need to refine the methodology to meet your needs. The detailed guide in *Appendix B* provides more information on how to define the purpose of the audit and how this may impact on your audit design.

Step 2: Classify materials types

Use of a standardised audit classification system will allow more direct comparison of results over time and from different areas, regardless of the auditor's used.

The material type, detailed in *Appendix B*, allow different levels of detail to be applied in the audits according to information needs. General broad categories are made up of second and third tiers of more detailed categorisation. For example, the general classification 'Plastics' is broken into different categories of plastic types, and these in turn are classified as 'packing' or 'non-packaging'. The actual category used will depend on what the audit needs to achieve.

Step 3: Determine sample size, audit method and accuracy levels

The statistical modelling tool accompanying this Guide has been developed to help councils estimate the size of the sample they need, to be confident in the results on their report. This model also allows councils to estimate the level of accuracy in samples that have already been completed. It is recommended that this tool is used when developing the scope of an audit. For typical bin audits conducted over an area with fairly uniform and typical variability in the waste stream, the following samples sizes are recommended:

- General garbage composition audit = 125 – 250 premises
- Recycling bin audit = 125 – 250 premises
- Garden organics bin = 50 – 125 premises

The cost and accuracy of the audit will be determined by sampling technique, and usually there is need to balance the available budget and the level of accuracy to make the audit results meaningful. Ideally, budget should be matched to information needs, but more typically, information needs will need to be matched to available resources. This will impact on the number of categories of materials, the sample size and the degree of accuracy of result. It is recommended that where budget is constrained it is better to limit the number of items audited rather than reduce sample size to the point where accuracy is poor.

Step 4: Consider the areas to be audited, and the appropriate audit type

This Guide is for weight-based physical audits where materials are manually sorted and weighed according to categories of materials types.

The accuracy of audits will depend on how well the sample taken matches the wider population's waste. This is typically achieved by randomly selecting a big enough population to be representative of the wider population. The detailed guide provides details of a recommended technique to selecting random populations using a randomised grid selection technique to select areas to audit.

Sampling accuracy will vary according to the variance within the population compared to the variance within the sample selected for the audit. Populations with less variation require fewer samples, and those with more variation will require more samples to gain the same level of accuracy.

One way to reduce the number of samples required in a varied population is to conduct stratified sampling, whereby areas or types of housing recognised as having different material stream characteristics are sampled separately using a randomised sample selection technique for this discrete sub-population. The audit results for each sub-population can then be used with demographic information to estimate the composition of the entire population. For example, areas within a municipality with high numbers of Multi Unit Dwellings (MUDs) may be isolated and sampled separately from the wider, lower density housing population. The audit results from the MUDs and wider population results could then be compared and multiplied with data about the number of MUDs and lower density housing to estimate total materials composition of the municipality.

Step 5: Consider seasonal and other variability

Records of the tonnes of waste collection over the year can be used to identify variations and periods where 'average' quantities of materials are typically collected. Knowledge about the nature of variability can also be valuable, and secondary audits conducted during periods of seasonal variation may be useful.

Audit limitations due to seasonal variability can be minimised through the following measures:

- Do not audit during holiday periods, such as Easter, Christmas or New Year unless the objective is to test waste at peak times.
- Do not audit before, during, or after long weekends, public holidays, or the week after the AFL grand final.
- Do not audit within four weeks of an extreme weather event such as a cyclone, very heavy rains, heat wave or other extraordinary conditions.
- Ensure all audits are full collection cycles. If a kerbside system has fortnightly alternating recycling and green waste collections, a typical waste stream audit would need to be collected over the fortnightly period and then averaged to establish the true waste profile for waste, recycling and organic streams.

Unless the intent of the audit is to test for seasonal variability or the average composition of the organics stream, the best months to conduct green waste audits are generally the autumn months of March, April and May of any given year. This is the time of the year when the amount of garden organics typically most closely matches the annual average. This will depend on weather conditions in the weeks preceding the audit. Audit data should be compared to records of quantities of materials collected from the wider community annually and during the audit period.

Step 6: Select sample populations

The following method is recommended:

1 Map the area or areas to be sampled.

2 Superimpose a grid over areas to be sampled and allocate numbers to each cell in the grid.

3 Use randomised grid sampling to select cells to be sampled. Select at least 5 grid cells to audit.

4 Allocate numbers to all streets within the selected grids.

5 Use randomised number sets to select streets to be audited. Audit at least 5 streets per grid.

6 Use randomised number sets (between 1 and 10) to allocate premises from the corner of the street to be sampled to commence auditing.

7 For streets with more than 50 households, select every 5th household from the starting premises and collect at least 5 premises per street.

8 For streets with less than 50 households, select every 2nd households until the required number of samples are taken (at least 5 for garbage and recycling, at least 1 for green organics).

Where stratified sampling is to be used:

- Randomised grid selection can be used if the stratification is based on geographic area (e.g. stratified sampling of higher density/terrace housing separate to areas with mainly lower density dwellings)
- If the stratification is according to housing type (e.g. MUDs) dispersed through the rest of the population, address lists will be needed. Numbers should be allocated to the addresses, and then random number sets used to select the sample population.

Step 7: Determine bin collection and field data collection protocols

Due to significant OH&S, privacy and efficiency advantages, this Guide recommends that for standard composition audits, aggregated samples should be collected by mechanical-lift vehicles. This implies separate collection of each of the garbage, recyclables and/or organics services being audited, but with aggregation of collected samples. This allows assessment of composition, and comparison of sub-samples allows assessment of variation in the quantities and composition of materials collected per household. Possible auditing techniques are described in *Appendix B*.

Step 8: Consider limitations to selected sample populations

Although the intent of the random selection process is to gain a representative sample, local knowledge can be used to assess whether the sample chosen may not be representative. Particular areas or types of premises may be over represented in the random sample. If it is felt that this may be the case, then additional sample areas, streets and premises should be added to the audit until it is felt that the sample is representative of the wider population.

Other limitations and factors that should be considered include:

- Collection days of all services in the selected areas. The total sample for the day should match the available auditing resources. Many councils collect garbage weekly, but have less frequent collection for organics and recyclables. Sampling should aim to capture garbage in both weeks of the cycle, and the other services once.
- Collection times of all services. It is important to coordinate audits to collect materials before the council service is scheduled. It is recommended that there should be good and clear communications between the audit team and collection contractors and council contract managers to coordinate collections.

Step 9: Consider OH&S and working conditions

Waste auditing poses significant risks to auditing personnel from lifting and handling materials, and exposure to sharps, hazardous and infectious materials, heavy vehicle work areas and potentially the sun. It is unpleasant work.

It is vitally important that audits methodologies are designed and carried out with consideration of health and safety issues.

All sampling methods used in the State of Victoria must comply with Work Safe Workplace Laws and Handbooks

- "Safe Collection of Hard Waste" and
- "Occupational Health and Safety Guidelines for the Collection, Transport and Unloading of Non-Hazardous Waste and Recyclable Materials".

Details of OH&S requirements are provided in *Appendix C*.

In most instances, councils will be required to provide a venue for the sorting of materials. This should be a well ventilated area where workers are protected from the elements and have access to amenities.

Step 10: Prepare audit documents and protocols

Councils typical engage second parties to conduct audits. To ensure clarity regarding the audit scope and expectations of what the auditor will deliver, it is recommended that councils prepare audit brief documentation prior to seeking quotes that include:

- A clear statement of the purpose of the brief
- Proposed standardised audit materials classification and proposed data collection forms
- Proposed collection areas and minimum numbers of samples to be collected
- Proposed sampling protocols
- Proposed operating procedures to ensure quality assurance of collected data
- Minimum standards of OH&S management and protocols
- Clauses to protect the privacy of the community
- Clauses to ensure that council retains intellectual property and ownership of all audit data and information.

Once the auditor is appointed, the methodology can be refined to ensure cost-effective delivery of the brief.

A comprehensive overview of Audit Design is provided in *Appendix B*.

4 Commissioning and conducting an audit

Quotes for providing the audit services should be assessed against the audit brief. Due d iligence should be conducted to ensure that the auditor selected has appropriate experience, trained auditing staff, equipment, OH&S systems and insurances to conduct an audit.

Once an audit team has been appointed, the council personnel managing the audit should:

- Establish a clear chain of command and communications channels between the audit team, relevant council personnel, and waste and recycling collection contractors.
- Ensure audit team have access to the right equipment and a suitable area for sorting materials.
- Ensure common understanding of audit outcomes, with council sign off on the final audit methodology, data collection sheets, and audit protocols.
- Ensure adequate levels of audit team training and data quality assurance.
- Conduct due diligence to ensure that the auditor complies with OH&S requirements (*see Appendix C*),

An important factor in the appointment of an auditor is to manage the risk of actual or perceived conflicts of interest. The contract under which the contractor is engaged should require disclosure of existing and potential working relationships with waste management companies, and ensure that council retains exclusive (not shared) copyright to all data and information from audits. All data and information should be made equally available to waste management firms in future council waste service contracts.

5 Using audit results

5.1 Determining accuracy and refining audit methodology

Audits deliver a range of data. The proposed audit methodology in this Guide should ensure a level of confidence that the data gathered from the sample populations approximate the situation in the wider community. However, this should not be assumed. The following checks on data quality are recommended:

- Field data recording sheets should prompt auditors to note observed anomalies in the presentation and content of materials from sampled premises. Household participation and set out rates for the sampled population should be kept and compared to a wider count of these factors. Unusual loads of materials present in samples should be noted during auditing and the field data sheets should allow and encourage this.
- Sampling protocols should ensure frequent field calibration of weighing equipment.
- Audit data should be used to estimate per household waste generation rates. These should be compared to records for the quantities of materials collected annually and during the audit period. If the audit results differ markedly, reasons for the anomaly should be considered in the reporting and use of the audit data.
- Where practicable, sampling should break the sampled population into at least five sub-samples (e.g. 25 premises per sample x 5 for a sample population of 125). This will allow some statistical assessment of variability within populations; allowing observations on the accuracy of samples and refinement of future audit methodology (*see Appendix B*).

5.2 Benchmarking and reporting

This Guide is accompanied by a suggested data analysis tool that can be used to generate audit reports.

Audit results can be used to:

- Quantify the composition of different materials streams.
- Set and monitor performance targets, such as: increased recycling and organics recovery and reduction of contamination levels in recycling and organics bins, or to reduce waste through greater home composting. Accurate audits allow you to set priorities for action and numeric targets for programs to achieve these outcomes. Periodic audits (at least every two years) allow performance to be tracked and priorities to be reassessed.
- Identify data gaps and uncertainties. Subsequent audits can be designed to fill these gaps.

5.3 Greenhouse and other sustainability benefits

Audit results can be used to estimate the greenhouse and other sustainability ‘footprint’ measures of current waste management practices within your municipality, and estimate the net benefits of improved performance of recycling and organics recovery systems. Suggested factors for estimating greenhouse and some other benefits are contained in *Appendix E*.

Audit brief checklist

Clearly stated audit aims and objectives

- ☐ Does the brief clearly state the aim of the audit?
- ☐ Does the brief list the objectives of the audit?
- ☐ Does the audit brief list the questions or hypothesis the audit is seeking to answer?
- ☐ Does the audit list the acceptable level of error associated with the data?

Supply of background and baseline information

- ☐ Have previous audits been reviewed and taken into consideration in designing the audit brief?
- ☐ Are past audits, baseline information and waste management strategies included in the brief's appendix?

Establishing a baseline and a future point of comparison

- ☐ Has a full waste stream audit been commissioned (i.e. are all kerbside collection services included?)
- ☐ Does the brief require the auditor to supply a transparent waste methodology?
- ☐ Does the brief require the auditors to document and define all the audit categories?
- ☐ Does the audit brief require the auditor to supply the category data interpretation and sampling protocols?
- ☐ Does the audit brief require copies of the completed data sheets?

Minimising audit bias

- ☐ Has the timing of the audit been considered and scheduled to minimise bias?
- ☐ Are there provisions in the audit brief to allow the audit to be postponed in the event of a major storm or high winds in the weeks prior to the scheduled audit?

Auditor competency

- ☐ Does the audit brief give preference to a professionally trained /experienced lead auditor and teams?

Conflict of interest

- ☐ Will the audit report be a public document?
- ☐ Does the audit brief prevent competitive advantage for organisations, subsidiary business groups or businesses that have the opportunity to tender for future waste management contracts? (That is, tenderers, and the successful contractor or auditor must not benefit unfairly from having access to audit information).

Confidentially and security

- ☐ Does the audit brief and terms of engagement clearly state that the commissioning agent retains exclusive ownership of all Intellectual Property resulting from the audit?
- ☐ Are the auditors and waste sorters required to sign privacy agreements?
- ☐ Is the waste auditor required to landfill or destroy identifying documents?
- ☐ Does the audit brief require police checks for lead auditors and waste sorters?

