HSE

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Collecting, transfer, treatment and processing household waste and recyclables

Assessment of the occupational health and safety risks of systems to provide HSE, local authorities, waste/recycling companies and others with data that will assist in the selection of the most appropriate system whilst meeting environmental targets

Prepared by the **Health and Safety Laboratory**
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Given the potential increase in the number of employees working in the waste and recycling industry, it is reasonable to anticipate that there will be greater exposure to health and safety related hazards, particularly in collecting and sorting waste where human involvement is essential. In order to reduce the high accident rate within the waste and recycling industry, it is essential to ensure that considerations of health and safety are included in the decision-making process regarding which systems to operate. The Health and Safety Executive (HSE) has identified that the provision of appropriate guidance or tools could present a useful means of assisting Local Authorities, or organisations (including community organisations) that are responsible for delivering waste management services, to select the most appropriate systems to ensure environmental targets are met with the least possible health and safety risk.

As a means of obtaining this information, the Health and Safety Laboratory (HSL) were jointly commissioned by HSE, the Department for Environment, Food and Rural Affairs (Defra), the Scottish Government (SG), and the Welsh Assembly Government (WAG) to undertake an assessment of the occupational health and safety risks of systems for collection, transfer, treatment and processing of household waste and recyclables.

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EXECUTIVE SUMMARY

Introduction

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As a means of obtaining this information, the Health and Safety Laboratory (HSL) were jointly commissioned by HSE, the Department for Environment, Food and Rural Affairs, the Scottish Executive, and the Welsh Assembly Government to undertake an assessment of the occupational health and safety risks of systems for collection, transfer, treatment and processing of household waste and recyclables.

Objectives

The overall aim of the project is to provide a means for Local Authorities and others to compare the level of health and safety risk from different waste and recyclables management systems for the full waste life cycle (not just collection). This can then be used alongside other factors, for example environmental targets, cost and local availability, to help make a balanced decision on the most appropriate overall system, taking appropriate account of health and safety. It is stressed, however, that determining how to balance other factors alongside the health and safety information is outside the scope of the current work.

The objectives of the work include:

- Provide an approach capable of assessing and comparing the occupational health and safety risk of different waste and recyclables management systems at different levels of detail, including the overall system life cycle, subsystems, individual component (activity) level and individual hazards.
- Provide the various stakeholders with guidance and information to inform their selection of collection and processing systems, enabling them to ensure the occupational health and safety of workers, so far as is reasonably practicable, whilst meeting environmental targets.

Main Findings

In order to address the aims and objectives of this work an Excel based tool has been developed. This tool, the Risk Comparator Tool, is described in this report, including guidance on its use. In addition, as part of populating the tool, the result of the hazard identification and risk assessment processes that were applied have been described. This includes justification for all assumptions made.

The Risk Comparator Tool is considered fit-for-purpose, although it cannot be guaranteed that it will work everywhere and is provided as-is without any ongoing support. It is the first version of the tool, and as such many improvements could be made, some of which are listed below.

However, at this stage it was considered the best approach was to allow the tool to be used for a period of time, and its usefulness evaluated, prior to considering whether effort for further development can be warranted.

Notwithstanding the above comment, a fairly limited trial with four Local Authorities was undertaken. Some of the feedback from this trial has been incorporated into the tool's development, whilst other feedback is incorporated into the recommendations below. Across the trials, Local Authorities suggested a variety of uses for the tool, which appeared to map well with the objectives for its development. Essentially these were:

- To help with strategic decision-making;
- An aid to the risk assessment process; and
- To increase visibility of internal/business processes (e.g. decisions between different systems proposed, or rationale behind rejection of a proposed system).

Recommendations

1. The ultimate aim of this project was to provide health and safety information that can be used alongside other factors, for example environmental targets, cost, politics and local availability of a particular system, to help make a balanced decision on the most appropriate overall waste and recyclables management system, taking appropriate account of health and safety. It is stressed, however, that determining how to balance other factors alongside the health and safety information is outside the scope of the current work. Therefore, it is recommended that further work is carried out to develop a decision making framework utilising the outputs from this work and the other factors.

2. The development of the Risk Comparator Tool has been limited to a defined range of waste and recyclables management systems, where a generic approach has been taken to describe each of these systems. Further consideration should be made following evaluation of the tool whether a wider range of systems or more differences within a specific system should be captured.

3. The data contained within the tool, i.e. hazards, hazard probability and consequence ratings, and modification factors have been derived based mainly on expert judgement, but using a range of approaches to increase the robustness of the data. They will therefore have inherent uncertainty. Accident data was investigated to support the assessments, although it was found that it was not sufficiently detailed to map onto the component and hazard breakdown as adopted here. Where improvements in accident data classification occur from across the industry, this should be used in the future to update the judgments made.

4. The guidance presented in Appendix F should be considered by HSE and the Waste Industry Safety and Health (WISH) forum for further development and publishing by HSE/WISH.

5. The following improvements to the Risk Comparator Tool should be considered:

- Developments to the output of the tool to make it easier to compare the risk ratings from different systems;
- Graphical and colour-coded output of the risk results;
- Increased flexibility to allow new components and hazards to be added;
- Functionality to allow summary reports to be produced; and

- Save assessment and load previous assessment functionality.

6. The Risk Comparator Tool should be used and evaluated by users over a period of time, say a year. Following this period a meeting between interested parties should be held to evaluate the usefulness of the tool and consider further developments.

1 INTRODUCTION

1.1 BACKGROUND

The United Kingdom produces over 100 million tonnes of waste from household, commercial and industrial sources each year, a total that is growing at a rate of around 3% per annum (References 1 and 2). While waste cannot be eliminated, its environmental impact can be reduced, by preventing its production wherever possible, and making more sustainable use of the waste that is produced. The different options for waste management are often considered as components in a ‘waste hierarchy’ (Reference 3), as demonstrated in Figure 1, with those towards the top of the pyramid being more desirable than those towards the bottom.

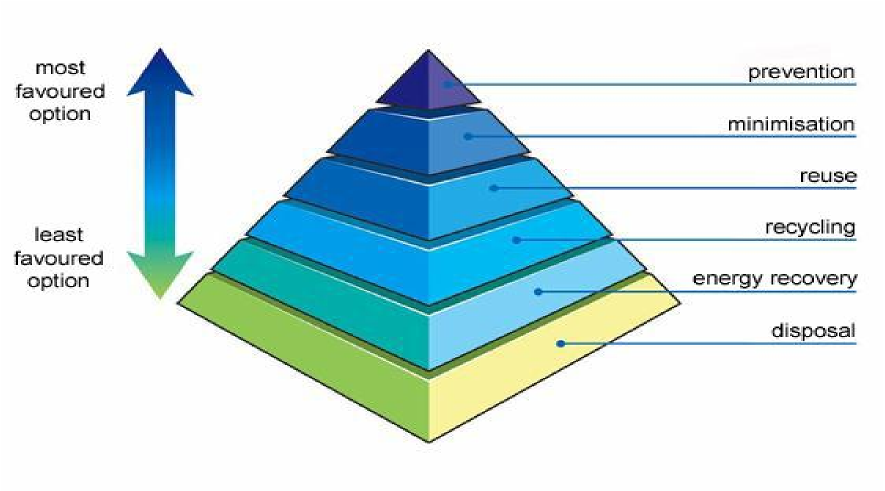

Figure 1 The Waste Hierarchy

The first priority within the hierarchy is to prevent production of waste wherever possible. Following this, the second most preferred option is waste reduction or minimisation, as far as is economically sustainable, with particular priority given to the hazardous components of waste. The third most preferable is the reuse of objects in order to prevent them entering the waste stream. The fourth priority of the hierarchy is broad, including materials recycling and composting. The fifth best option is the recovery of energy from waste. Waste disposal is at the bottom of the hierarchy, and includes final disposal to landfill and incineration of waste without energy recovery. Whilst there will always be a need for waste disposal of materials that cannot be recovered in any other way, the objective is to ensure that this is done to the highest standards of sustainability, safety and environmental compliance.

In response to increasing environmental concerns, the UK government has set out its vision[1] for sustainable waste management. These government policy documents have caused significant changes in the UK in the way that household waste is collected, handled and either recycled or

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[1] *This is contained in Waste Strategy 2000, the England and Wales waste strategy, National Waste Strategy Scotland – The National Waste Plan 2003, Wise about Waste – The National Waste Strategy for Wales 2002, Towards Resource Management: The Northern Ireland Waste Management Strategy 2006 - 2020 and Waste Strategy for England 2007.*

disposed of. In addition, the Landfill Directive[2] has introduced challenging targets for the reduction of the amount of waste sent to landfill through promoting reduction, reuse, recycling and recovery of materials. These targets place duties on Local Authorities (LAs) that will shape the activities of the UK household waste and recycling industry over the next 15 years and beyond.

To deliver the household waste and recycling targets, LAs are seeking to implement changes to services that will result in an increasing amount of materials recycled and a greater percentage of waste being diverted from landfill. This is resulting in the development and implementation of a range of new collection and processing systems, and an expansion of the industry as a whole. It is anticipated that the industry will continue to evolve in order to meet current and future targets.

1.2 HEALTH AND SAFETY IN THE WASTE AND RECYCLING INDUSTRY

It is estimated that around 162,000 workers are currently employed in the UK waste management industry; many more are employed in other activities associated with specific recyclables and ancillary activities such as transport (Reference 4). The research also indicates that as LAs implement new systems to meet their environmental targets under the Landfill Directive, the employment numbers within the industry are likely to increase. It is estimated that if the national recycling target is to be met in 2010 then around 45,000 extra jobs could potentially be created in the UK, with around 9,000 extra jobs in collection, 26,000 in sorting and 9,000 in reprocessing (Reference 5).

The overall accident rate within the industry is very high in comparison with the national average. To illustrate this, a recent analysis of accident statistics for HSE (Reference 4) estimated the overall accident rate for the waste industry to be around four times the national average (2,500 accidents per 100,000 workers in 2001/02), and the fatal injury accident rate to be around ten times the national average (10 per 100,000 workers in 2001/02). Analysis of accident statistics indicated that the majority of accidents within the industry occur during refuse collection activities, and are dominated by musculoskeletal injuries, slips, trips and falls, cuts, and injuries resulting from the use of workplace transport. For the purpose of clarification, it should be realised that due to shortcomings within the Standard Industrial Classification systems analysed for the BOMEL report (Reference 4), the terms ‘waste industry’ and ‘refuse’ used here include both waste and recycling activities.