Confidentially and security

- ☐ Does the brief require that a full risk assessment be conducted for the audit?
- ☐ Does the brief require that an OH&S plan be developed and submitted prior to the commencement of any auditing?

Insurance

- ☐ Does the auditor have (or will have) in place before the audit, professional indemnity, legal liability and Work Cover insurance?
- ☐ Does the waste auditor have Work Cover insurance for the waste sorting team?

Data management

- ☐ Does the audit brief contain the data collection sheet that will be used for the audit?
- ☐ If the audit brief does not prescribe the data collection sheet are the auditors required to supply their own data collection sheet as part of the audit report appendices?
- ☐ Are the required data collection requirements listed?
- ☐ Are the auditors required to provide their waste category descriptions and data interpretation rules as part of the audit report appendices?
- ☐ Are the auditors required to supply copies of the completed data sheets to the client?
- ☐ Are the auditors required to outline their data input protocols in their audit methodology?
- ☐ Are the auditors required to supply raw audit in an electronic format eg. Excel file?
- ☐ Does the brief require the auditor to confirm contamination categories with the recycling processing contractor and local government prior to the commencement of the audit and setting of the data collection categories?

Data collection accuracy and calibration

- ☐ To what level of accuracy is the auditor required to record data i.e. 1 gram or 10 grams?
- ☐ Is the auditor required to disclose their volume estimation protocols as part of their methodology or accompanying report appendix?
- ☐ Is the auditor required to have all the tubs, crates and samples, used in the measurement process, weighed and calibrated?
- ☐ Is the auditor required to ensure that measurement scales are calibrated, ready for the audit?

Data validation

- ☐ In order to confirm that waste and recycling profiles are an accurate reflection of the actual waste stream, does the audit brief require the data to be validated against annual waste and recycling tonnage?

Key performance indicators

- ☐ Does the audit brief list the required key performance indicators with equations that must be reported as part of the audit report?

Due diligence

- ☐ Does the audit brief require an occupational health and safety risk management plan to be in place as part of the audit?
- ☐ Does the audit brief require all waste auditors and sorters to have Hepatitis and Tetanus injections and supply documented proof that all audit team members are immunised?
- ☐ Is the audit day sign-off sheet contained in the audit brief and is the auditor notified of the need to complete and pass the sign-off before the commencement of an audit?

Appendix A: Getting Started

Bin audits are conducted for different reasons. It is important to plan your audit so that it cost effectively delivers you the information and level of data accuracy you need. The following section outlines key factors when planning an audit.

Clearly define the purpose of the audit

The key to auditing is to know what questions you want the audit to answer. Factors to consider include:

- **Is the audit to obtain general waste composition information, or for more specific information about differences in waste management behaviours, contamination, or particular items in the waste?**

  If obtaining general waste composition information is the main audit aim, then aggregated sampling from known sample populations can be undertaken. Such audits are the primary focus of this guide. If more detailed information is required, then audit methodology may need to be refined.

- **What waste materials are you interested in?**

  Generally, audits focusing on items that make up a larger proportion of the waste by weight and/or have less variability from household to household will require few samples to be taken to gain an accurate picture of that material in the waste stream.

- **What level of accuracy is required?**

  Do you need to know how accurate the audit information is? Sampling of sub-sets of a sample population or loads will allow some statistical assessment of variability within the waste stream and sample population. This will allow some observations about the accuracy of the audit.

- **Is knowing the volume of waste types important?**

  Limiting bin size has been found to be one the most effective strategies for promoting waste minimisation and changing behaviour. Knowledge of the volumes of bulky items such as plastic packaging, cardboard and garden organics can inform decisions about bin sizes and potentially the number of households that can be serviced before collection vehicles are full. Similarly, food waste is dense so it contributes high weight but relatively low volume and may be able to be transferred from the garbage bin to the organics bin without significant change in collection volumes but significant change in weights. In this instance a weight based audit may suggest the need for bigger bins, but an audit assessing volume will show that there is not.

- **Is knowing variability between households' waste management behaviours important?**

  Knowing different household waste and recycling behaviours can help to tailor and monitor community education change programs and identify opportunities to offer smaller bin sizes. Aggregated audits provide an average weight per household, but do not provide information about the proportion of households that are high or low waste generators, good or poor recyclers, and/or are causing the majority of recyclables and organics contamination.

Some key issues and needs to consider when planning and commissioning an audit are:

- **What is the purpose of the audit?**

  It is important to list the information that you want the audit to provide and define the aims and objectives of the audit, considering the nature, and levels of detail and accuracy required. This involves defining the factors that are of interest, such as:

  - which materials streams are to be considered (garbage, recyclables, and/or green organics)
  - the types of materials to be considered in each materials stream sampled
  - whether demographic variability within the target area impacts on waste management practices
  - whether weight and volume measurements are important
  - whether the impacts of changes to services or community engagement initiatives to be measured

  This Guide is primarily for those wanting to use weight-based audits to measure the composition of garbage, recyclables and green organics with a view to improving and monitoring the performance of systems over time. More or less specific information needs will require different levels of auditing rigor, and this is discussed further in the guide.

- **What information is already available?**

  You may find that some of the information you wanted from an audit is already available from existing sources.

  Information from waste, recycling and green organics contracts should provide information about quantities of waste from different collection areas, seasonal variability in quantities, and potentially anecdotal information about areas with higher and lower than average contamination or bin set out. Having information about average waste generation per household per year is important as it will allow you to determine how closely the audit results match the wider population average.

Previous waste audits conducted in your area may provide information about variability in materials that can help you estimate the size of the sample you need to obtain accurate audit results. Comparison of audit results with previous audits will help to identify any anomalies that may reflect on the accuracy and timing of either audit.

Recycling contractors will be able to provide information about what is considered to be contamination through their processes; for example, many MRFs treat any items in bags as contamination, even though the items in them are recyclable. Similarly, items containing food and beverages, or with labelling or lids that reduce the recyclability of materials may be considered as contaminants.

Demographic information and local knowledge of waste management operators will help to identify where there may be a need to treat different areas as a discrete sample population. A common example is different density of housing and Multi Unit Dwellings (MUDs). This is discussed in *Appendix B*.

- **What are potential sources of variability across the audit area and over the course of the year and how can these be avoided?**

  It is common for seasonal factors to influence the quantities of garden organics and other yard maintenance materials in the wastestream. Public holidays and other festive times of the year can also increase levels of glass, food and other wastes at kerbside. School holiday periods can see a fall in waste presented at kerbside in some areas and corresponding increases in others. Consideration should be given to these and local events (festivals, etc) that may affect quantities and composition of wastes presented at kerbside.

  Unless the intent is to measure this sort of variability, an audit will ideally be staged over a number of weeks and during periods that are representative of 'average' levels of waste generation.

- **How will any abnormal bin samples in an audit sample be detected?**

  Abnormal bin samples included in a small sample can skew results. For example, home renovation and home based businesses can result in very heavy bin-loads being presented at kerbside. Sample design should also consider ways in which abnormal samples might be noted during collection (e.g. visual inspection or weighing of bins prior to lifting; video record of collected samples where collection vehicles have mounted cameras for monitoring loads). These bins should still be collected as part of the sample as they do occur in the wider population, but noting their presence may help to interpret the audit results.

- **What budget and resources are available for the audit?**

  Knowing what the budget is will help to define what the audit will be able to deliver. Choices may need to be made about what information will and will not be collected and what levels of accuracy the audit results will have. Budget constraints can also help to refine methodologies, allowing you to collect some of the required information using cheaper methods than full scale auditing. How much material can realistically be sorted in the audit period? If materials cannot be stockpiled at the receival site, then the amount of waste collected on a day will be limited by how much can be sorted by an audit team in a one day. More materials will mean more audit staff and higher costs.

- **How will sampling be coordinated with regular collection?**

  A common problem for auditors is that regular collection vehicles sometimes service sample areas before the audit collection vehicle gets to the area. Coordination is required.

  Auditors need to ascertain what days and at what times different services are collected.

- **Are there any physical, commercial or other constraints to accessing samples?**

  Some MUDs have separate collection of larger bins and/or have basement storage and collection of waste. Audit design needs to recognise the significance of this, and where necessary gain access to this materials through a separate audit. This is discussed further in the guide.

  Some areas may have private kerbside services for items such as green organics. If there is significant participation in these services, audit design needs to recognise the potential for sample bias if audited households are users of such services.

- **How will privacy and other community concerns be managed?**

  Bins can contain personal information that could potentially be used for identity theft and fraud. Those involved in the audit should be required to sign confidentiality agreements and undergo police checks, and the main auditor should have systems in place to prevent misuse of such information.

  Bin contents can reveal information about householder's lifestyles and some may feel an audit to be an invasion of privacy. This can be overcome by aggregating collected samples to prevent identification of any individual household's waste and listing sampled addresses with a number that is not linked in any way to a known address.

  One strategy is to notify the community that audits are to be conducted and letting them nominate to not be involved. This is not recommended as it may influence household behaviour (e.g. recycling better and not disposing of hazardous materials during the audit period) and bias sampling. Once material is placed on the kerbside for collection it effectively becomes the property of the council providing the collection service.

Who will have access to reports from audits? If the audits are conducted or commissioned by a waste service contractor as part of a council contract, it is important that the council retains intellectual property rights to data from the audit and that the contractor is bound by confidentiality agreements. Councils must be able to make such audit data available to all tenderers in future contracts or the current contractor may be unfairly advantaged.

- **What OH&S requirements will be placed on the audit?**

  Waste auditing poses significant risk to auditing personnel (e.g. manual lifting and handling of materials, risk of puncture wounds, exposure to hazardous and infectious materials, exposure to the sun, etc). The agent commissioning an audit should ensure that the audit collection and sorting is conducted in compliance with Worksafe requirements. They may also propose suitable sites (e.g. councils transfer stations and depots) where audits can be conducted.

- **Who needs to be consulted in designing and coordinating the audit?**

  Council and waste services contractors need to be consulted to ensure that the audit collects meaningful information and is conducted without disrupting services.

Match your audit to your budget and your budget to your information needs

Waste audits can be costly, and it is important to optimise the audit methodology to obtain the quality of information you need. It is also important to match your audit to your budget, and to set a realistic budget for an audit that will meet your information needs. There are two basic rules of thumb:

- Audits cost more the more samples you take, but this declines per sample with bigger samples (Figure 1). Set up and collection costs are high and not greatly influenced by the number of samples once the sample size is greater than about 100 -200 premises. There are fixed costs associated with setting up for auditing for a day, and the aim should be to collect as much material that an auditing team can sort in a day. This avoids the situation where a part day is required to complete an audit. Where small samples are being taken over a number of days, audit costs can be reduced by stockpiling materials until a 'day's worth' is available for the audit team. This may be impracticable for putrescible materials, but may be used for recyclables if there is a suitable housed storage area available.
- Audit costs increase with the number of categories of waste to be audited (Figure 2). Match the number of categories to be audited to your information needs and budget. Costs can increase greatly if items that are more difficult to separate (e.g. classifying sub-categories of food waste) are included in the audit.

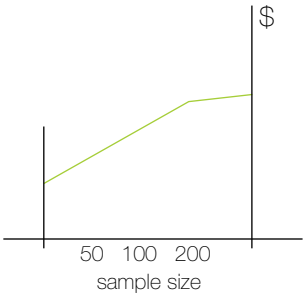


FIGURE 1.

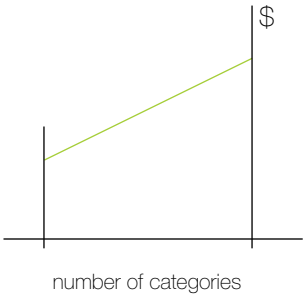


FIGURE 2.

Where there are budgetary constraints, do not fall into the trap of sampling fewer premises for a broad range of materials categories. Results from such audits are likely to be less accurate. It is better to reduce the number of materials categories audited to ensure higher levels of accuracy. If information is needed about a broader range of materials categories, then additional budget will be required to gain accurate audit results. Information about determining optimal sample sizes is provided in *Appendix B*. This Guide is acompanied by an electronic tool allowing users to determine the size and accuracy of audit samples.

Appendix B: Audit Methodology

This section provides more detailed information and advice about key factors in developing an audit methodology. It is recommended that council personnel take an active role in the development of the methodology to ensure that the auditor delivers results that meet the council's needs.

Use consistent classification of materials

Greater standardisation of audits will allow councils to compare their performance with other areas, and potentially use information from similar areas in developing their own audits. Standard classification of materials will also allow direct comparisons of audit results over time, even if different auditors are used.

Recommended categories are shown in Table B.1. These categories align with Towards 2010 waste reporting. It is expected these categories will evolve in line with those required for the National Waste Report. This system allows primary categories to be used for all audits, with secondary and sub-categories be used for more specific information needs. Not all of the secondary and sub-category classifications need to be used – only those about which you want information should be selected. For example, an audit of organics may use all of the primary classifications, but only the organic categories at the secondary level. Not all of the secondary classifications need be used. For example, an audit looking at paper may only use the 'Newspaper', 'Cardboard' and 'Printing and writing paper' categories and put all other paper types under the 'other/mixed' category.

Although sub-categories may be refined for the purposes of your audit, it is recommended that the primary and secondary classifications are used as required.

The classification of wastes should aim to collect the information required to meet the audit objectives and not collect superfluous information. The minimum number of categories possible should be used. The level of detail that the audit design considers will depend on the objectives of the audit. For example, if plastics are not a key focus of the audit, these may be classed generally as 'plastic' or perhaps 'recyclable' and 'non-recyclable' plastics. However, if the focus of the audit was discrete types of plastics, then the audit would need to classify the plastics separately, and a larger sample size would be needed to gain as accurate picture.

Examples of materials classification and field data collection sheets are provided on the following pages.

Audit categories

In addition to classifying materials types to be audited, it is important to define how different items should be managed during an audit. Audit personnel must have clear direction on how to categorise different items. This is particularly the case for auditing contamination levels. This guide provides examples of categorisation, but the actual categories used will depend on the purpose of the audit and what materials are not recyclable under individual contracts. Many items that are in themselves 'recyclable' (i.e. made of recyclable materials) are treated as contamination if they are not presented correctly when received at the Materials Recovery Facility (MRF). Common examples are:

- Recyclables presented in a bin liner or bag. These are often not opened at the MRF and treated as contamination.
- Beverage or food containers still containing drink, food or other waste.
- Plastic packaging items that have labels or lids made of incompatible plastic for recycling.
- Heavily soiled paper and cardboard food packaging.

All waste sorters and auditors should be given the waste category list prior to commencement of the audit and the use of auditor pictorial category boards or posters is encouraged.

An example of categorisation of items is provided in the following pages.

Classification of contamination

In most kerbside materials audits, an important factor is the measurement of contamination. Auditors should consult with their recycling contactors to gain their definitions of contamination. For example, many, but not all, recyclers consider bagged materials or containers still holding food or drink to be a contamination of the recycling stream. Similarly, different recyclers will recover or reject different grades of plastic and paper, and the recyclers need to be consulted to determine what will actually be recycled. Audit classification sheets should reflect this, and treat these items as separate materials categories. An example of such a sheet is provided in the following pages.

To improve statistical accuracy, the number of categories used should be kept to a minimum, or alternatively, grouped under higher levels of categorisation (e.g. Primary or Secondary) for statistical analysis

TABLE B.1 Suggested Categories

PRIMARY CLASSIFICATION CATEGORY Material Type	**SECONDARY CLASSIFICATION CATEGORY** Material Detail
Paper	Paper / Newspaper
	Cardboard
	Liquid Paperboard (LPB milk/juice)
	Other/Mixed
Organic compostable	Food / Kitchen
	Garden
	Other Putrescible
Building materials	Wood/timber
Clothing/textile/fabric	Textile/rags
Glass	Packaging bottles /containers
	Other (pyrex, windscreen)
Plastic	Code 1-3 (1 PET, 2 HDPE, 3 PVC
	Code 4-6 (4 LDPE, 5 Polypropylene, 6 Polystyrene
	7 Other
Metal	Aluminium cans/foil
	Steel cans/aerosol cans
	Other
Potentially hazardous	Paint
	Fluorescent globes
	Dry cell batteries
	Nappies/Hygiene products
	Car batteries
	H'hold chemicals
	Pharmaceuticals
Other	Ceramics
	Dust/ dirt/ rock/inert
	Ash
	Special
	Non recyclable plastic film
	Non recyclable hard plastic
	Soil
	Other

Examples of Materials Classification and Audit Sheets

Example of an Audit Sheet

STREAM AUDITED	DATE	SHEET NUMBER	LOCAL GOVERNMENT	AUDIT AREA	LEAD AUDITOR

Material	Weight			Total	Volume			Total
RECYCLABLES								
	Sample 1	Sample 2	Sample 3	Total	Sample 1	Sample 2	Sample 3	Total
Glass (bottles and jars)								
PET(1) bottles								
HDPE(2) bottles and containers								
PVC(3) bottles								
LDPE(4)								
PP(5) containers								
PS(6) containers								
Other plastic(7) containers								
Aluminium cans / foil								
Steel cans								
Aerosol cans								
Liquid paperboard (milk - juice								
Paper/Newspaper/Magazines								
Cardboard								
ORGANICS								
	Sample 1	Sample 2	Sample 3	Total	Sample 1	Sample 2	Sample 3	Total
Green waste								
Food waste								
Timber (tree logs)								
OTHER DEGRADABLE								
	Sample 1	Sample 2	Sample 3	Total	Sample 1	Sample 2	Sample 3	Total
Textiles								
Leather and rubber								
Timber (construction & demolition)								
Nappies								
NON RECYCLABLES								
	Sample 1	Sample 2	Sample 3	Total	Sample 1	Sample 2	Sample 3	Total
Non recyclable packaging								
Bagged items *(recycling & organic samples)								
Other metal objects								
Plastic items								
Hard rubbish								
Compact fluorescent tubes and globes								
Batteries								
E-waste								
Building materials (excluding. timber)								
Inert dust, soil, sand...								
Other waste								

Example of Classification and Interpretation of 'Contaminant' Items

DESCRIPTION	CLASSIFICATION
Beverage bottle containing fluids and considered to be at least 1/3 full with fluids.	Contaminant
Plastic beverage bottle with a plastic sleeve	Contaminant
PVC beverage drink bottle	Contaminant
PET beverage container with metallised label	Contaminant
Plastic container with plastic sleeves	Contaminant
Glass bottles in plastic sleeves	Contaminant
Coloured PET (*only if mixed stream is not collected)	Contaminant
Bagged recyclables in a recycling sample	Contaminant
Food soiled packaging that contains food scraps/ food waste water logged cardboard	Contaminant
PET biscuit tray or fresh fruit tub	Contaminant
Rigid plastic i.e. buckets, trays, baskets, drums....	Contaminant
Plastic toys with clearly labelled recycling code	Contaminant
Plastic hard rubbish with clearly labelled recycling code	Contaminant
Kitchen metal pots and pans	Contaminant
Steel and aluminium hard rubbish items	Contaminant
Composite packaging i.e. half plastic / paper / film intertwined packaging	Contaminant
Novelty packaging	Contaminant
Non recyclable packaging	Contaminant
Plastic cups, tubs, lids, containers and Tupperware	Contaminant
Batteries	Contaminant
Non-cullet glass	Contaminant
Anything that is not listed in the audit categories	Contaminant

The above table provides and example of how the audit methodology and classification materials should clearly define items as contaminants. This is based on the ability and willingness of recycling service contractors to recover items. Such lists should be developed in consultation with the recycling services contractors to determine what they consider to be a contaminant in their system.

Example of a Custom Audit Sheet for a Contamination Audit

MATERIAL	WEIGHT				VOLUME			TOTAL
NON RECYCLABLE PACKAGING (will depend on recycler's specifications)								
	Sample 1	Sample 2	Sample 3	Total	Sample 1	Sample 2	Sample 3	Total
Glass in plastic sleeves								
Containers in plastic sleeves								
Plastics (1-7) trays, tubs, etc...								
Composite packaging								
NON RECYCLABLE PACKAGING LABEL PROFILE								
	Sample 1	Sample 2	Sample 3	Total	Sample 1	Sample 2	Sample 3	Total
Packaging printed with recycling logo								
Packaging printed with European recycling logo								
Packing implies product is recyclable								
Packaging states it is not recyclable								
Packaging printed with PACIA plastic recycling code								
Packaging has no disposal instructions								
OTHER CONTAMINANTS								
	Sample 1	Sample 2	Sample 3	Total	Sample 1	Sample 2	Sample 3	Total
Plastic bags								
Bagged items *(recycling & organic samples)								
Other metal objects								
Plastic items								
Hard rubbish								
Compact fluorescent tubes and globes								
Batteries								
E-waste								
Building materials (excluding. timber)								
Inert dust, soil, sand...								
Other waste								
Rocks and concrete								

Sample selection

The aim of auditing is to have a sample population that represents the wider population. This can be achieved by sampling a sufficiently large number of houses to average out variability within the sample population so that it is representative of the wider population.

In waste auditing, three methods are commonly used to selected sample populations from the wider population. All methods use some randomised sampling techniques in the selection of individual premises:

Randomised Grid Sampling.

This can either be used where there is little variation across the sample area or, alternatively, where a higher number of samples are to be taken. Under this method sample areas, streets and/or individual properties are given numbers and then selected according to the outputs of a random number generator program. For example, a grid with each cell numbered may be overlaid on a map of the municipality, and a random number set used to select areas to be sampled. Sampling within each of these areas can be further refined using more numbered grids and/or allocating numbers to streets within the areas and selecting these using random number generators. Individual premises to be sampled can be either selected according to random selection by allocated or street number, or more typically by randomly selecting the first premises sampled and then sampling every second, forth or fifth sample until the required number of samples have been collected. Higher levels of randomisation in sample selection prevent subjective judgement by those sampling to bias and skew the audit results. In municipalities where there is a high incidence of commercial, industrial or agricultural land, the area from which the sample is drawn could be restricted to residential areas serviced by council kerbside collection services. If there are residential areas that are highly atypical of the wider population they may be excluded from the sample areas and/or audited separately. Once the sample is selected, it can be reviewed to see the extent to which housing and other demographic factors in the sample areas match the wider population. If there are concerns that the sample areas do not match the demographics of the wider population, then this suggests that variability has not been adequately considered in the sample size. Further sampling may be required.

Representative sampling.

This method is used where there is significant variation recognised across the wider area and budget restricts sample size. It attempts to select areas that are 'typical' of the wider demographic of the whole area, or of different demographics of the area. For example, an area that is known to have a demographic mix typical of the wider area may be selected for sampling. Alternatively, the wider area may be divided into sub-populations according to different demographic characteristics, with random selection techniques being used to select areas and individual dwellings within these sub-populations. For examples, areas with higher or lower density living or higher or lower socio-economic characteristics may be grouped separately. The risk of sample bias is higher when subjective judgements are made about what areas are 'like'.

Stratified sampling.

This method deliberately samples specific sub-populations, and then uses known demographic information about the incidence of these sub-populations in the wider population to extrapolate overall waste characteristics. For example, lists of types of housing (e.g. Single Unit Dwellings and different forms of Multi-Unit Dwellings or MUDs) may be developed and used with some form of random sampling technique (e.g. such numbering individual dwellings and selecting those to be sampled through random number generation programs), and the results of the audit related back to information about the numbers of different dwelling types within the wider population. Some form of stratified sampling is recommended for conducting audits of MUDs (see section Auditing Multi Unit Dwellings).

Audit collection methods

There are two sampling strategies that can be used:

- The "aggregation method" is the collection and aggregation of materials from the households in the sample population. This method is primarily a mechanical collection process that avoids manual handling and potential privacy issues. It is the preferred method for general composition audits as it is cheaper and less prone to OH&S, privacy and litter incidents.
- The "per household method" is the manual 'bagging and tagging' of each sample from each household in the sample population. This method requires manual handling and lifting of material at the kerbside. This provides a more detailed data set, but is more expensive and has significant OH&S risk associated with manual lifting and handling at kerbside. It also has problems associated with real and perceived invasion of privacy, and high risk of litter during collection.

Estimating sample size

The quantities and types of wastes that households present for collection will vary within and between different areas in the overall sample area. Some households put out no or little or no waste or particular material; others put out large volumes. Some households put out their bins every second, third or fourth collection; some place it out full every week. Audit samples must be designed so that the average figures obtained by the audit are approximately the same as the average of the wider population. The audit sample must be designed so that the probability of collecting an atypical number of abnormally high or low samples is small, and that the sample will not be unacceptably skewed to a higher or lower average than the wider population.