1.3 OBJECTIVES

Given the potential increase in the number of employees working in the waste and recycling industry, it is reasonable to anticipate that there will be greater exposure to health and safety related hazards, particularly in collecting and sorting waste where human involvement is essential. In order to reduce the high accident rate within the waste and recycling industry, it is essential to ensure that considerations of health and safety are included in the decision-making process regarding which systems to operate. The Health and Safety Executive (HSE) has identified that the provision of appropriate guidance or tools could present a useful means of

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[2] *The Landfill Directive represents a step change in the way waste is disposed of in the UK, and will help drive waste up the hierarchy through waste minimisation and increased levels of recycling and recovery. The Directive's overall aim is "to prevent or reduce as far as possible negative effects on the environment, in particular the pollution of surface water, groundwater, soil and air, and on the global environment, including the greenhouse effect, as well as any resulting risk to human health, from the landfilling of waste, during the whole life-cycle of the landfill". The Directive sets demanding targets to reduce the amount of biodegradable municipal waste landfilled.*

assisting LAs, and others, to select the most appropriate systems to ensure environmental targets are met with the least possible health and safety risk.

As a means of obtaining this information, the Health and Safety Laboratory (HSL) were jointly commissioned by HSE, the Department for Environment, Food and Rural Affairs, the Scottish Executive, and the Welsh Assembly Government to undertake an assessment of the occupational health and safety risks of systems for collection, transfer, treatment and processing of household waste and recyclables.

The overall aim of the project is to provide a means for Local Authorities (LAs), or organisations (including community organisations) that are responsible for delivering waste management services, to compare the level of health and safety risk from different waste and recyclables management systems for the full waste life cycle (not just collection). This can then be used alongside other factors, for example environmental targets, cost and local availability, to help make a balanced decision on the most appropriate overall system, taking appropriate account of health and safety. It is stressed, however, that determining how to balance other factors alongside the health and safety information is outside the scope of the current work.

The objectives of the work include:

- Provide an approach capable of assessing and comparing the occupational health and safety risk of different waste and recyclables management systems at different levels of detail, including the overall system life cycle, subsystems, individual component (activity) level and individual hazards.
- Provide the various stakeholders with guidance and information to inform their selection of collection and processing systems, enabling them to ensure the occupational health and safety of workers, so far as is reasonably practicable, whilst meeting environmental targets.

Within the framework of this project, seven work packages were identified to address the aims and objectives. These are as follows:

- Work Package 1 – Identification of household waste and recyclable management systems;
- Work Package 2 – Definition of system components;
- Work Package 3 – Methodology for assessment of risks and presentation of outputs;
- Work Package 4 – Assessment of risks for each system component;
- Work Package 5 – Trial of risk tool with Local Authorities;
- Work Package 6 – Identification of principles of best practice control of occupational health and safety risks for each system, and development of case study examples; and
- Work Package 7 – Output and presentation of results.

The main output from these work packages was the development of an Excel based Risk Comparator Tool. This report provides the background to the tool’s development and guidance on how it should be used. An important point to stress, however, is that this report does not provide a risk ranking of the different waste and recyclable management systems, or specific aspects of them, as this potentially could be extremely misleading. Instead the Risk Comparator Tool can provide this information, but only when local factors have been entered by the user.

1.4 SCOPE OF THE WORK

The scope of this work includes consideration of the full range of existing and possible future systems for reuse, recycling, composting, recovery and disposal of household waste and recyclables. It thus includes systems for collection, transfer, treatment and processing of household waste and recyclables (municipal waste).

The research involved assessment of the level of occupational risk of the various systems and presentation of the output in a user friendly format that allows users to make a comparison between them. Assessment of the risks from individual components of the systems, from individual hazards as well as from the overall systems has been carried out.

In carrying out the work, it was important to consider not only the systems themselves, but the full range of environments in which the systems have to operate. For example, the effects of local geography (e.g. urban or rural environments), housing type (e.g. detached or terraced, or high-rise flats), as well as seasonal effects (e.g. public holidays, severe weather, etc.) were all taken into account.

The research also involved identification of good practice for specific hazards, where sufficient guidance is not already published, in terms of control of health and safety risks.

The work focuses on the negative health and safety effects of working in the waste and recycling industry. However, although outside the scope of the current work, these effects must be compared alongside any potential health benefits that some activities may provide.

1.5 STRUCTURE OF REPORT

The remainder of the main report is structured as follows:

- Section 2 summarises the overall project and the methodology followed;
- Section 3 presents the scope of the project in terms of the waste and recyclables management systems considered;
- Section 4 introduces the Risk Comparator Tool developed as part of this project;
- Section 5 presents guidance on using the tool;
- Section 6 discusses issues around use of the tool; and
- Section 7 summarises the project conclusions and recommendations.

Supporting information is provided as a number of appendices as follows:

- Appendix A describes the work carried out for Work Package 1 – identification of household waste and recyclables management systems;
- Appendix B describes the work carried out for Work Package 2 – definition of system components;
- Appendix C describes the work carried out for Work Package 3 – methodology for assessment of risks and presentation of outputs;
- Appendix D describes the work carried out for Work Package 4 – assessment of risks for each system component;
- Appendix E describes the work carried out for Work Package 5 – trial of the risk tool with a sample of Local Authorities; and

- Appendix F describes the work carried out for Work Package 6 – identification of principles of good practice control of occupational health and safety risks.

2 PROJECT METHODOLOGY

2.1 OUTLINE OF OVERALL PROJECT

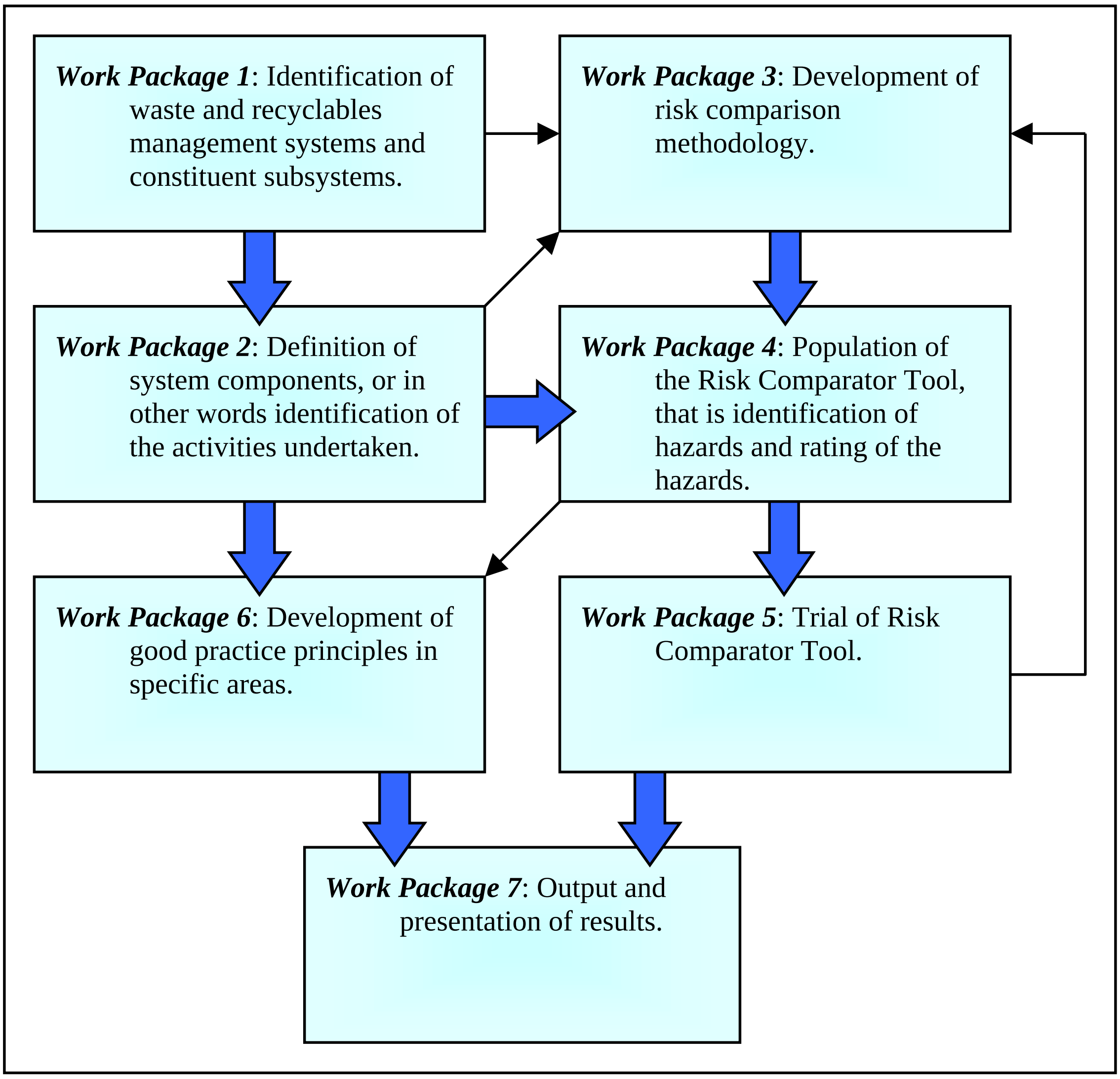


Figure 2 Interaction of project work packages

Figure 2 illustrates the work packages and their interaction. The purpose of each work package is summarised below:

Work Package 1 – identification of waste and recyclables management systems and constituent subsystems. The objective of this work package was to identify the range of household waste and recycling collection, transfer, treatment and processing systems available now, and likely to be available in the future. The scope of the work included consideration of the full range of existing and possible future systems for reuse, recycling, composting, recovery and disposal of household waste and recyclables. From this a number of systems were chosen for detailed analysis. The work carried out as part of this work package is presented in Appendix A and the systems chosen for analysis, which essentially defines the detailed scope of the project, are presented in Section 3.1.