The sample size required will be determined by:

- The types of waste being considered in the audit:
  - The more categories of waste being audited, the bigger the required sample. Keep the number of categories to a minimum. This will also reduce auditing time.
  - The lighter the representation of audited categories of materials in the waste, the bigger the required sample. Again, broad categories that increase the weight of the sample category will reduce the auditing time and the number of samples required.
- The variability of wastes within the community:
  - If there is significant variation, more samples will need to be taken to ensure that the average of the audit population matches the wider population in the sample area.
- The method of selecting the sample populations:
  - The greater the randomisation in selecting sample populations, the fewer samples required. This needs to be balanced against the practicality of collecting the sample from across a large area versus randomly or selectively choosing areas and then randomly selecting sample populations from within these areas.

Statisticians have previously assessed variability within MSW and developed methods for determining the number of samples that will be required to gain an accurate estimate of particular items in the waste stream.

In assessing waste audit results, statisticians define accuracy according the following two parameters:

- Allowable range of uncertainty.
  - This refers to the ± % range that is considered acceptable for different materials. The smaller the range, the greater the number of samples required. This range is first used when setting the sample size on the basis of assumptions about the relative contribution and variability of items in the waste stream, but can be recalculated once the actual audit data has been collected to express the actual range of uncertainty of the audit results for particular materials.
- Level of confidence required.
  - This refers to the probability that the difference between the audit results and the wider population will be within an acceptable range. A confidence interval of 95% means that there is a 95% chance that the audit results are within the allowable range of uncertainty. The higher the confidence interval, the greater the accuracy and the greater number of samples required. A confidence interval of at least 90% is recommended for waste audits

Figure B.2 shows some estimates for sample sizes required to gain an accurate representative sample from a wider sample population.

This Guide is also accompanied by a spreadsheet tool to help councils and auditors to set sample sizes to meeting their information needs, and also to assess the accuracy of the audit undertaken.

It is recommended that a sample population size of at least 125, and preferably 200 or more, is used for general kerbside garbage and recycling bin composition audits. The results of the first audit can be used to refine the size of the audit needed for subsequent audits. Please refer to the calculator provided at [insert link] to work out what the minimum is for your audit. The more you know about your council's compositions, the less bins you will need to audit.

Assessing variability in audits

It is important to assess the actual variability of audit results when the results will be used to estimate total quantities of materials available in the waste and recyclables stream, particularly where major planning and commercial decisions are to be made on the basis of the figures. If audit results are manipulated with other audit results, there is a potential for a compounding of errors. Methodologies that allow recognition of potential inaccuracies in results can allow results to be presented as a range. This avoids decisions being made without recognition of the uncertainty and potential inaccuracy of figures.

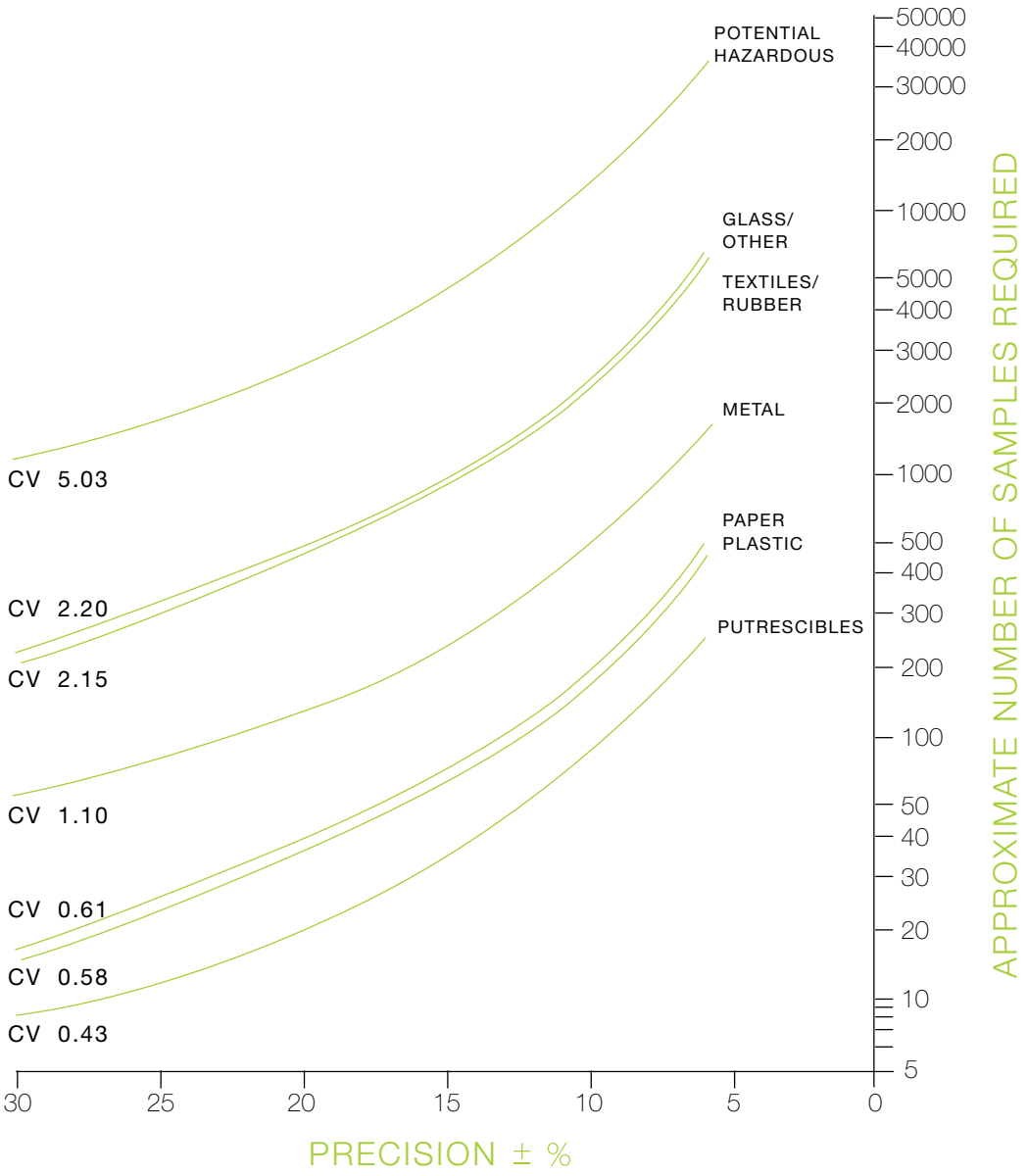
Generally speaking a uniform representative sample will be adequate. However if you wish to measure variability within and between samples, this can be achieved by breaking samples into at least five sub-samples by either:

- Collecting sub-samples (e.g. for a total sample of 200 households, collecting 40 households per collection run). This may be impractical, but may be possible for randomised block sample design where a number of areas are sampled. It will be more practical where a large sample size is being used, and will provide more accurate assessment of variability.
- Breaking aggregated samples into five roughly equal volume sub-samples (e.g. once a load is dropped out on the ground, measuring the length of the pile and then segregating the pile into five measured lots, taking care to segregate the material vertically to ensure that the mix of materials is not influenced by heavy items moving to the bottom of dumped loads).

Standard data analysis tools on computer spreadsheet packages allow statistical analysis of variability.

Tools for both estimating the sample size needed and then assessing the accuracy of the actual sample audited accompany this guide. Please refer to the calculator provided at [insert link].

FIGURE B.2 Curves for Estimating the Sample Population Size needed for Different Materials and Levels of Accuracy



(NZ Ministry of the Environment 2002 Solid Waste Analysis Protocol Summary Procedures p 18)

FIGURE B.1 Example of Establishing Audit Categories

The following example shows a three-step process for setting audit categories for materials. This example is for defining contamination. It is important that the audit data collection sheets provide audit teams with clear definitions of how items should be categorised. The categories you use in your audit will depend on your information needs and, in the case of setting contamination categories, consultation with recyclers and organics recovery service providers about what they consider to be contaminants.

Step 1

Contamination classification should be established prior to the finalisation of the audit category list. This should be done through consultation with the processing recycler or recycling contract holder or regional waste management group. For example, a recycling contractor may inform the auditor that PET trays and tubs are not recyclable. In this instance the classification of materials may be as follows.

For example:

CATEGORY	DESCRIPTION	CLASSIFICATION
PET(1) beverage bottles	PET (1) bottles are a common plastic used in beverage containers.	Resource
PET (1) other, i.e. trays, tubs...	PET (1) tubs, trays and squeezable containers are not always recyclable.	Contaminant

Step 2

The way a product is presented and the specifications of the recycler will determine its recyclability. Again, this should be determined in consultation with the processing recycler and/or recycling contractor and/or the relevant councils. The following example shows how normally recyclable products can be classified as contaminants if they are found in altered states outside the specifications of the recyclers

For example:

DESCRIPTION	CLASSIFICATION
Beverage bottle, containing fluids and considered to be at least 1/3 full with fluids.	Contaminant
Bagged recyclables in a recycling sample.	Contaminant
Food soiled packaging that contains food scraps/ food waste or water-logged cardboard	Contaminant

Step 3

The way a product is presented and the specifications of the recycler will determine its recyclability. Again, this should be determined in consultation with the processing recycler and/or recycling contractor and/or the relevant council body. The following example shows how normally recyclable products can be classified as contaminants if they are found in altered states outside the specifications of the recyclers

For example:

CATEGORY	PROCESS
Bagged recyclable	Bagged recyclables are only classified as a separate category when they are found in a recycling sample. The contents of these bags should not be opened and mixed with other waste streams. The bagged recyclables need to be separated, weighed and volume estimated. The still unopened bagged recyclables should then be set aside, in a safe area, following the OH&S plan and standard operating procedures for moving bagged waste. At the completion of regular waste sorting the contents of the bagged recyclables are to be audited. A new audit sheet specifically for bagged recyclable is to be used. The data should be collected and then analysed accordingly.

Auditing Multi Unit Dwellings

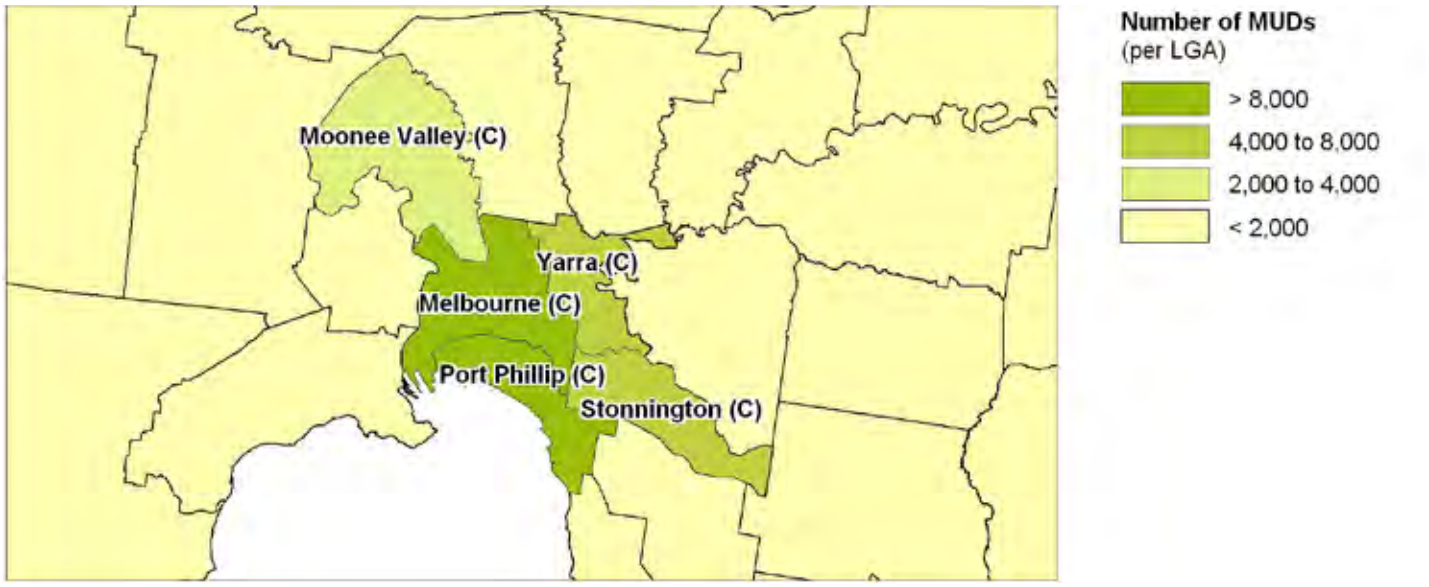
A special case for kerbside audits is waste from Multi Unit Dwellings (MUDs). These dwellings have a significantly different waste profile to those living in detached and semi-detached dwellings and also present challenges for audit collection as bin types may need a separate collection vehicle and/or there may be restricted access to bins. In addition, it is difficult to assess the number of individual households within a MUD that are occupied or have presented waste for collection. There are also a range of types of MUDs, ranging from townhouses and dual-occupancy development, to low rise units (fewer than 4 floors), through to apartment buildings with four or more floors and high rise developments. These have different ways of collecting garbage, recyclables and food organics that impact of the waste profile. The residents of each MUD can put out large amounts of waste each week, and audits need to be designed to take a representative sample from each MUD rather than sampling all of the materials presented.