Work Package 2 – definition of system components, or in other words identification of the activities undertaken. The objective of this work package was, for each of the waste and recyclables management systems proposed for detailed assessment in Work Package 1, to carry out a detailed task analysis. The task analysis was carried out following in-depth observations of the range of systems considered within scope, discussions with people working with these systems and review of any relevant operating procedures. The output from this work package was the definition of each waste and recyclables management system, considered to be within scope, in terms of a number of discrete components or activities. The assessment of risk was then focused on each of these components. The work carried out as part of this work package is presented in Appendix B. The components are selected as part of running the Risk Comparator Tool, and are listed within the guidance associated with the tool, presented in Section 5 of this main report.

Work Package 3 – development of risk comparison methodology. The aim of this work package was the development of a methodology for the assessment of risk for the various waste and recyclables management systems. As part of this, the methodology had to have maximum utility for LAs and others as a decision aiding tool and it had to take account of, where possible, local factors that have an effect on the level of risk. Appendix C describes the development of the risk assessment methodology. The Risk Comparator Tool has been developed to implement this methodology.

Work Package 4 – population of the Risk Comparator Tool. The aim of this work package was ultimately to populate the Risk Comparator Tool. This involved the following activities:

(1) Estimation of hard-wired modification factors. These are factors that convert a baseline exposure frequency (number of properties collected from for collection systems or volume of waste for post-collection systems) into an exposure frequency for each component. This is further described as part of the methodology development (Section C3.1.1, Appendix C).

(2) Identification of the hazards and range of consequences for each system component identified in Work Package 2.

(3) Assignment of probability and consequence ratings for each component hazard.

Details of the approach taken to generate the hard-wired factors, hazards and hazard ratings, the data generated and justification are presented in Appendix D. This data is used by the Risk Comparator Tool, along with local factors, that are entered at run time, to calculate a risk profile for the selected system(s).

Work Package 5 – trial of the Risk Comparator Tool. Four trials were organised to include a variety of Local Authorities from England, Scotland and Wales. The objective of the trials was to give a sample of Local Authorities the opportunity to explore the tool, and provide feedback to HSL, with regards to usability of the tool and utility of the resultant information. Appendix E describes the trials and their findings.

Work Package 6 – development of good practice principles in specific areas. The initial aim of this work package was, for each of the systems that have been assessed in detail, to develop a case study example of the principles of best practice for the control of occupational health and safety risks. However, during the course of this project, the direction for this work package was changed slightly to focus on producing good practice principles in areas not currently having sufficient coverage specific to the waste and recyclables industry. This included developing good practice guidance in the following areas:

(1) Manual handling;

(2) Slips and trips;

(3) Exposure to microbiological hazards; and

(4) Stress.

Appendix F describes the approach taken and presents the guidance that was produced.

Work Package 7 – output and presentation of results. The main purpose of this work package was to take the results of the above work packages and present the information in a suitable format. This has involved the following key tasks:

(1) An Excel based tool, the Risk Comparator Tool, has been developed that allows the risk tables produced as part of Work Package 4 to be interrogated and used in a relatively user-friendly way.

(2) Guidance has been developed for Local Authorities, and other relevant stakeholders, on how to use the Risk Comparator Tool, which is the subject of this main report.

(3) Production of a project report describing all aspects of the work carried out. This is contained in the main report and supported by a number of appendices that contain details of each of the above work packages.

(4) Presentations of the work will be made to the Project Management Board, the Project Advisory Committee and the industry via a series of seminars.

2.2 PROJECT TEAM

The approach taken in carrying out the project has been to utilise a core project team from within HSL utilising personnel with a range of expertise in different areas relating to health and safety. In addition, the core team was supplemented with HSL specialists, as necessary, and industrial expertise from personnel outside the industry, including industrial partners, a Project Advisory Committee, a Project Management Board, the customers, and wider stakeholders who have been involved at various stages in the project. The project team, and main interactions are illustrated in Figure 3. The involvement of the key groups of people were:

Project Management Board – this consisted of members representing the clients (HSE, Department for Environment, Food and Rural Affairs (DEFRA), Welsh Assembly Government and Scottish Executive) and the Chartered Institution of Wastes Management (CIWM). They oversaw the whole project and provided direction throughout.

Project Advisory Committee – this consisted of representatives from the industry and included operators (private, public and community), regulators, industry bodies, Local Authority representatives and government bodies, including representatives from the Welsh Assembly and Scottish Executive. The Project Advisory Committee provided comment at each stage of the project and provided advice to both the Project Team and Project Management Board. The purpose of the Project Advisory Committee was for them to act on behalf of the industry and to try and ensure that the outputs from the project had maximum utility and were as robust as possible, the latter to ensure buy-in by the wider industry.

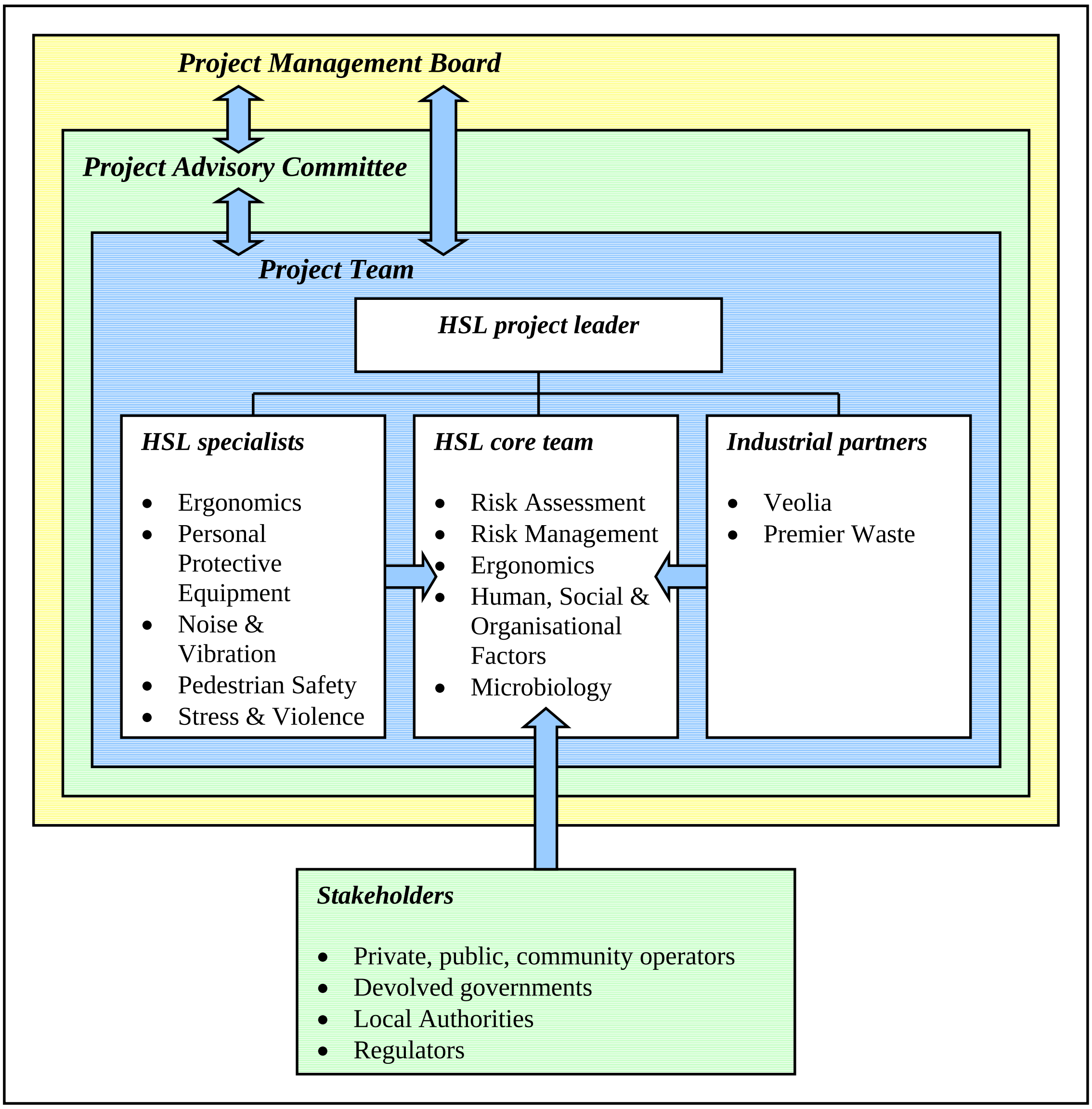


Figure 3 Project team and other partners and stakeholders

Stakeholders – in addition to the Project Advisory Committee a wider range of relevant stakeholders were involved at various stages in the project. This included: discussions to identify current and future systems, as part of Work Package 1; observations of waste and recyclables management systems, discussion with operatives and review of operating procedures, as part of Work Package 2; attendance at four risk assessment workshops that were carried out as part of Work Package 4; and working with the Project Team to trial the Risk Comparator Tool, as part of Work Package 6.

Industrial partners – in addition to the HSL team two organisations agreed to partner HSL in the project, Veolia Sheffield and Premier Waste. They were utilised to input operational experience as required and to supplement the input from other industrial stakeholders. Their main areas of involvement included:

- Contribution of expert knowledge of the industry with respect to the range of systems currently in use within the UK, and the range of systems likely to be available in the future;
- Provision of quick access to company accident records, method statements, safe systems of work and risk assessments;
- Contribution to the brainstorming meetings; and
- Access to observe the range of systems they operate.

2.3 METHODOLOGY

The overall approach taken to the development of the Risk Comparator Tool has involved the following key activities.

- ***Review of written information*** – this has included a literature review, and review of information provided by the stakeholders including operating procedures, risk assessments and accident data.
- ***Discussion with stakeholders and observation of the systems in practice*** – further information has been generated through discussion with operatives and observations of the systems. The purpose of this was to capture the job in practice and explore variations not observed, e.g. differences in other conditions, for example following a bank holiday, staff shortages or different times of the year etc.
- ***Analysis of information –*** information gathered in the above two stages was analysed to essentially define the scope of the Risk Comparator Tool.
- ***Project team semi-structured brainstorming*** – the project team, utilising the information gathered in the above activities, undertook several semi-structured brainstorming sessions to identify hazards and populate the Risk Comparator Tool with hazard ratings and component specific modification factors.
- ***Industry workshops*** – four workshops were held with representatives from industry. These workshops are described in more detail in Annex D2 of Appendix D. The purpose of the workshops was to review and validate the assessments that had been carried out by the HSL project team, including the activities, the hazards, the hazard probability and consequence ratings, and the activity exposure frequency modification factors. Furthermore, it was expected that by discussing the hazards, examining the assumptions made and utilising the experience and knowledge of the attendees that the ‘hard wired’ part of the tool could be made as robust as possible.
- ***Sense checking and bringing together of the disparate strands*** – utilising the outputs from the industry workshops alongside the outputs from the project team brainstorming sessions and other information generated from the above activities an overall view, mainly in terms of the Risk Comparator Tool data, was developed.
- ***Trial of the Risk Comparator Tool with LAs*** – four trials of an early version of the Risk Comparator Tool were organised with Local Authorities from England, Scotland and Wales.
- ***Check points with Project Advisory Committee and Project Management Board*** – at various stages throughout the project key decisions were checked with both the Project Advisory Committee and Project Management Board. This was to ensure that the project developed in line with their expectations and to give sufficient confidence in the Risk Comparator Tool.

A different combination of the above activities have been used for each work package. Which have been used, the interaction of the stakeholder groups (as described in Section 2.2) in this process and how this fits together with each of the work packages (as described in Section 2.1) is illustrated in Figure 4.

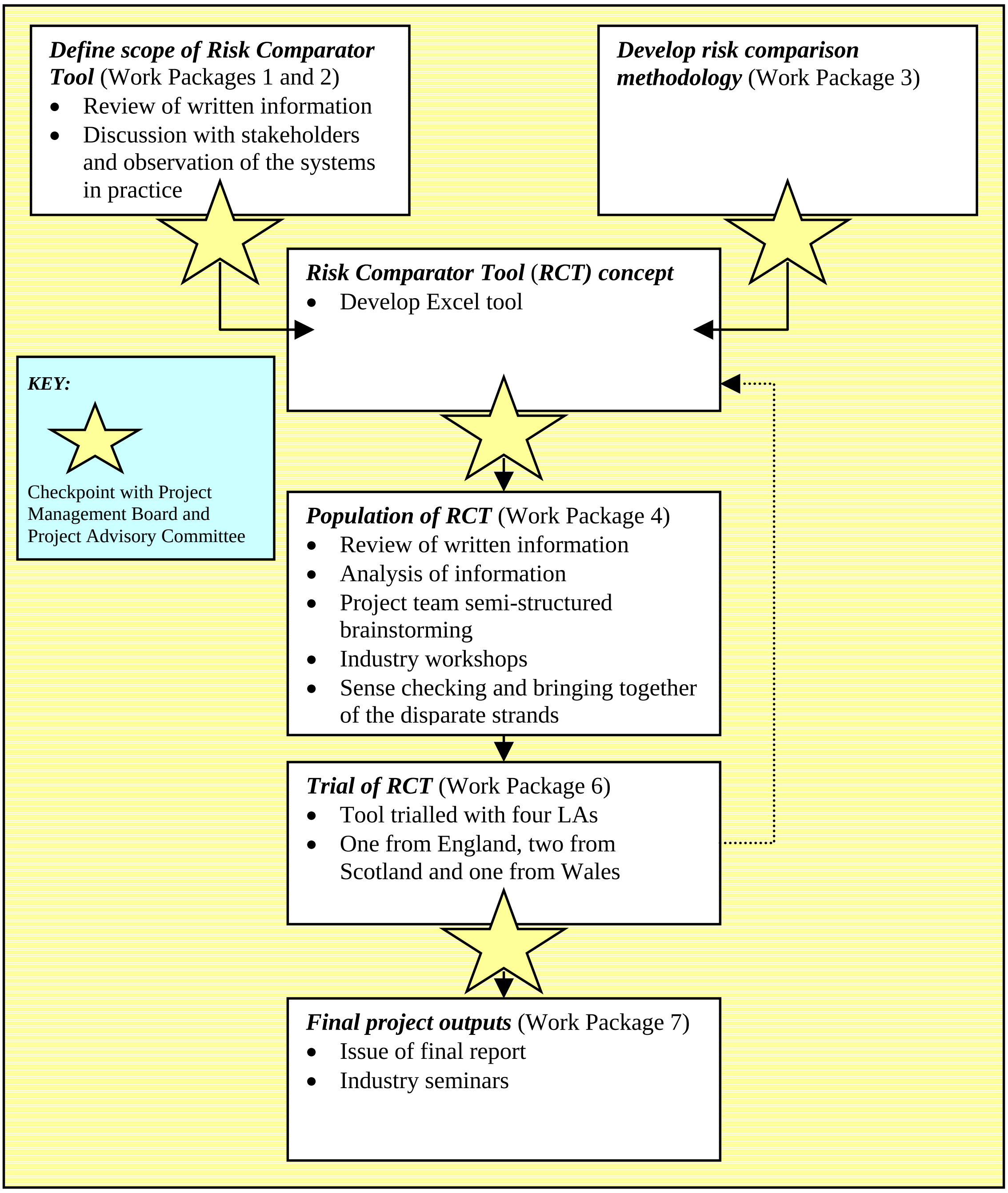


Figure 4 Project methodology

3 SCOPE

This section outlines the scope of the development of the Risk Comparator Tool in terms of the systems (Section 3.1) and the activities that have been considered (Section 3.2). The detailed scope of the tool itself is described in Section 4.3.

3.1 WASTE AND RECYCLABLES MANAGEMENT SYSTEMS

Based on the output from Work Package 1, as described in Appendix A, Section A10, the scope of the further work packages and the Risk Comparator Tool was limited to the following waste and recyclables management systems:

Collection

- Wheeled bin
- Boxes with kerbside sorting (using both Kerbsider and Stillage vehicles)
- Bags (disposable sacks and reusable bags)
- Small bins (e.g. for food waste)
- Communal bin stores (for use by a specific defined population)
- Door-to-door collections from flats

Transfer and sorting

- Transfer/bulking stations
- Materials Recycling Facilities (MRFs)

Processing

- Composting (both open windrow and in-vessel)
- Mechanical Biological Treatment (MBT)

Disposal and energy recovery

- Incineration
- Landfill

It is, however, possible to add to these systems in the future if required.

As there is a wide range of different systems within each life cycle stage, it was first acknowledged that it was not practical to assess every different system in detail as part of this project due to time and cost constraints. Therefore, it was necessary to select as ‘representative’ a set of systems for detailed analysis as possible, although in the context of such variability, this was not a simple task. Therefore, a number of factors were considered in selecting the systems, which assisted in justifying the inclusion or exclusion of a particular system. These factors were as follows:

- Most workers involved;
- Most occupational accidents;
- Highest individual risk;

- Most HSE concern;
- Widely used throughout the UK;
- Include majority of different components;
- Ease of access to systems (e.g. project partners/offers of assistance); and
- Parts of life cycle where it is possible to choose between different systems.

It was agreed that the majority of the emphasis should be placed on collection systems, as this is where both greatest variability in system types and prevalence of health and safety risks are present. For collection, it was agreed that focusing on a range of types of receptacle, such as wheeled bins, boxes and bags, would allow maximum coverage of the systems currently in use within the UK. Following discussion with the Advisory Committee, it was decided that observation of the collection of boxes without kerbside sort would not be of significant benefit, given that this system is not widely utilised, and the system components could be surmised from other observations. In addition to the receptacle-based systems, specifically considering collection from flats was felt to be of utility, given that this operation is likely to become more prevalent in the future.

For the latter parts of the waste life cycle, where there is great variability in specific systems, for example across different MBT systems, the more complex examples of the system were chosen for observation. Therefore, the elements of the simpler systems were implicitly examined.

3.2 SYSTEM COMPONENTS

Each of the systems described in Section 3.1 has then been defined by a number of discrete components. These components essentially define the scope of each system. Appendix B, Section B5.3, proposes the components for each system and describes what activity each of these components represents. It is noted that as the activities carried out at any particular site will differ, in some cases substantially, that the Risk Comparator Tool is only able to give a high-level generic indication of the level of risk between different systems. Particular designs and risk management procedures may alter the level of risk substantially. In addition, some activities may have been omitted that are carried out with a particular operation or at a specific site. This would, therefore, represent a risk gap within the tool.

The selection of components was based mainly on the analysis of the task analysis presented in Appendix B. Components were selected such as to:

- Capture the key activities;
- Enable more complex systems to be constructed based on parts of different defined systems; and
- Have a similar level of detail between components.

An initial set of components were created and these were circulated to the Project Advisory Committee for consideration and were also discussed at four risk assessment workshops (refer to Appendix D, Annex D2, for detail of these workshops) with representatives from all aspects of the waste and recycling industry. The discussions were focused on the following questions:

- Are there any key activities that have been missed for each system?
- Are there any activities whose inclusion appears strange?

- Is the level of detail, in terms of activities included or neglected, consistent across each of the systems?
- Have we cut off in a sensible place, i.e. ignored those tasks that are trivial?

4 INTRODUCTION TO THE RISK COMPARATOR TOOL

4.1 INTRODUCTION

In order to assess and compare the level of risk from different waste and recyclables management systems an Excel based tool, the Risk Comparator Tool, has been developed that allows users to define the systems they are interested in, in terms of components that make up that system, and calculate the risk profile for each of the defined systems at the hazard, component, subsystem and overall system level. This section, therefore, introduces this tool and Section 5 presents guidance on its use, including how to interpret the output appropriately.

At the outset of this project it was envisaged that a number of risk tables would be produced, which could be used by Local Authorities, and others, to aid their decision making on selection of the most appropriate system(s) taking account of health and safety, environmental targets and other factors. However, it soon became apparent early into this project that a purely paper based system around lots of tables would be unwieldy and, hence, difficult to use. In response to these problems it was decided to develop a prototype risk tool with a simple user interface that automated much of the interrogation of the risk tables. Although the fundamental approach has not changed, the vision in how to present and utilise the risk information has developed significantly during the course of the project. Implementation within Microsoft Excel was therefore chosen for the following reasons:

- The risk assessment methodology could be easily automated within Excel;
- This was a quick and easy way to implement the approach and generate a working tool; and
- Excel is extremely portable in that the vast majority of stakeholders would be able to run it.

The Risk Comparator Tool has been developed using Microsoft Excel 2000.