Given the different types of bins present at MUDs, it is recommended that a collection vehicle (or vehicles) than can collect both front end 1.5 to 4.0 cubic metres and 120L and 240L MGBs is used for the audit.

The following approach is recommended for auditing MUDs in areas where there is a high incidence of these developments (see Figure B.3).

- Unless there is a very high incidence of these within a sample area, dual occupancy and townhouses with fewer than four units (and therefore 4 waste, recycling or organics bins), can be audited within a regular audit, with note being made of the additional dwellings and collected bins during the audit.
- Where MUDs are encountered in regular audits, all materials should be collected and attributed to the total number of dwellings in the MUD.
- In areas with a higher incidence of MUDs, stratified sampling should be adopted for auditing MUDs separate to an audit of low rise /single occupancy dwellings, with audit results being used to extrapolate the impact of these developments on the area's overall waste profile.
- The MUD sample design should allocate numbers to identified MUD complexes and then randomly select these using random number sets.
- The number of bins taken from each MUD complex should be based on the number of dwellings in each MUD. It is recommended that at least four bins per MUD are selected using random number sets to allocate which of the bins is selected.
- Details of each audited MUD should be recorded including:
  - Total number of bins presented for audit
  - The number of units in the complex
  - Observations about levels of occupancy (e.g. is it a new apartment with few occupied units?)
- The sample size for the stratified audit should be the same as for that undertaken for the wider population audit, with the total number of bins collected matching that collected in the wider audit.
- Where selected MUDs do not present waste at kerbside, arrangements should be made to sample waste.
- Where MUDs are serviced by private waste contractors separate to council services, arrangement should be made to access material, and the time since the last collection noted so that results can be related to waste generation per week figures obtained from other audits.

FIGURE B.3 MUDs - Flat, Unit or Apartment in a Four or More Storey Block in Local Government Areas



Measuring participation and set out rates

It is important to know how many of the selected households actually put out bins. Some households do not put out bins for every collection, and often households will put out some, but not all of their garbage, recycling and green organics bins.

Data recording sheets should be developed to allow auditing personnel to record:

- Whether households in the sample participated at all (i.e. They are recorded as not participating if they set out no bins, and participating if they set out any of their bins)
- Which of the bins are set out (i.e. garbage, recyclables and/or green organics)
- Where councils offer different bin sizes or additional bins, the number and sizes of bins should be recorded.
- Where a randomly selected premise does not have bins set out, this should be recorded, but additional bins collected from subsequent premises on the sample list.

The sample list should have an excess number of streets and premises to be sampled so that you can stop auditing when the required number of samples is taken and not 'run out of' premises on the sample list.

In instances where the sample population is fewer than 200 households, the audit team should record the participation and set out rate information for a wider population. This involves using separate auditing sheets to record set out and participation rates for households (not just those from which an audit sample is collected) in the streets where collection is carried out. This information will allow observations about whether the sample population was typical of the wider population, and provide more accurate information about participation and set out rates.

Recommended kerbside auditing methodology in Victoria

A description of some commonly used different audits types, their strengths, weaknesses and application are summarised in Table B.2.

The recommended approaches to kerbside waste auditing are:

- Weight-based physical 'sort and weigh' audits.
- Randomised block and/or stratified selection of sample populations.
  - The first method uses statistical randomised number sets to randomly select areas, streets and households to be audited. The whole area from which the randomised block sample areas are drawn may be defined to residential areas and to exclude areas that are highly atypical of the wider population.
  - The second method randomly selects premises to be audited from sub-populations of specific demographics (e.g. MUDs, different housing density areas).
  - A combination of techniques can be used.
- Aggregated collection of materials from the sample population.
  - Samples from audited premises are aggregated in the collection vehicle. This overcomes privacy and OH&S issues.

This should be coupled with collection of data about household participation and bin set out rates in both the sample population and the wider population.

If variability in household waste generation rates is required, sampling can include weighing of full bins on the street using small industrial scales prior to collection, with adjustment for bin weight to provide this data. Individual collection of household bin contents on the street has issues associated with OH&S risk, litter, and community concern about invasion of privacy. All manual handling of waste must be avoided, where possible, and only be conducted in areas where mechanical collection is not possible or where detailed analysis and comparison of sample contents per individual household are required.

TABLE B.2 Different Audits Types, their Strengths, Weaknesses and Application

METHOD OF MATERIALS COLLECTION	STRENGTHS	WEAKNESSES	APPLICATION
Aggregated auditing of waste from a known/selected sample population, collected in a single truck run	• Statistically valid method of obtaining a representative sample. • Can be used to conduct stratified sample to audit specific sub-populations (e.g. MUDs, commercial precincts) • Easiest to arrange • Can be a cheaper option if large sample sizes are being considered.	• Does not allow assessment of variability in household waste generation and waste management behaviour. • Only provides waste composition data • Does not provide any 'per household' information	• Recommended in most situations due to OH&S, simplicity and cost factors. • Sub-samples from the sample population and/or aggregated waste can allow some analysis of variability within the sample and wider population. This will allow assessment of sample accuracy and refining of future audit sample size.
Per household or "bag and tag" sampling	• Statistically valid method of obtaining a representative sample. • Can be used to conduct stratified sample to audit specific sub-populations (e.g. MUDs, commercial precincts) • Can achieve the same level of precision with smaller sample size. Can better identify and exclude 'outliers' and assess the accuracy of audit results. • Allows assessment of the profile of different waste management behaviours by households.	• Serious OH&S concerns with the manual handling and lifting of waste and exposure of collection crews to traffic. • More expensive. • High risk of litter and glass breakage in the street during collection. • Real and perceived privacy issues. • Is very obvious that households are being audited and can be seen as an invasion of privacy by the community.	• Not recommended unless specific information is required about individual household behaviour (e.g. if you want to see how many households are /are not diverting all organics or recyclables to recycling services; how many households put out no organics; how many households have unacceptable levels of contamination, etc).
Physical sort and weigh	• Accurate and empirical • Allows statistical assessment of variability and accuracy • Repeatable with different auditors to allow comparison of results.	• OH&S risks associated with sorting of wastes. • Costs need to be managed by matching the sample size to information needs.	• Not recommended auditing unless very specific measures are required.
Visual estimate auditing	• Cheapest auditing option • Lower OH&S risks where sorting is reduced	• Less accurate and often unreliable. Needs to be verified with some form of weight-based auditing. Densities of waste material vary significantly, and any conversion to weight is likely to be very inaccurate • Subjective assessment is prone to auditor bias and error. • Audit results cannot easily be compared due to auditor bias. • Bulky items can be overstated and denser items overlooked	• Not recommended for composition audits • Potentially useful for generally monitoring contamination or when general information is needed about volumes of key materials in bins or only bulky items such as garden organics and paper/ cardboard.

METHOD OF SAMPLE SELECTION	STRENGTHS	WEAKNESSES	APPLICATION
Completely randomised sampling. The sample households are selected across the entire sample area using random number selection of numbers allocated to addresses.	• High level of statistical validity	• Expensive, as collection vehicles may have to cover large areas to collect the sample. • High level of inconvenience to regular collection services.	• Not recommended as other techniques more simply and cheaply provide a sufficient level of statistical accuracy.
Randomised block sampling. Random number selection techniques are used to select areas to be audited within the sample population (using a numbered grid overlaid over the sample area). Streets to be audited are selected according to random number selection. Houses are either all selected from a randomised number set or on the basis of sampling every nth household from a first randomised number set selected house.	• Sample areas are reduced, whilst maintaining a high level of statistical validity. • Allows sampling of different areas on different days	• Could select atypical areas to sample unless a large enough number of areas are selected. In areas where there is significant variation, a higher number of samples or stratified sampling should be used. • Not a completely randomised sample, but this is not a significant issue.	• Recommended for most audits across areas without obvious concentrations of different housing types.
Stratified sampling. Sub populations that are likely to have different waste characteristics and auditing requirements are identified and randomised samples are selected from the sub-populations. Audit results are extrapolated with demographic information to estimate the wider population's waste profile.	• Provides information about demographic differences in waste generation and management • Allows significantly smaller sample sizes across highly variable areas	• Need to work to identify the sub-populations from which the sample populations will be selected. • Greater care is needed from the audit team to make sure they collect from the right properties.	• Recommended where there is a high proportion of MUDs or other significant differences in demographics across an area.
Representative sample selection. Auditing is conducted in an area that is seen as 'typical' of the wider population, with the mix of demographics and housing types approximating the wider community.	• Allows sampling to be isolated to a single area, reducing collection times, effort to coordinate with other collection services, and costs.	• Selection of the sample are is subjective and prone to error • Larger sample sizes are likely to be needed	• May be useful when trailing a new system or behaviour change program in a smaller area. • Not generally recommended as other techniques can provide more accurate results.

Additional audit information

Where information is required about variability in the amounts of wastes presented by individual households, it is recommended that small industrial scales are used to weigh audit sample bins prior to collection. Bin sizes and type should be recorded, and the results corrected for average weights of these bin types. There will be some inherent inaccuracy in weights due to variations in the weights of actual empty bins, but this should average out across the sample and not significantly skew results. Information about individual bin content weights is useful for gauging different behaviours and identifying potential causes of bias in the final audit sample (e.g. if a large number of very heavy or very light bins feature in the sample).

Collection method and recording

The following methodology is recommended for collecting materials.

- From the wider population, select sample areas (or sample populations) using randomised block or stratified sampling techniques.
- Using randomised number sets, select streets to be audited within the sample areas.
- For each of the streets selected, randomly select a number between one and five as the first sample. In streets with fewer than 50 households, select every second premises for auditing up to a maximum of ten premises per street. For streets with more than 50 houses, select every fifth household for a maximum of ten households per street. The random sample selection sheets should have an excess of streets and premises so that you stop auditing when the required number of samples is gathered and not 'run out of' premises to collect from.
- Where houses do not present all or any bins, record this, but do not collect the neighbouring bins – move to the next sample as it would have been counted had the household placed out bins. The total number of bins for the street and in collected will remain the same, as collection will continue until that number is reached. Data analysis should recognise the number of households included in the sample, including households that did not present the relevant bin. Weight per household per week figures for both participating households and all households in the sample population can be calculated from this data.
- Trained audit personnel should travel with the collection vehicle to ensure that materials are collected in accordance with the sampling protocols and to record participation and set out rates. The audit protocols should include clear direction about which premises are to be audited and actions to be taken in the event of exceptional circumstances

Calibration, accuracy and estimation

The accuracy audit results can be compromised by inaccurate measuring equipment and variability in the weight of seemingly identical containers used to hold weighed items.

It is important to calibrate scales before an audit commences and periodically re-calibrate them during an audit. This can be done using standard weights.

The scales used should be appropriate to the materials being weighed. Scales accurate to 100 grams should be used for weights of over 100 grams, with measurements rounded to the nearest 100 grams. A data recording accuracy level to 1 gram should be used for audits that measure weights of less than 100 grams. Rounding to the 10th gram should not be used for weights under 100grams.

Due to variations in plastic thickness, identical looking tubs and crates can have variations in excess of 10%. Therefore all measuring containers should be weighed. As a guide:

- Identical looking containers of less than 20 litres or used to weigh lighter materials such as plastics should weigh within 5 grams of each other.
- Identical looking containers of greater than 20 litres should weigh within 10 grams of each other.

The weight of all containers should either be removed from the sample weight by 'zeroing' the scale with the empty container on the scale, or subtracting the weight of the container from the sample.

If sampling containers have different weights, these should be marked on the containers and noted and subtracted for each sample.

It is useful to also collect field data about the density or volume of materials. Due to the subjective nature of volume estimation, it is recommended that volume estimation protocols are developed and implemented for all audits. This may involve provisions such as data input protocols and be included in the audit's methodology or appendix. To reduce volume estimate variation it is recommended that only one person is used in the entry of this data. The ways in which materials are stacked within bins and crates will affect the number of items and the weight recorded for the volume. Small containers will result in less settling and lower density. This can be avoided by using larger volume measuring containers, such as 120L or 240L bins which will more closely approximate the volumes of materials in kerbside bins.

Seasonal variability and the timing of audits

Seasonal variations may cause 'spikes' in volume and or weight above the annual average. The materials most susceptible to seasonal variation are:

- Garden organics, which vary by season with spring and early summer being the peak. In suburbs with a large number of deciduous street trees, autumn can also see abnormally high levels of garden organics
- Hard waste from gardening and yard clean ups
- Glass, where due to its weight a relatively small increase in the number of bottles (for example the lead up to Christmas, and other festive occasions) will have significant impact on the weight of glass in the sample.
- Food organics following festive events

Where possible, audit limitations such as seasonal influences should be avoided (unless the purpose of the audit is to measure seasonal variability). In the event that limitations cannot be avoided they should be minimised otherwise the audit will be of limited value. Limitations may undermine the audit's aims and objectives or compromise its data collection. In this instance, the audit's feasibility should be questioned and the audit should proceed only after it is redesigned to overcome the limitations.

Records of the tonnes of waste collection over the year can be used to identify variations and periods where 'average' quantities of materials are typically collected. Knowledge about the nature of variability can also be valuable, and secondary audits conducted during periods of seasonal variation may be useful.

Audit limitations due to seasonal variability can be minimised through the following measures:

- Do not audit during holiday periods, such as Easter, Christmas or New Year unless the objective is to test waste at peak times,
- Do not audit before, during, or after long weekends, public holidays, or the week after the AFL grand final.
- Do not audit within four weeks of an extreme weather event such as a cyclone, very heavy rains, heat wave or other extraordinary conditions.
- Ensure all audits are full collection cycles. If a kerbside system has fortnightly alternating recycling and green waste collections, a typical waste stream audit would need to be collected over the fortnightly period and then averaged to establish the true waste profile for waste, recycling and organic streams.

Unless the intent of the audit is to test for seasonal variability or the average composition of the organics stream, the best months to conduct green waste audits are generally the autumn months of March, April and May of any given year, which is a time of the year when the amount of garden organics typically most closely matches the annual average. This will depend on weather conditions in the weeks preceding the audit.

If annual green waste generation figures are known, a green waste generation factor can be applied to audit data to adjust results for seasonal variability. This will establish an annualised waste profile for the total kerbside stream.

For example:

For an audit of a green waste recovery service:

- Records show that 10,000 tonnes of green waste are collected annually but the audits report data extrapolates to 20,000 tonnes of green waste annually. In this case, the seasonal adjustment factor to applied to audit results for organics will be 10,000/20,000 = 0.5.

For a mixed waste/garbage audit:

- Records show that on average, households set out 500kg of garbage per year. The audit extrapolates to 550kg per household per year, with average garden organics content of 70kg/hh/yr. If the sample is sufficiently accurate and there are no other significant factors likely to have resulted in the different values, then the additional waste can be assumed to be seasonal variability in garden organics. The assumed annual weight of garden organics is estimated to be in the order of 70-(550-500) = 20kg/hh/yr; with 20/500 = 4% and not the 12.7% (70/550) that the audit results suggested. Note that there is scope for error in this approach if other materials are responsible for the noted increase, but it will allow some observation about whether the sampled level of garden organics is representative of the annual average amount.

In both cases, the higher waste generation observed in the audit sample might be able to be checked against recorded weights of materials delivered to landfill or green organics recovery facilities during the same period as the audit. If the audit figure for per household waste generation is significantly different to that observed in the wider population during the same period, then the accuracy of the audit results need to be reassessed and further sampling may be required.

If available, records from recycling materials recovery facilities on seasonal variation of the weight and composition of recyclables may also help to identify where audit results may understate or overstate the significance of different materials.

Another way to deal with seasonal variation is to conduct a number of audits throughout the year. Secondary audits may not need to be as detailed (e.g. looking only at the garden organic stream) allowing smaller audit sample sizes.

Data quality assurance

It is important to check the accuracy of audit results. In addition to statistical assessment of the accuracy of sampling and ensuring the accuracy of measuring materials, a number of other measures can be employed to check accuracy and allow future users of the data to assess the relative accuracy of the audit, such as:

- Validating results by comparing them to records from annual council landfill waste, recycling and organics collection and disposal contracts. Where possible, figures for these materials streams from the general population during the audit period should also be obtained and compared to the audit results.
- Field observation. Sometimes it is very apparent that an atypical load of materials is in the audit sample –e.g. a bin full of construction and demolition waste. This can be noted and referred to if the sample shows abnormal results.
- Presentation of raw data sets with the audit report. This will allow independent review of results in the event that any major discrepancies are detected at a later date.
- The provision of transparent data measurement protocols and interpretations. Any assumptions and manipulation of data should be spelt out, so future users can be aware of factors that may have influenced the final results. Clear statements about the limitations and uncertainties regarding data should be included in the audit report.

Data transparency and reproduction

An audit cannot be replicated without transparency but more critically it cannot be third party validated.

To ensure an audit can be a tool of measurement and evaluation the following needs to be in place.

- A detailed methodology that outlines data collection, data input protocols and interpretation processes.
- Data collection sheets in the appendix of the report.
- A description of data collection categories in the appendix of the report.
- A listing of all data interpretation rules.
- A clear definition and explanation of what are contaminants, how they are identified and how they are recorded.
- Copies of all the completed data collection sheets provided to the client in an accessible electronic format such as an Excel spreadsheet.
- All equations used in key performance indicators; diversion calculation and any stated figures included in the report. Each equation to have a short explanation and example showing its calculations.

Appendix C: Occupational health and safety guidance for waste auditing

Due to the potential Occupational Health and Safety risks inherent in waste auditing and the strict duty of care that all Victorian employers are lawfully obliged to exercise in the management of their employees activities, Sustainability Victoria considers the development of a site-specific Occupational Health and Safety plan to be an essential component of any waste audit process.

Any party commissioning, outsourcing or authorising a waste audit must ensure that a site specific OH&S plan is prepared before a waste audit commences. This plan must address at least the following minimal criteria:

- Overall Occupational Health and Safety policy;
- Sample collection, risk-minimisation procedures;
- Appointment of an appropriately-qualified project Safety Officer;
- Outlining of specific OH&S responsibilities for each individual waste auditor, the Audit Manager and Safety Officer;
- Ensuring that all audit staff have been vaccinated for Hepatitis B and Tetanus and that all audit staff have had the full course of hepatitis injections;
- Ensuring that the audit site is equipped with a first aid kit;
- Consideration of provision of OH&S training requirements of staff;
- Site specific OH&S issues;
- Provision of Personal Protective Equipment, such as goggles and gloves, a clear policy requiring equipment use by audit staff and consideration of provision of ongoing maintenance of same equipment;
- Requirement for a project specific risk identification process and standard operating procedures for specific risk i.e. a step by step process to specify procedures for securing a syringe found during a waste sort; and
- The monitoring of ambient site conditions during the audit processes.

Occupational Health and Safety (OH&S) responsibilities for audit manager and safety officer

Prepare documentation that clearly outlines the specific OH&S responsibilities of the Audit Manager and Safety Officer during the waste audit. This information should assist the Audit Manager and Safety Officer to resolve any OH&S issues that may arise during the sample collection and/or waste audit process in a timely manner. for example:

Possible role for the audit manager

- Decide which OH&S responsibilities are to be delegated to the Safety Officer.
- Ensure that OH&S procedures are to be followed by audit staff.
- Ensure the provision of adequate Personal Protective Equipment for each member of audit staff and any other contractors present at the audit.
- Ensure adequate time and budgetary provisions for the implementation of OH&S protocols.
- Ensure each member of the audit staff has read, understood and signed individual OH&S plans.
- Ensure the team is briefed on the OH&S plan prior to the commencement of any auditing.
- Check individual auditors have received training in waste-characterisation methods to assist them in the early identification of hazardous wastes and that they understand the risks associated with materials-handling, managing site traffic, controlling dust and airborne contaminants and common back injury prevention techniques.
- Ensure each member of audit staff understands incident reporting processes, emergency procedures and the location of assembly areas.

Requirements and role of the Site Safety Officer

- To successfully complete the appropriate OH&S training, to participate in the OH&S plan and to hold a current Level II First Aid Certificate.
- To prepare a site-specific OH&S plan prior to the commencement of any on-site activity including designated assembly area/s and evacuation procedures.
- To ensure this plan is approved by the Local Government Manager with responsibility for the waste audit before any audit work commences.
- To demonstrate an understanding that it is their duty to stop unsafe operations as soon as they become apparent and, if necessary, supervise the provision of first aid and/or decide when to contact emergency services.
- To ensure that the rules, procedures and guidelines outlined in the OH&S plans are followed by each and every staff member engaged in the audit process.
- To carry at all times the emergency services contact list and to have knowledge of the quickest route by car to the nearest hospital and doctor's surgery.
- To conduct OH&S meetings with staff before the commencement of each shift and to hold a summary meeting at the completion of the shift in order to ensure that staff are updated on OH&S matters as they arise;
- To actively seek input from staff on potentially safer operating procedures.
- To ensure that all staff use their Personal Protective Equipment and to inspect and maintain said equipment.
- To constantly monitor onsite hazards and the audit staff for any early warning signs of dehydration, fatigue or heat stress. Note that it is recommended that during hot weather outdoor sampling activities are undertaken in the cooler hours of the day.

A risk assessment should be conducted that enables all hazards for all aspects of the program to be identified and acceptable management strategies implemented.The following information should be made available to all auditors. This will assist in timely resolution of any issues that may arise during the sample collection and/ or waste audit process.

FIGURE C.1 Key OH&S risks in kerbside audits

SAMPLE COLLECTION PROCESS (minimised with mechanical lifting).
• Effects of exposure to hazardous materials
• Back injury
• Slipping and falling
• Heat stress, sunburn and fatigue
• Traffic
• Heavy equipment movement
PHYSICAL AUDIT PROCESS
• Physical hazards
• Cuts and punctures from sharp items in the sample (e.g. hypodermic needles, broken glass, razor blades).
• Effects of exposure to hazardous materials such as medical waste, aerosol cans, chemicals (powder and liquid), bottles of unknown/unlabelled substances, plastic bottles containing used syringes, and other hazardous materials.
• Back injury
• Slipping and falling
• Heat stress and fatigue
• Traffic or heavy equipment movement
• Noise exposure from operation of heavy equipment
• Animal and/or insect bites
• Airborne contaminants
• Dust from solid waste
• Fire

General Safety Procedures

It is essential that a risk management process has been undertaken and an OHS plan prepared for all separate audits that are to be undertaken so any specific issues are identified and appropriate strategies implemented.

Personal Protective Equipment (PPE)

It is important that those conducting the audit recognise that the use of PPE does not replace the need to observe other aspects of safe handling procedures. PPE should be seen as an essential part of an overall safety plan. A list of suggested PPE is provided.

Incident reporting

Auditing collection and sorting teams should be provided with and trained to use an incident reporting sheet to record actual or 'near miss' accidents and injuries incurred during the course of an audit. Such reports should be acted on to avoid future incidents.

Medical Monitoring

All staff must ensure that they are medically fit to perform any duties requested and that these duties will not aggravate any existing conditions. Should any issues be identified that may impact on the physical well-being of a staff member, the Safety Officer will discuss such issues with the individual staff member.

Contact numbers of local medical practitioners, the hospital and ambulance service must be provided to all auditors and site supervisors. The Safety Officer must be contactable by all site supervisors in order to provide prompt responses to any incident.

Insurances

Auditors and councils and all sub-contractors should have appropriate levels of Personal and Professional Indemnity and Workers Compensation insurances.

OH&S PPE LIST
Recommended personal safety/protective equipment (PPE) is used by individuals to prevent injuries, exposure or contact with hazardous substances or objects. The following section lists some of the personal safety/protective equipment recommended for a visual and physical sort of solid waste.
Body protection
• Sun screen
• Broad brimmed hats
• Disposable coveralls
• Chemical resistant coveralls, if appropriate
• Hard bottomed, non-slip, steel capped boots
• A supply of outer rubber (cut and puncture resistant) gloves
• Chemical goggles or safety glasses with splash shields
• Dust masks
• A supply of inner (latex) gloves
• Insect repellent
• Hearing protection (e.g. ear plugs or ear muffs) if site has equipment or activities that generate loud noises.
Other safety equipment
• Supply of water and soap for washing/flushing etc.
• Disinfecting handwash
• Industrial first aid kit
• Field blanket
• Eye wash kit
• Moist, disposable towels/wipes (e.g. baby wipes)
• Mobile telephone
• Liquids to replenish fluids (water and cups for dehydration)
• Trolley
Personnel required to collect the audit sample should be issued with and required to wear:
• High visibility safety vests
• Overalls
• Safety foot wear
• Heavy duty PVC gloves
• Masks
• Safety glasses
• Broad brimmed hats if collecting during daylight areas

Appendix D: Commissioning an Audit

Once planning of the scope and types of audit required has been completed, the agency commissioning the audit (the council or their contractor) needs to secure the services of an auditor capable of delivering the required outcomes. The following section outlines the main issues in commissioning an audit.