4.2 PURPOSE OF THE TOOL

The main purpose of the Risk Comparator Tool is to allow the level of risk to be compared between different waste and recyclables management systems. It is aimed at providing information to Local Authorities, and others, on the risk profiles of different systems, taking into account some of their local factors, which can then be used alongside other information, such as environmental targets and costs, before reaching a decision on the most appropriate system for that Local Authority. It is stressed that this should be used as one input only as being a generic assessment, based on typical systems, it may not represent a specific planned or implemented system. It is essentially a desk based rough and ready comparator tool.

This tool should ***not*** be used for the following:

- Outlawing any particular system or activity; or
- As a substitute for a risk assessment for any implemented system – this would not constitute a suitable and sufficient risk assessment under the Management of Health and Safety at Work Regulations.

Notwithstanding the above, the tool may still be of benefit in informing a risk assessment of an implemented system, for example as a checklist for ensuring the hazards identified have not been missed in a specific risk assessment, or as a sense check on a risk profile produced from an independent risk assessment. It is, however, stressed again, that because of the scope of the tool, its purpose and the way that it has been developed, there will be risk gaps. It could be used also as a starting point for a site-specific assessment, and consider in a systematic way whether there are any additional hazards, or significant differences in the specific situation that require any additions or modifications to the generic assessment. However, extreme caution would be needed here, as this is not the tool's primary purpose.

The scope of the tool described below should also be read carefully as this will also dictate how and what it should be used for.

4.3 SCOPE OF THE TOOL

Other than the systems and activities that are discussed in Section 3, the following summarises the remaining boundaries that define the scope of the Risk Comparator Tool:

- Health and safety risks are both within scope. The risk to the environment is outside of scope.
- Acute and chronic outcomes are both within scope.
- The tool considers risk to all those exposed through work activities, that is occupational risk. The risk to others, e.g. members of the public, is considered to be outside scope. Where a particular part of the system is contracted out, for example, the risk to those workers is still within scope.
- Exporting of waste and recyclables and the risk associated to workers or others outside the United Kingdom is outside scope.
- The risk tool considers risk from reasonable foreseeable non-trivial hazards, that relate directly to the activities being carried out as part of waste and recyclables management.
- It is important to note that risk will be assessed for standard management practices so that the risk from different systems can be compared. Also, an average will be taken across how systems are operated in practice as opposed to in theory.
- The tool will calculate the risk in terms of collective risk, i.e. the totality of the risk to all those exposed and not the risk to an individual. It is important to point out, however, that in order to manage risk it is necessary to consider both the collective risk and also individual risk, as people's individual risk can vary vastly depending on the specific activity. Knowledge of the relative level of collective risk for a system provides no indication of the level or tolerability of individual risk arising from different activities or from the system as a whole. However, consideration of individual risk is outside the scope of the methodology.
- Risk is calculated using a relative risk ranking approach. The resulting value of risk does not relate to an absolute measure of risk, and indeed it should not be interpreted in this way.

4.4 OVERVIEW OF THE RISK COMPARATOR TOOL

The purpose of this tool is to compare the relative risk of harm presented by the various waste and recyclables management schemes. In doing so it identifies the risk of all types of occupationally related harm including the chronic and acute effects of injuries and ill health that may result from reasonably foreseeable non-trivial hazards.

The concept of the tool is based around system, subsystem, component and hazard. The relationship between these is shown diagrammatically in Figure 5.

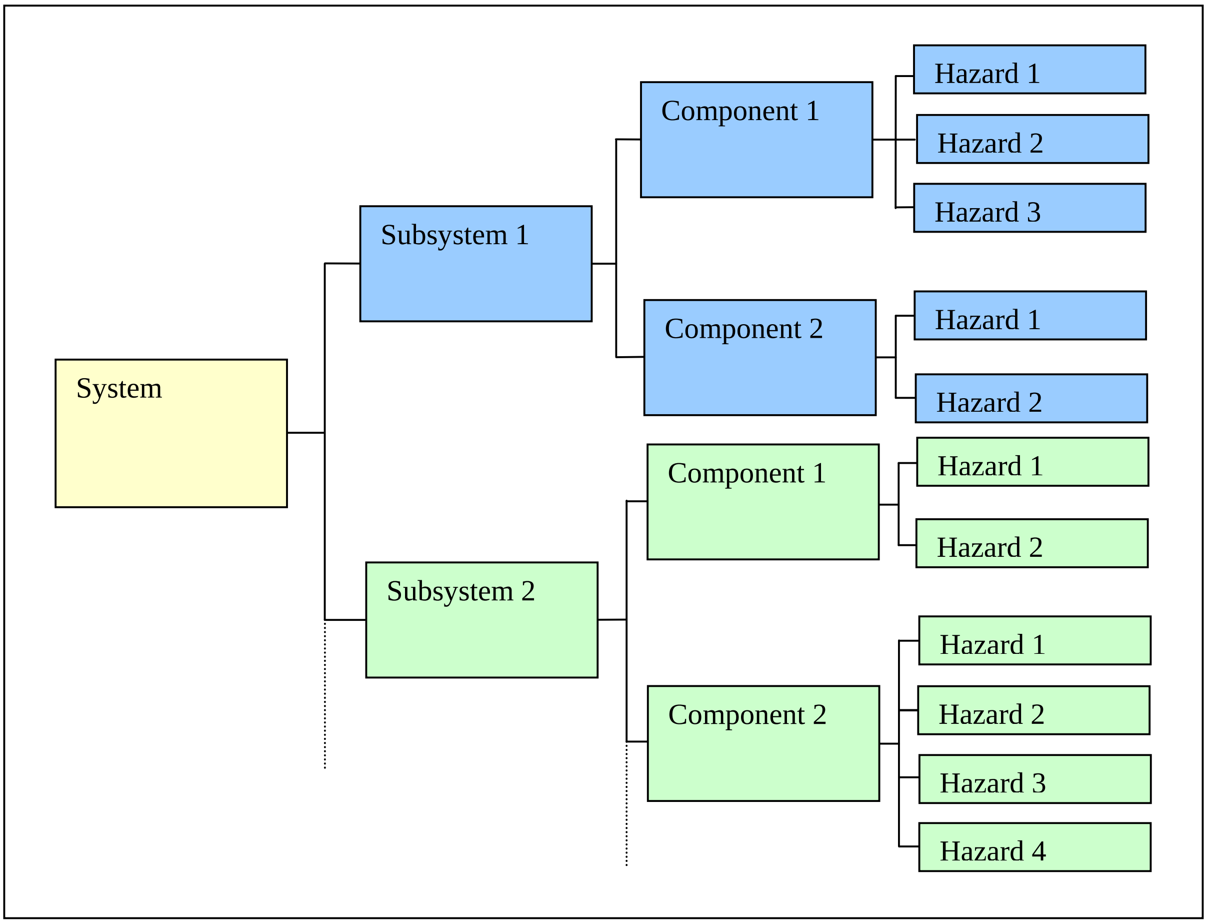


Figure 5 Structure of waste/recyclables management system

The use of the tool in the comparative risk assessment process is outlined in Figure 6. In order to evaluate a system the user specifies the components of the system; for example, for the collection of residual waste in wheeled bins subsystem, the components would look something like:

- Assembly of collection crew at start of shift
- Driving from location to location
- Getting in and out of cab
- Wheeled bin collect and return
- Wheeled bins empty
- Walking to and from collection point
- Operating compactor
- Emptying collection vehicle

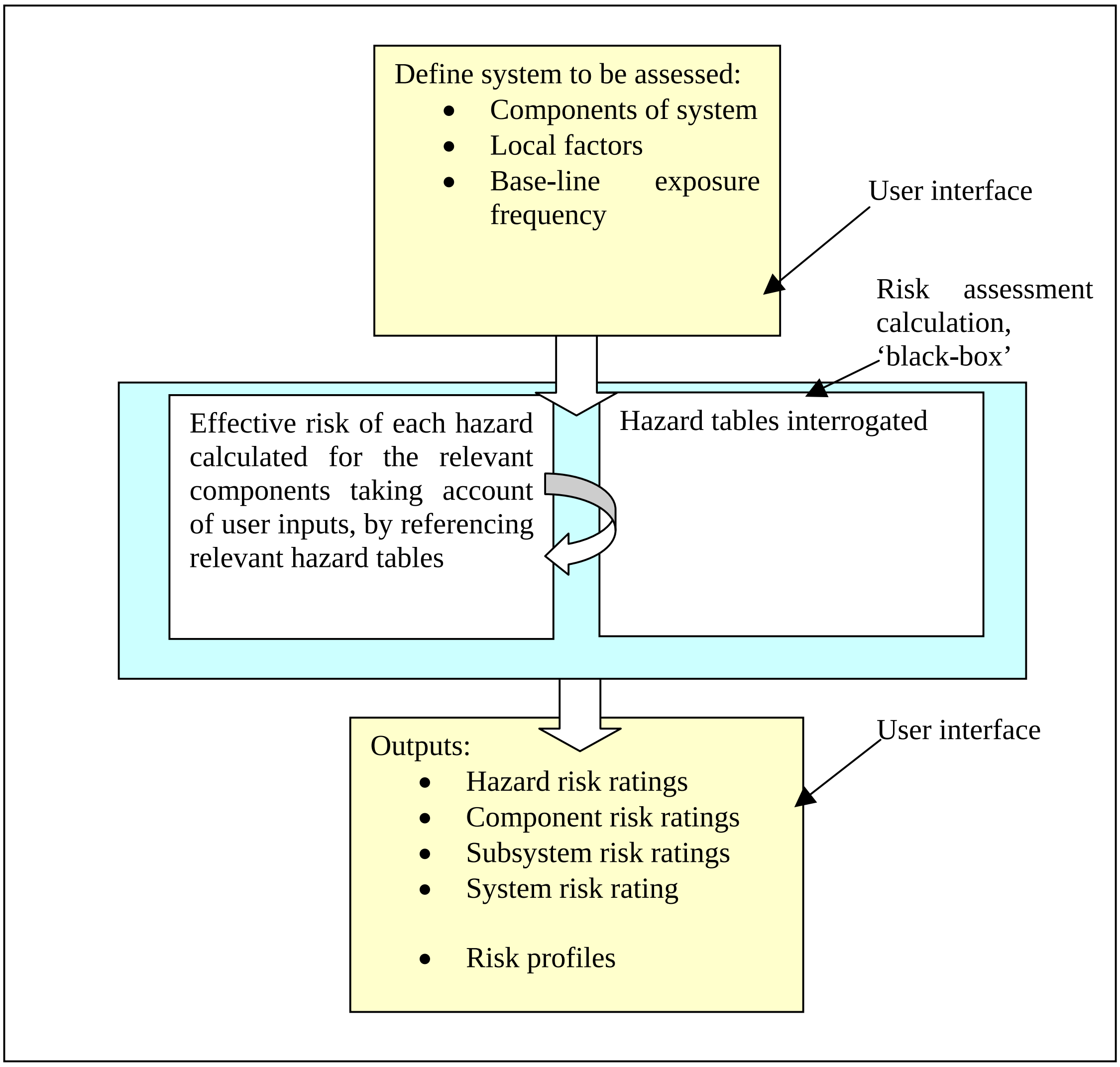


Figure 6 Risk assessment process

For each component there would be a number of hazards/hazard outcome categories; for example, for wheeled bins empty this may include:

- Exposure to hazardous substances
- Moving machinery
- Falling bins
- Other falling objects, e.g. rubbish
- Insects/vermin bites
- Manual handling
- Exposure to microbiological substances
- Noise
- Other animal bites

- Slips and trips
- Stress
- Violence
- Workplace transport

For each of these hazards, the level of risk would be estimated.