The audit brief

Prior to commissioning any audit, it is important that there is a very clear understanding as to why there is a need to conduct the audit and what information is being sought.

The audit brief is the document that sets the requirements for the audit, and should form the basis for the contracted service to be delivered by the auditor.

Clearly define audit aims and objectives

Audits that clearly define the aim, purpose and objectives in the brief are more likely to produce data that will aid system improvements, evaluate performance and meet the stated objectives.

The following questions can help clarify the audit objectives for the audit brief.

- What is the reason for the audit?
- What information is required from the audit?
- What are the key questions that the audit must answer? (Is there a hypothetical question the audit might answer?)
- What might the audit reveal that could influence programs and project or affect key decisions?
- How will the audit information be used?
- What is the greatest value that can be obtained from the audit? (i.e. is there information/data that could be collected through the audit that may be useful to answer questions that are not the main focus of the audit?')

The answers to these questions will determine the extent of the investigation required to address the audit aims and objectives as well as the level of detail required by an audit. Furthermore, this information could assist to reduce the cost of an audit.

Provide existing and pertinent information

Existing information can help to refine audit methodology. Information about quantities of garbage, recyclables, and green organics collected annually and the number of serviced households will help to estimate average per household generation and recovery rates.

The results of any previous waste audits are also useful in determining variability within and between areas to be audited. Such information can used to estimate how many households need to be sampled to obtain enough material for accurate auditing. When conducting the audit, this information can also be used to identify any significant variation between the quantities of materials collected from the sample population(s) as the general population. Other information pertinent to the conduct of the audit includes:

- Demographic differences
  - These influence waste quantities and waste management behaviour. Information about the types and distribution of dwellings, and socio-economic and ethnicity/first language factors in sample areas should be analysed to identify the potential for these factors to influence audit outcomes. It is recommended that the characteristics of different parts of the area to be audited are noted on a map of the audit area. It is possible that where areas are very different, separate audits or audit sub-samples may be required to better account for variability.
- Collection days, routes, times and contractor details.
  - The auditor will need to coordinate sample collection times with regular service providers. It is recommended that the auditor maintains mobile phone communications with the collection contractor on audit days to let them know the audits progress and when they have finished collection in particular areas.
- Topography and vehicle access.
  - Some areas cannot be served by side lift vehicles. Some premises do not present materials at kerbside and have materials collected from their basement or rear access. The auditor needs to be aware of this information.

Ensure clear communications between parties

It is important that the commissioner of an audit is clear about the purpose of the audit and communicates this directly and unambiguously to the auditor. It is equally important that the auditor clearly communicates to the client the quality and usefulness of data from different audit methodologies. Of vital importance is communications between the auditor and the regular waste and recycling collection contractors /crews on the days leading up to, and on, the audit days.

Establish baselines and future points of comparison

For an audit to measure change or evaluate performance over a given period, a baseline is required. Without this baseline an audit can only establish waste stream profiles at a particular point in time.

To enable an audit to assess change or evaluate performance it must have a point of comparison. This point of comparison can be previous audits that have transparent methodologies outlining category definitions, data interpretation rules, sampling rules and data collection sheets.

Baseline audits provide the basis for future trend analysis and performance monitoring.

A baseline audit is a full waste stream audit of all three kerbside collection streams; garbage, organics and recyclables. Baseline audits are the only audits capable of producing diversion rate analysis. They also have the ability to produce a wider range of key performance indicators with results that can be compared over time.

If an audit does not have a baseline audit to support it or have other background audits, suitably formatted to allow comparison, then a new baseline will need to be established.

Baseline audits not only need to be transparent, they also need to supply data in an accessible electronic format such as an Excel spread sheet so future analysis and performance evaluation can be completed.

Require repeatable and transparent auditing

It is important to have transparency, consistency and accuracy designed into the audit.

Transparency: Commissioned audits should be designed to allow audit methodology replication and future comparison. The methodology should be fully explained together with the sampling procedure and standard errors associated with the data. This also includes the supply of the raw data in electronic form such as Excel.

Consistency: All audits should have measures to minimise data misinterpretation and recording error. These measures can include data recording protocols and material interpretation rules. For instance, how should auditors classify and measure a bottle half filled with a liquid or recyclables disposed in a plastic bag?

Accuracy: All audits should have measures in place to ensure data collection and documentation accuracy.

Minimise the potential for bias

The timing of an audit can affect the integrity of the results. Seasonal and climatic factors can skew the audit and produce misleading results.

It is important that audits make reference to the timing of the audit to ensure transparent data interpretation.

However, if the audit's objective is to analyse peak load performance, planning an audit after a public holiday or storm is critical to assess system performance or parameters under peak conditions.

Outline the required key performance indicators

The audit brief should list the required key performance indicators with their equations. This will ensure the audit's data collection is appropriately designed and capable of producing the required performance measures. For example, some typical key performance indicators can include:

- the reporting of kilograms per household per year
- the diversion or resource recovery percentage of targeted resources

Set the data collection boundaries

By setting the data collection boundaries, unnecessary data collection can be avoided and costs kept to a minimum, while still meeting audit aims, objectives and key performance indicator requirements. For example, if the aim of an audit is to measure the amount of recyclables found in residential garbage samples, then it would be sufficient to report on two categories only, recyclables and other. If the aim of the audit is to determine the level of PET recyclables in a garbage sample, then the categories would be sufficient as PET and other. Such factors also impact on sample size and cost.

Require minimum levels of experience and competency

It is recommended that experienced and professionally trained auditors be secured for waste audits. Auditors that are not trained or have limited experience are more likely to be exposed to more occupational health and safety risks. Inexperienced temporary waste sorting employees should not be used in waste audits unless they have been provided with an induction program outlining the risks they will be exposed to and are closely supervised or paired with an experienced auditor. If councils are considering using permanent staff to conduct audits, training must take into account the recommendations in this guide (OH&S, privacy etc).

Avoid conflict of interest

Waste audits produce information can be used to design, assess and plan waste and recycling collection and processing contracts. Auditors have access to privileged information which can be valuable in future waste management contracts, tenders submissions and negotiations.

In order to avoid unfair contract tendering advantage and in the interests of transparency it is recommended that the following issues are considered:

- Maintain commercial in confidence and ensure the integrity of future waste management tenders. Waste auditors that are subsidiary organisations of companies that plan or have an opportunity to tender for future waste management contracts should only be considered if there is absolute transparency of process so other such companies can have equally access to data collected.
- Ensure that the commissioner of the audit (e.g. the council) maintains legal intellectual property and ownership of all data from audits.
- Make waste audit reports publicly available and accessible to all interested parties.
- Require audit companies to sign a confidentiality agreement with the client as part of contract arrangements.

Require householder confidentially and security

It is recommended all auditors sign a form regarding confidentiality and a code of conduct before they commence an audit and they should be adequately briefed on what standards are expected in terms of confidentiality.

It is further recommended that all waste sample audits that sort paper streams should not redirect this sorted material to a recycling facility. It should be disposed to landfill to ensure identifying papers, legal documents and business statements remain confidential.

Occupational health and safety (OH&S)

The audit brief should contain an OH&S plan to be completed prior to the commencement of any auditing. No auditing should commence without the completion of an audit day sign-off ensuring all safety measures are in place and no waste auditor or sorter is placed at risk.

The supporting guidance documents are contained in *Appendix C*.

Due diligence

To reduce risk, it is important that no audit takes place unless the appropriate due diligence has been undertaken. Due diligence covers a number of aspects that include OH&S, data management, confidentiality and prevention of a conflict of interest for future council tenders. Due diligence should take the form of a checklist report that ensures that all of these aspects have been appropriately managed. The auditor and commissioning agent should sign off on this report, with appropriate management level approval by the commissioning agent.

Appendix E: Verification & Use of Audit Results

Data from audits are mainly used to measure the performance of the system, and use of a consistent methodology allows more accurate target setting and monitoring of performance over time. As more councils adopt the more standard audit methodology proposed in this guide, councils will be able to benchmark their performance with other councils with increasing accuracy.

The following section outlines how auditors and councils can verify and use the results of audits.

Data analysis

The first step in all analysis is data validation.

A simple approach, which can be used by local governments to validate a waste profile, is to compare the audit's extrapolated figures against the known annual waste and recycling collection figures. If there is more than +/- 15% discrepancy between these figures that cannot be explained by known factors such as seasonal variability of green organics or a holiday period, further collection of samples could be necessary.

For example, an audit may report each household is producing 12 kilograms per week per household. This extrapolates to 510 kilograms per household per year. If the known annual figure is 620 kg per year there is a problem, and the data should be re-examined.

If data validation problems are discovered the following steps can be taken to determine corrective action and to provide an explanation:

- Conduct a review of the sampling plan
- Confirm that sampling correctly logged the number of households failing to present a sample (e.g. the designated household chosen in the random sample did not have bins out).
- Confirm no double sampling has occurred due to collection crews collecting neighbouring bins where households have not presented a sample.
- Ensure the sample was taken over a full collection cycle and averaged, because households can have alternating waste disposal behaviours on waste and organic recycling weeks.
- Ensure the audit data has been correctly averaged.
- Review audit data collection sheets
- Double check annual collection figures
- Establish whether a holiday or long weekend or other seasonal factor has affected the data set.
- Establish whether an unexpected weather event has affected the audit (e.g. strong winds or heavy rain).
- Confirm that no major new programs or system changes have occurred that could explain the variation.
- Establish whether the data set can be legitimately adjusted to approximate the wider population average.
- Establish whether additional sampling could repair the data set and whether specific demographics in the sample group can be sampled or re-sampled to minimise the number of additional samples required.

In some instances, discrepancies in the audit may simply be noted. This will ensure the methodology of subsequent audits do not replicate these discrepancies.

Councils are encouraged to conduct audits on at least a biennial basis. If the results of subsequent audits are not markedly different, the results can be averaged to provide a larger sample and greater accuracy.

Key performance indicators

Key Performance Indicators, also known as KPIs or Key Success Indicators (KSIs), help define and measure progress toward goals. These are quantifiable measurements that reflect the factors that are critical to the success of any local government or business.

It is important that KPIs are established and considered in an audit's data collection design to ensure data collection meets and provides the required data. Without key performance indicators, many audit goals and objectives cannot be measured or assessed.

The following key performance indicators could be reported in kerbside waste audits.

KEY PERFORMANCE INDICATORS		
Waste	**Commingled recycling**	**Organics**
Presentation rate	Presentation rate	Presentation rate
Waste generation by household/ week/year	Resource recovery per household/week/year	Resource recovery per household/week/year
Food waste disposed by household by week	Local government annual resource recovery	Local government annual resource recovery
Green waste disposed by household by week	Diversion rate	Diversion rate
Recyclables disposed by household by week	Diversion by material (paper, cardboard, metal glass, plastic.....)	Diversion for green waste and food waste
Waste related CO2 gas emissions per household per year	Plastic bag contamination per household/year	Avoided CO2 emissions
Cost to landfill recoverable resources per household year	Council wide plastic bag contamination/year	Plastic bag contamination per household/year
Cost to landfill recoverable resources shire wide	Nappy contamination per household/year	Council wide plastic bag contamination/year
Percentage of recoverable resources in waste stream	Council wide nappy contamination/year	Nappy contamination per household/year
Total waste generation by local government	All contamination generation by household/year	Council wide nappy contamination/year
	Contamination rate	All contamination generation by household/year
	Contamination cost (processing, landfill and process damage)	Contamination rate
		Contamination cost (processing, landfill and process damage)
		End stream contamination percentage (*contractor landfill)

Equations for the above key performance indicators are provided in the following pages. Data on KPIs can be collected and in most cases custom KPIs will be required for complex research questions and hypothesis tests.