In addition to defining the system in terms of its constituent components, the user also provides details of local factors such as the number of houses, anticipated set-out rate, frequency of collection and distributions in other localisation factors. This data is then used to inform the risk modelling within the tool to deliver a number of outputs that provide information on the system risk rating and profile and detail on the component and hazard risk ratings that underpin the system risk rating.

The tool utilises a semi-quantified risk ranking as this allows hazard risk scores to be combined to give a suitable comparative assessment at the component, subsystem and system level. Because the tool is limited to comparative analysis, a collective approach to risk is used; this means the risk to an exposed population and not to any specific individual. This tool is not intended to provide any assessment of whether the safety of workers and others is ensured *So Far As Is Reasonably Practicable* (SFAIRP).

The risk ranking is based on three risk elements, which are combined to give the collective risk:

- Exposure to a hazard – the frequency at which the hazard generating activity is carried out;
- Criticality of the exposure – the likelihood (or conditional probability) that harm occurs due to (and given) the exposure; and
- Consequences – a measure of the different harm outcomes given that exposure to the hazard causes harm.

Section C3 (Appendix C) describes how risk is calculated from these risk elements. The risk score essentially represents the risk of injury across the workforce engaged in the process or material life cycle. A process with a moderate level of risk and a large number of employees may have a similar risk score as a process with a high level of risk, but a small number of employees.

5 RISK COMPARATOR TOOL GUIDANCE

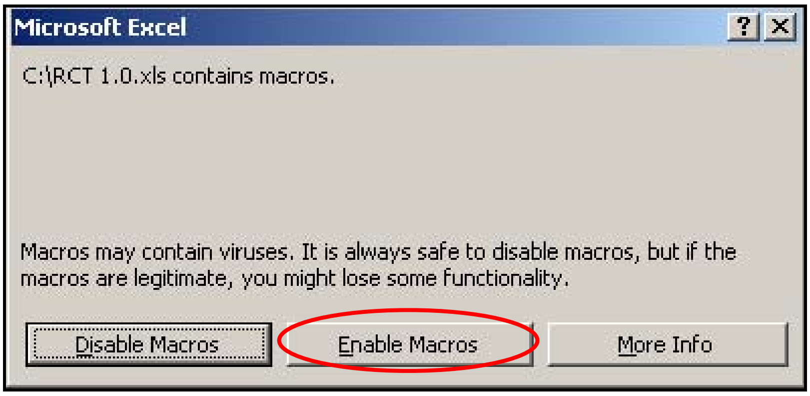
This section describes how to use the Risk Comparator Tool. An illustrated worked example is also provided in Annex 1.

5.1 INITIATING THE RISK COMPARATOR TOOL

The Risk Comparator Tool is a Microsoft Excel 2000 spreadsheet, named: '***RCT 1.0.xls***'.

Before starting, it is essential for the security level within Excel to be set at 'medium' (in Excel 2000 this can be set in: Tools > Macro > Security > Security Level > Medium) as this allows the macros embedded in RCT to be enabled.

Upon opening this file, the user is asked whether they wish to disable or enable the macros, as shown in Figure 7. As the methodology is incorporated within the spreadsheet by utilising Visual Basic Applications coding and macros, the '***Enable Macros***' button must be selected for the tool to operate.

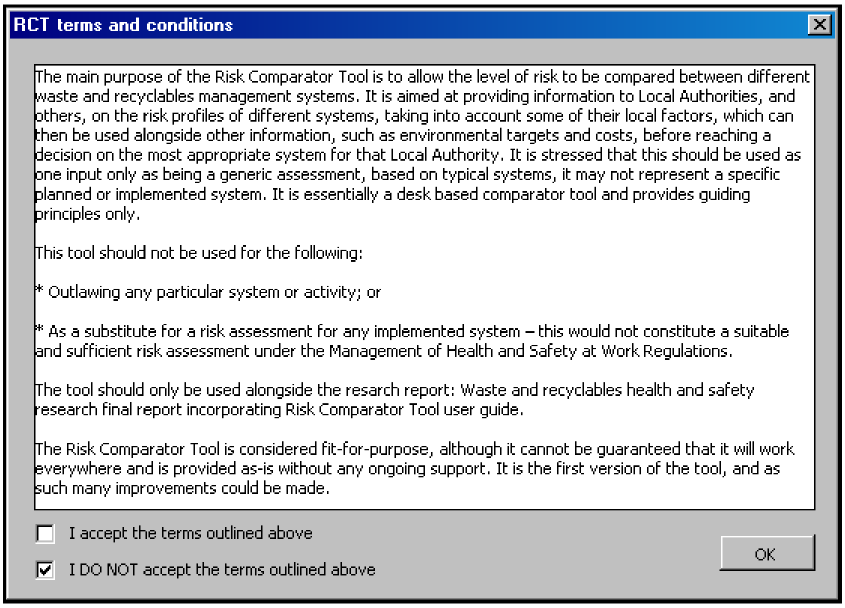


C:\RCT 1.0.xls contains macros.

Macros may contain viruses. It is always safe to disable macros, but if the macros are legitimate, you might lose some functionality.

Figure 7 Running macros option

After selecting *Enable Macros* the *RCT terms and conditions* screen, as shown in Figure 8, will be displayed. It is necessary for the user to read these terms and conditions and then agree to them by selecting '*I accept the terms outlined above*' and clicking 'OK'. Failure to select '*I accept the terms outlined above*' will cause the RCT to close down.



The main purpose of the Risk Comparator Tool is to allow the level of risk to be compared between different waste and recyclables management systems. It is aimed at providing information to Local Authorities, and others, on the risk profiles of different systems, taking into account some of their local factors, which can then be used alongside other information, such as environmental targets and costs, before reaching a decision on the most appropriate system for that Local Authority. It is stressed that this should be used as one input only as being a generic assessment, based on typical systems, it may not represent a specific planned or implemented system. It is essentially a desk based comparator tool and provides guiding principles only.

This tool should not be used for the following:

* Outlawing any particular system or activity; or

* As a substitute for a risk assessment for any implemented system – this would not constitute a suitable and sufficient risk assessment under the Management of Health and Safety at Work Regulations.

The tool should only be used alongside the resarch report: Waste and recyclables health and safety research final report incorporating Risk Comparator Tool user guide.

The Risk Comparator Tool is considered fit-for-purpose, although it cannot be guaranteed that it will work everywhere and is provided as-is without any ongoing support. It is the first version of the tool, and as such many improvements could be made.

☐ I accept the terms outlined above

☑ I DO NOT accept the terms outlined above

Figure 8 RCT terms and conditions screen

Once the terms and conditions have been accepted Excel will open on the '***Control***' worksheet, which is shown in Figure 9. Tabs for the worksheets '***Grouped RA – hazard***', '***Grouped RA – component***' and '***Grouped RA – system***' should be visible at the bottom of the Excel application. Depending on whether the tool has previous assessments saved or not there may be additional worksheet tabs visible labelled '***Assessment #***', where # is an integer. On first use, these worksheets will not be shown as they are created at the point of assessment. These worksheets provide the output from the tool and are discussed in Section 5.4. Operation of the tool is carried out from this worksheet, '***Control***', by clicking on one of the three buttons shown on the left hand side:

- ***Input data***
- ***Set-up components***
- ***Calculate risk***

The operation of each of these buttons is described in the following subsections. To carry out an assessment on a defined system the buttons should be selected in order, that is: firstly set-up the local factors by selecting '***Input data***', next define the systems to be assessed by selecting '***Set-up components***' and finally click on '***Calculate risk***' to calculate the risk profile.

User defined risk rating data, and other advanced options, can be set-up by selecting the '***Advanced…***' button. This functionality is described in Section 5.5.

Previous assessments can be deleted from the tool by selecting the '***Delete previous assessments***' button. However, extreme caution is required as once deleted none of the assessment outputs can be retrieved. This will delete the data contained in all output worksheets: *Grouped RA – hazard*, *Grouped RA – component* and *Grouped RA – system*, delete the summary information on the *Control* worksheet and will delete all *Assessment #* worksheets.

Also shown on this worksheet is a summary of overall risk for each assessment run. This gives the overall rating for all the hazards applicable for the selected components. Shown is the total rating for acute outcomes, total rating for chronic outcomes and overall rating, '*Total*', which is the sum of the acute and chronic ratings. Figure 9 shows no data under the results summary as no assessments have been run. However, as assessments are run the results will be summarised with the '*Assessment No.*' corresponding to the '***Assessment #***' worksheets.

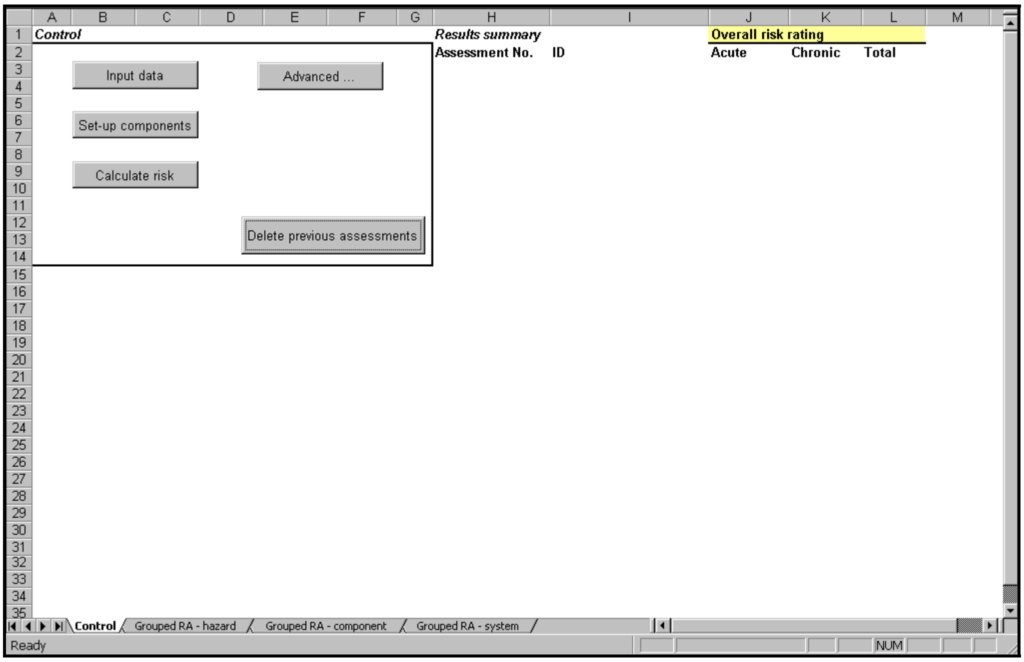


Figure 9 *Control* worksheet

5.2 LOCAL FACTORS

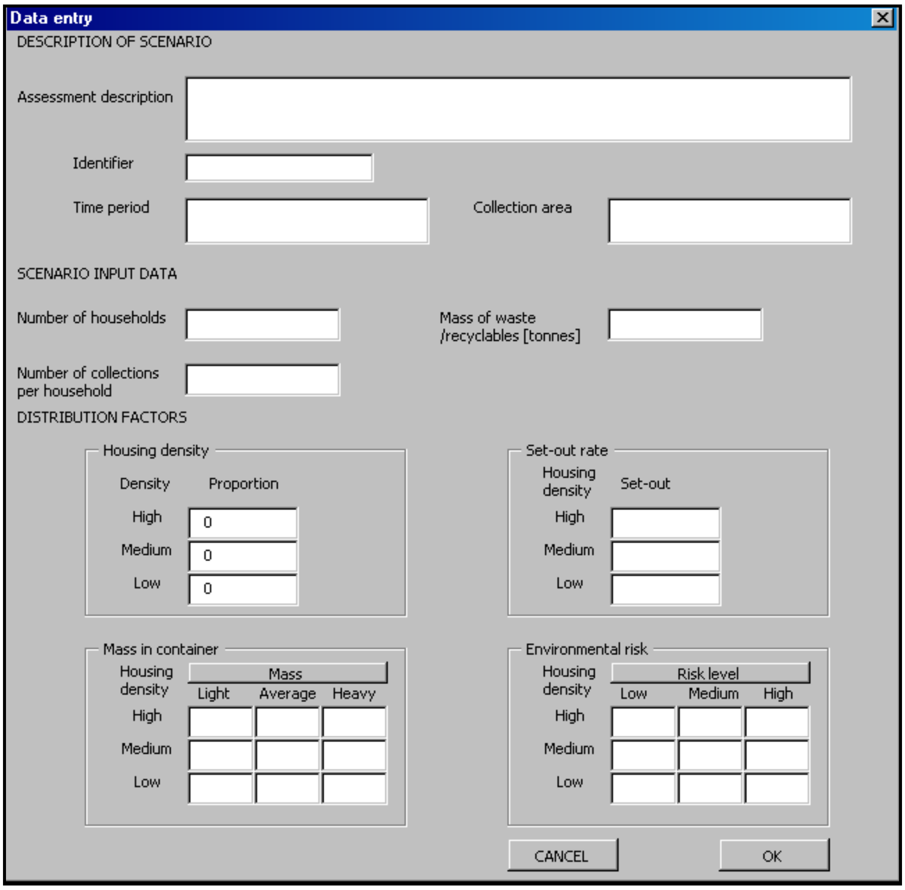
By selecting the '***Input data***' button on the *Control* worksheet the *Data entry* screen, as shown in Figure 10, is displayed. The purpose of this screen is to allow the user to define certain local factors. These factors affect the calculation of the exposure frequency for both collection and post-collection systems, and the risk ratings for each collection system related hazard. How these factors are used by the Risk Comparator Tool is described in detail in Appendix C. This section discusses each of the data entry requirements in turn explaining what they are and, where necessary, provides guidance on the information required to be entered. The data entry requirements are grouped into the following three categories:

- Description of scenario (Section 5.2.1) – this includes '*Assessment description*', '*Identifier*', '*Time period*' and '*Collection area*'.
- Scenario input data (Section 5.2.2) – this includes '*Number of households*', '*Number of collections per household*' and '*Mass of waste/recyclables*'.
- Distribution factors (Section 5.2.3) – this includes distributions for '*Housing density*', '*Set-out rate*', '*Mass in container*' and '*Environmental risk*'.

A value must be added in each of the white boxes on this screen.

When data entry is complete select '***OK***' at the bottom right-hand side of the *Data entry* screen. This will then save the new input data and return the user to the *Control* worksheet. If incorrect data has been added, for example outside valid ranges or non-numeric in a numeric only field, then an error message is displayed. The data must be corrected else the user will be unable to save the altered data.

Clicking on '***CANCEL***' will return the user to the *Control* worksheet; any changes made to the values on the *Data entry* screen will be discarded.



High 0
Medium 0
Low 0

Figure 10 *Data entry* screen

5.2.1 Description of scenario

The *DESCRIPTION OF SCENARIO* category contains four descriptive data inputs. There is no constraint on this data as it is purely informative to help identify the assessment. The information is not used by the tool. This information should, however, be consistent with the *SCENARIO INPUT DATA*, described in Section 5.2.2.

- *Assessment description* – this is a description of the assessment being carried out.
- *Identifier* – this allows for a unique identifier to be entered so that different assessments can be identified.
- *Time period* – this is a descriptor of the time period that the assessment is being carried out over. It is recommended that because of the way that the hazards have been rated

that a period of one year is, generally[3], considered. As discussed in Appendix D, hazards have been rated by considering the average situation over a year, for example by taking the typical range in weather into consideration. Therefore assessments should be carried out consistently with the assumptions made in rating each hazard.

- *Collection area* – this is a description of the area that is being considered for the assessment, for example details of the rounds that are being considered. It is possible to carry out the assessment for individual streets, individual rounds, total areas within a LA's or operator's control.

5.2.2 Scenario input data

The *SCENARIO INPUT DATA* is used to define the baseline exposure frequency and is used by the tool to calculate the exposure frequency and therefore exposure rating for each hazard. Section C3.1.1 in Appendix C describes how this data is used to calculate exposure ratings. Three inputs are required:

- *Number of households* – this is the maximum number of properties that are being collected from, in the defined area (*Collection area*) and time period (*Time period*). Whether or not properties present their waste and recyclables is not relevant here and should not be taken into account as that is captured separately under *Set-out rate* (see Section 5.2.3). It is the total number of possible collections in the collection area, from a single collection. Care is required if carrying out the assessment for flats or for bins stores as the number of households is effectively the number of bin stores and for high-rise flats door-to-door collection the number of properties is the total number of flats.
- *Number of collections per household* – this is the maximum number of collections per household made in the defined time period (*Time period*). For example, for a weekly collection with a 1 year time period this would be of the order of 52 collections (possibly less on average depending on bank holidays etc.) and for a biweekly collection over the same time period this would be 26 collections. It is important to review the assumed set-out rates if the number of collections is changed as this has a direct impact on the set-out rate.
- *Mass of waste or recyclables* – this is the total mass in tonnes of the waste and recyclables collected from the defined area and time period by the system under consideration. It is important to stress that where both collection and post-collection systems are being considered together, i.e. the risk from the whole waste life cycle, the total mass must be that resulting from the collections made to the defined households (i.e. number and frequency).

The following constraints apply on the above data:

$$0 \le \textit{Number of households} \le 99999999$$

$$0 \le \textit{Number of collections per household} \le 999$$

$$0 \le \textit{Mass of waste or recyclables} \le 99999999$$

If values are entered outside this range or a different data type is entered an error message is displayed once '***OK***' is selected on the *Data entry* screen, as shown in Figure 11. Following this message, select '***OK***', and check and correct the erroneous data entry.

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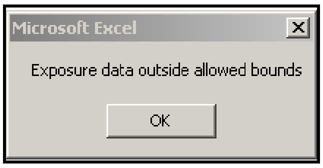
[3] *For seasonal systems, such as green waste collection, a shorter time period may be more applicable.*


Microsoft Excel

Exposure data outside allowed bounds

Figure 11 *Scenario Input Data* error message

If an assessment is being carried out on only collection systems then the risk tool only uses data from the *Number of households* and *Number of collections per household*. Any data entered for *Mass of waste or recyclables* will under these circumstances not be used. If an assessment is being carried out on only post-collection systems then the opposite is true, that is only the *Mass of waste or recyclables* is used by the tool. If an assessment is being carried out on the whole waste life cycle, including both collection and post-collection activities then all three values are required.

A potential pitfall with utilising the Risk Comparator Tool is that because the frequency rating scale is set at run time and is determined by the three values entered under this category, it would be inappropriate to compare the results from different assessments where different values had been entered. How the rating scale, which is used to rate the exposure frequency for each hazard, is set is discussed in Section C3.1.1.1 (Appendix C). However, it is possible to fix the frequency rating scale to allow different assessments to be compared by using the advanced options (see Section 5.5). Note, this issue is only relevant for the risk rating results and not the relative risk values[4].