Suggested key performance indicators and equations for estimating these from audit results

WASTE	
KEY PERFORMANCE INDICATORS	**EQUATION**
Presentation rate	$\frac{(\text{ Number of samples presented }) \text{ X } 100\%}{\text{Total sample}}$
Waste generation by household/week/year	Average amount of waste generated by each household every week
Food waste disposed by household by week	Average amount of food waste disposed by each household every week
Green waste disposed by household by week	Average amount of green waste disposed by each household every week
Recyclables disposed by household by week	Average amount of recyclables disposed by each household every week
Waste related CO2 gas emissions per household per year	Using the greenhouse conversion factors for landfills and consideration of gas recovery from landfills calculate the amount of greenhouse gases that will be emitted based on the average amount of waste disposed by households on an annual basis (see table E-1 of this section) .
Cost to landfill recoverable resources per household year	Weight of material per household per year (kg/hh/yr)/1000 X (Financial cost of landfilling ($/t) + Financial value of resource ($/t) Non-financial resource values can also be used
Cost to landfill recoverable resources shire wide	$\frac{(\text{ Cost to landfill recyclables }) + (\text{ Cost to landfill organics }) + (\text{ GHG emission X carbon cost })}{(\text{ Number of households sampled }) \text{ X } (\text{Sample audit cycle – i.e. each house audited twice over two week })}$
Percentage of recoverable resources in waste stream	$\frac{\text{Amount of commingled and organic recoverable resources found in waste stream}}{\text{Total amount of waste stream}}$
Total waste generation by local government (Audit calculated)	Average waste generated by each household annually X Number of households in the local government
Total waste generation by local government (actual landfill receipts)	Figure calculated by landfill receipts

COMMINGLED RECYCLING	
KEY PERFORMANCE INDICATORS	**EQUATION**
Presentation rate	$\frac{(\text{Number of samples presented}) \times 100\%}{\text{Total sample}}$
Resource recovery per household/week/year	Average amount of commingled resources generated by each household every week. This must not include contamination.
Annual resource recovery	Average resource recovery generated by each household annually $\times$ Number of households in the local government
Annual resource recovery (against reported MRF figures)	Figure calculated by landfill receipts
Diversion rate / resource recovery rate	$\frac{(\text{Resources recovered in the recycling sample})}{(\text{Commingled resources recovered in the recycling sample}) + (\text{Commingled resources found in all other samples (waste and organics samples)})}$
Diversion / resource recovery rate by material (paper, cardboard, metal glass, plastic.....)	$\frac{(\text{Resource (i.e. paper) recovered in the recycling sample})}{(\text{Resource (i.e. paper) recovered in the recycling sample}) + (\text{Resources (i.e. paper) found in all other samples (waste \& organics samples)})}$
Plastic bag contamination per household/year	Average number of plastic bags found in the recycling sample per household per week. $\times$ 52 weeks
Council wide plastic bag contamination/year	Plastic bag contamination per household/year $\times$ Number of households that exist in the local government
Nappy contamination per household/year	Average number of nappies found in the recycling sample per household per week. $\times$ 52 weeks
Council wide nappy contamination/year	Nappy contamination per household/year $\times$ Number of households that exist in the local government
Contamination generation by household annually	The average amount of contamination that is by each household annually
Contamination rate	$\frac{\text{Contamination found in the recycling sample}}{(\text{Contamination found in the recycling sample}) + (\text{Recoverable resources in the recycling sample})}$

COMMINGLED ORGANICS	
KEY PERFORMANCE INDICATORS	**EQUATION**
Presentation rate	$\frac{(\text{Number of amples presented})}{\text{Total sample}} \times 100\%$
Resource recovery per household/week/year	Average amount of recovered organics by each household every week. This must not include contamination.
Green Waste resource recovery per household/ week/year	Average amount of recovered green wastes by each household every week. This must not include contamination.
Food Waste resource recovery per household/ week/year	Average amount of resource recovered food waste by each household every week. This must not include contamination.
Annual organic resource recovery	Average organic recovery generated by each household annually X Number of households in the local government
Annual green waste resource recovery	Average green waste resource recovery by each household annually X Number of households in the local government
Annual food waste resource recovery	Average food waste resource recovery by each household annually X Number of households in the local government
Annual organic recovery (Contract figures)	Processed material – Contaminated organics dumped to landfill
Diversion rate	$\frac{(\text{Recovered organics})}{(\text{Recovered organics}) + (\text{Organics found in all other samples (waste\& recycling samples)})}$
Green waste diversion rate	$\frac{(\text{Recovered Green waste})}{(\text{Recovered green waste}) + (\text{Green waste found in all other samples (waste\& recycling samples)})}$
Food waste diversion rate	$\frac{(\text{Recovered food waste})}{(\text{Recovered food waste}) + (\text{food waste found in all other samples (waste\& recycling samples)})}$
Avoided CO2 emissions per household per year	Use greenhouse conversion to calculate the amount of avoided landfill greenhouse gases emissions on the average amount of organic resource recovery by a household on an annual basis. (see table E1)
Plastic bag contamination per household/year	Average number of plastic bags found in the organic sample per household per week. X 52 weeks
Council wide plastic bag contamination/year	Plastic bag contamination per household/year X Number of households that exist in the local government

COMMINGLED ORGANICS	
KEY PERFORMANCE INDICATORS	**EQUATION**
Nappy contamination per household/year	Average number of nappies found in the organic sample per household per week. x 52 weeks
Council wide nappy contamination/year	Nappy contamination per household/year x Number of households that exist in the local government
Contamination generation by household annually	The average amount of contamination by each household annually
Contamination rate	$\frac{\text{(Contamination found in the organic sample)}}{\text{(Contamination found in the organic sample)} + \text{(Recoverable resources in the recycling sample)}}$
Annual contamination cost (processing, landfill and process damage)	Cost to landfill contamination + Cost to process contamination + GHG landfill emissions + Amount contractor disposed to landfill
End stream contamination percentage (*contractor landfill)	$\frac{\text{(Amount of contaminated organics contractors disposes to landfill)}}{\text{(Amount of collected or processed organics)}}$

Benchmarks

Benchmarks provide points of reference for measurement in relation to best practice.

Benchmarking is a process used in management, which allows an organisation to evaluate various aspects of their processes, performance and achievements in relation to best practice.

Benchmarks provide local governments with critical information that can be used to develop plans on how to make improvements or adopt best practice, usually with the aim of increasing some aspect of performance.

Benchmarks are critically important for measuring performance in audited systems that do not have current baseline audits.

For continuous improvement it is recommend that kerbside audits (a) register their benchmarks with Sustainability Victoria and (b) report the local government's benchmark status. It is recommended the following benchmarks are registered:

It is also important that benchmarks are presented and analysed in context. For example, regional local government should not be benchmarked against urban or inner city local governments, but interstate benchmarking is encouraged. These latter benchmarks can be a valuable guide to establishing resource recovery goals.

Sustainability Victorian publishes an annual Victorian Local Government Data Collection report that provides benchmark data on local government waste, recycling and green waste generation. This data can be used to benchmark local government waste management performance.

BENCHMARK REPORTING	
Waste generation per household/year	Green waste landfill disposed per household/week
Recyclables landfill disposed by household/year	Council cost to landfill recoverable resources per annum
Percentage of recoverable resources in waste stream	Total waste generation by local government
Commingled resource recovery per household/year	Commingled diversion rate
Commingled diversion by material (paper, cardboard...)	Commingled resource recovery contamination
Green waste diversion rate	Green waste contamination

Environmental costs and benefits of management approaches

The ways wastes are managed impacts on the net environmental costs and benefits of councils' collection services. Knowing the relative impacts allows more informed decision making about alternative management options.

The ways wastes are managed impacts on the net environmental costs and benefits of councils' collection services. Knowing the relative impacts allows more informed decision making about alternative management options.

Key impacts are:

- **Greenhouse gas emissions.**
  In landfill, materials containing organic carbon degrade and produce the potent greenhouse gas methane. The actual emissions from landfill will depend on the extent of landfill gas recovery and oxidisation or conversion to energy. Some greenhouse emissions factors for different materials are shown in table E.1. Recycling typically reduces energy needed to refine raw or first use materials.
- **Water and resource use or conservation and other pollution.**
  Recycling generally reduces water and other resource use and pollution compared to first use refining of materials. Some factors for common waste items are also shown in Table E.2.

TABLE E.1 Greenhouse conversion factors based on national greenhouse and energy reporting factors and modelling of landfills with high life cycle gas recovery rates

MATERIAL	CONVERSION FACTOR CO2-EQUIVALENT PER TONNE OF MATERIAL IN LANDFILL (GAS POTENTIAL – NO LANDFILL GAS CAPTURE)	INDICATIVE TONNE CO2-E /TONNE OF MATERIAL IN LANDFILL 60% LIFECYCLE LANDFILL GAS CAPTURE, NO CONVERSION TO ENERGY	INDICATIVE TONNE CO2-E / TONNE OF MATERIAL IN LANDFILL 60% LIFECYCLE LANDFILL GAS CAPTURE AND CONVERSION TO ENERGY
PAPER AND CARDBOARD	2.5	0.6	0.2
TEXTILES	1.5	0.4	0.1
WOOD	2.7	0.7	0.2
GARDEN AND GREEN	1.3	0.3	0.1
FOOD	0.9	0.2	0.1
NAPPIES	1.5	0.2	0.1
RUBBER AND LEATHER	2.5	0.6	0.2
CONCRETE/METAL/ PLASTICS /GLASS	0	0	0

TABLE E.2 Indicative greenhouse and water saving benefits of recycling compared to extraction

MATERIAL	INDICATIVE GREENHOUSE EMISSIONS SAVINGS DUE TO RECYCLING TONNES CO2-E AVOIDED PER TONNE RECYCLED	INDICATIVE WATER SAVINGS L/TONNE OF MATERIAL RECYCLED
Aluminium cans	16.5	
Aluminium (other)	17.5	
Packaging steel	1.5	
Steel	1.7	
Copper	3.4	
Glass containers	0.6	
PET	1.0	
HDPE	1.1	
PP	1.6	
PVC	1.9	
Mixed plastics	1.4	
Cardboard/paper	0	
Garden organics	0	
Food organics	0	

Local governments are encouraged to calculate their kerbside waste-related greenhouse gas emissions and other environmental benefits and costs, as part of their kerbside waste audits. The economic and environmental modelling of waste related greenhouse gas emission will provide local governments with insight into future liabilities and valuable information for waste management planning.

Target setting, performance monitoring and audit reporting

Audit results can be used to set performance targets, such as increased recycling and organics recovery, and reduction of contamination levels is recycling and organics bins, or to reduce waste through greater home composting. Accurate audits allow you to set priorities for action and numeric targets for programs to achieve these outcomes. Periodic audits (at least every two years) allow performance to be tracked and priorities to be reassessed.

Audit results can be used to identify data gaps and uncertainties, and subsequent audits can be designed to fill these gaps.

After initial audits, methodologies can be refined to optimise sample size and to provide information about specific items in the materials stream that are of interest. This means that over time, the cost of audits may fall if the scope of audits is narrowed to meet specific needs.

Reporting costs should also fall, as audit results can be fed into standard assessment tools and format report formats that allow changes in performance to be charted. Such reporting helps to detect trends, and also to identify what has and hasn't been effective in promoting waste minimisation objectives.

Maintaining a budget for auditing allows more targeted information to be gathered about waste and resource management in your municipality.

Finally, a very real advantage of adopting an audit methodology consistent with other municipalities is the ability to compare performance with other councils and to share information about what strategies might be effective in your municipality to minimise waste.

GLOSSARY

Baseline	A set of data values that can serve as a comparison
Benchmark	A reference by which performance can be measured or judged
Calibration	The process of checking or adjusting the accuracy of a measuring instrument that will be used in the audit
Commissioning agent	The party for whom the audit is conducted, and who sets the audit scope and brief in consultation with recycler and auditors.
Contamination	Any item that is not allowed in a kerbside sample and / or any item that cannot be recovered at a recycling facility
Due diligence	The level of judgement, care, prudence, determination, and activity that a person would reasonably be expected to undertake to ensure; a safe working environment; a data quality assurance program; kerbside audit integrity; and avoidence of conflict of interest.
Full collection cycle	The collection of kerbside material over a number of weeks to ensure alternative week or the intermittent kerbside collection of samples does not bias or compromise the collected data
Green organics stream	All material placed in the green waste wheelie sample for the purposes of green waste resource recovery
Key performance indicator	The quantifiable measure that can used to track performance and progress towards a goal
OH&S	Occupational Health and Safety
MUDs	Multi Unit Dwellings
MRF	Materials Recovery Facility
Per household method	The sample by sample analysis of all household waste and resource streams (also known as 'bag and tag').
PET	The acronym for polyethylene teraphthalate, which is high gloss, crack-resistant, transparent plastic used largely in making carbonated beverage bottles
Quality assurance	A system for evaluating performance
Recycling stream	All material placed in the recycling wheelie sample for the purposes of recycling.
Sample	The total amount of wheelie samples that will be collected for the audits
Seasonal influence	The effect that seasons have on waste and recycling profile
Standard operating procedure	The prescribed processes and sequence of events that will be followed routinely
Waste stream	All material placed in the waste wheelie sample for the purposes of landfill disposal

SOURCES AND FURTHER READING

NZ Ministry of the Environment 2002 Solid Waste Analysis Protocol Summary Procedures http://www.mfe.govt.nz/publications/waste/solid-waste-analysis-mar02/index.html

ABS 2006 Census of Population and Housing

For further information and enquiries about
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