5.2.3 Distribution factors

The *DISTRIBUTION FACTORS*, with the exception of *Set-out rate*, are used by the Risk Comparator Tool to calculate an effective risk rating across a range of hazard scenarios; they are only used by the tool when assessing collection activities. If only assessing post-collection activities, this data is ignored by the Risk Comparator Tool. The scenarios take into account how the level of risk varies as a function of the following factors: housing density; amount of waste/recyclable in the receptacle; and environmental risk (road traffic density, traffic speed (road type) and terrain). Figure 12 illustrates the 27 scenarios that are considered for each collection hazard. Within the risk tool for every hazard there exists one of these scenario matrices (or hazard tables) and each scenario has a risk rating assigned to it. The distributions, entered here, are used to weight each of the 27 scenarios to produce an overall single risk rating for the hazard. This rating is then representative of the average local situation. Annex C2 in Appendix C provides further information on how this is calculated.

As referred to above the *Set-out rate* is not used by the risk tool to interrogate the hazard tables, but is used in calculating the exposure frequency for each hazard. It adjusts the baseline frequency, described in Section 5.2.2, to take account of that not all houses in the area will present their waste or recyclables. Section C3.1.1 in Appendix C describes how this data is used in the exposure rating calculation.

Each of the *DISTRIBUTION FACTORS* is considered in turn below, with error messages discussed in Section 5.2.3.5. It is stressed that only ballpark estimates are required for each of the distribution factors and it is unnecessary for significant effort to be spent trying to estimate these. Values are not required to be estimated to an accuracy better than 0.1. If values cannot be

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[4] *Risk is calculated in two ways by the RCT – these are discussed further in Section 5.4.*

easily obtained then rough estimates should be entered and the risk results obtained subject to a simple sensitivity analysis by changing the values to each of the extremes, i.e. all high mass, all low mass, all high environmental risk all low environmental risk, all low density and all high density.

Environmental Risk	***Housing density***	***Mass of material in container***		
		Low	Average	High
Low	Low			
	Medium			
	High			
Medium	Low			
	Medium			
	High			
High	Low			
	Medium			
	High			

Figure 12 Scenario matrix

5.2.3.1 Housing density

The proportion of properties in the defined area (*Collection area*) that fall into each of the following housing density categories are required to be entered:

Housing density	***Housing type***
High	Terraced and flats
Medium	Detached (urban), semi detached
Low	Small holdings and detached rural properties

In each case a number between 0 and 1 must be entered and the sum of the three values must equal 1. This information is used to calculate the average risk for the given distribution in housing density as the level of risk from some hazards is sensitive to this.

5.2.3.2 *Set-out rate*

The average proportion of houses that present their waste and recyclables on a collection is required to be input. This is required for each of the three housing density categories. Where there is no difference in set-out across the three housing density categories, the same value is required to be input in each case. In each case a number between 0 and 1 must be entered.

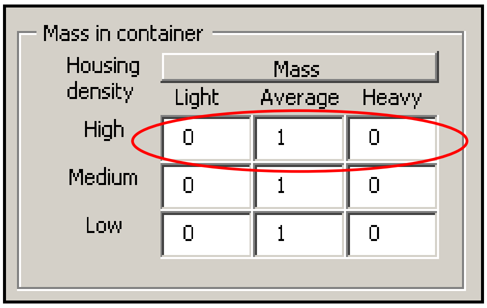
5.2.3.3 *Mass in container*

As shown in Figure 13, for a given housing density category the average distribution (over the *Time period* of interest) in the mass of material in the container is required to be input. The proportion of receptacles falling into each of the following mass categories is required to be entered:

Container volume usage	***Mass of waste/recyclable (relative to receptacle size)***
<30% used	Light
30 – 80% used	Average
>80% used	Heavy

The container volume usage should only be used as a guide to the mass, as the type of material will have a major impact on whether a container is heavy or not. For example, a container full of empty plastic bottles would not be classed as heavy. In addition, when collecting the same weight of material but using different systems the relative mass in the receptacle will vary depending on the receptacle, i.e. a 10 kg kerbside box will be "heavy" whilst a 10 kg wheeled bin will be "light". Therefore some pragmatism is required to be applied by the user in estimating this distribution depending on the particular waste or recyclables stream and the receptacle being considered.

In each case a number between 0 and 1 must be entered and the sum of the three values must equal 1. This information is used to calculate the average risk for the given distribution in mass as the level of risk from some hazards is sensitive to this.



Housing density	Mass		
	Light	Average	Heavy
High	0	1	0
Medium	0	1	0
Low	0	1	0

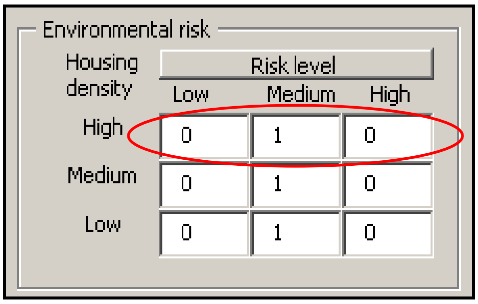
Figure 13 *Mass in container* distributions

This distribution must be entered for each of the three housing density categories. Where there is no difference in the distribution across the three housing density categories, the same set of values is required to be input in each case.

5.2.3.4 *Environmental risk*

As shown in Figure 14, for a given housing density category the average distribution (over the *Collection area* of interest) in the environmental risk is required to be input. The proportion of collections falling into each of the following environmental risk categories is required to be entered:

Environmental risk
Low
Medium
High



Housing density	Risk level		
	Low	Medium	High
High	0	1	0
Medium	0	1	0
Low	0	1	0

Figure 14 *Environmental risk* distributions

Environmental risk is made up of three factors:

- Terrain;
- Road speed; and
- Traffic density.

In order to estimate the overall distribution in environmental risk it is first necessary to estimate the distributions in terrain risk and road risk separately. Terrain risk is related to the gradient and nature of the surfaces where collection is being carried out. Therefore, first the proportion of collections (in the *Collection area* and *Time period* of interest) falling into each of the following terrain categories is required to be estimated:

Risk level	***Terrain***
Low	Flat to moderate gradients with even surfaces
Medium	Flat to moderate gradients with uneven surfaces or steep gradients with even surfaces
High	Steep gradients with uneven surfaces

In each case a number between 0 and 1 must be estimated and the sum of the three values must equal 1. This distribution must be estimated for each of the three housing density categories. Where there is no difference in the distribution across the three housing density categories, the same set of values should be used in each case.

Next the proportion of collections (in the *Collection area* and *Time period* of interest) falling into each of the following road categories is required to be estimated:

Risk level	***Road category***
Low	Low speed, any density traffic
Medium	Medium speed, sparse density to free flowing
High	High speed, sparse density to free flowing

In each case a number between 0 and 1 must be estimated and the sum of the three values must equal 1. This distribution must be estimated for each of the three housing density categories. Where there is no difference in the distribution across the three housing density categories, the same set of values should be used in each case.

From the two distributions an overall distribution must be estimated. Where the two distributions are similar, derivation of overall distributions is relatively easy using a little judgement. It is possibly best, however, to err on the side of caution and utilise the distribution that is biased towards the ‘high risk’ category. It is emphasised, however, that the choice here should be subject to some form of sensitivity analysis. Where the two distributions are vastly different it would be inappropriate to try and combine the distributions. In this case it is recommended that the tool is run using both distributions separately and those hazards affected scrutinised carefully such that the most appropriate hazard rating is used in each case. For example, the workplace transport related hazard ratings should be taken from the run utilising the road category distribution and the slips and trips related hazard ratings should be taken from the run utilising the terrain distribution. In this case combination of the runs would have to be carried out manually.

The same constraints on the data apply as with the separate distributions. In each case a number between 0 and 1 must be estimated and the sum of the three values must equal 1. This overall distribution must be estimated for each of the three housing density categories. Where there is no difference in the distribution across the three housing density categories, the same set of values should be entered in each case.

5.2.3.5 *Error messages*

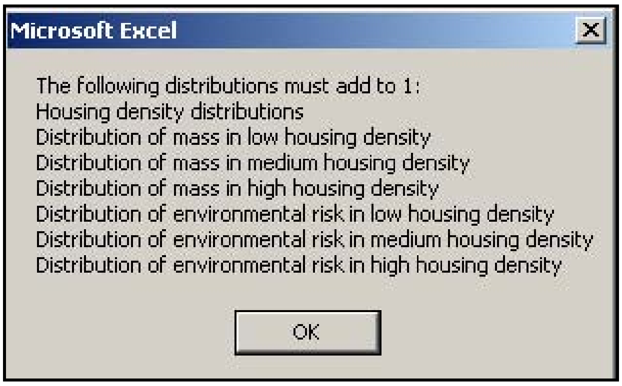
Two different error messages may be displayed as part of entering data into the *DISTRIBUTION FACTORS* section. These errors would be displayed once ‘***OK***’ is selected on the *Data entry* screen.

The first error message, shown in Figure 15, is displayed if anything is entered except a number between 0 and 1 inclusive. It may be that the wording on this error message is combined with the *SCENARIO INPUT DATA* error message described above (Section 5.2.2). Following the message select ‘***OK***’, and check and correct the erroneous data entry.

Distribution factors must be numbers between 0 and 1

Figure 15 *DISTRIBUTION FACTORS* error message number 1

The second error message, shown in Figure 16, is displayed if any of the distributions under the *Housing density*, *Mass in container* or *Environmental risk* do not sum to 1. The message states which of the distributions have been entered incorrectly. The example shown shows that all of the distributions have been entered incorrectly. Only text for the incorrect distributions would be shown in any particular case. Following the message select '***OK***', and check and correct the erroneous data entry.



Microsoft Excel

The following distributions must add to 1:
Housing density distributions
Distribution of mass in low housing density
Distribution of mass in medium housing density
Distribution of mass in high housing density
Distribution of environmental risk in low housing density
Distribution of environmental risk in medium housing density
Distribution of environmental risk in high housing density

Figure 16 *DISTRIBUTION FACTORS* error message number 2

5.2.4 Summary

The input data described above defines the local situation. It is anticipated that there may be huge variations in these distributions in different areas or at different times of the year. In these cases it is recommended that initially an average across the area of interest and over a year is considered. Following this a sensitivity study should be carried out whereby the distributions are varied to reflect particular situations and the results from this compared and analysed.

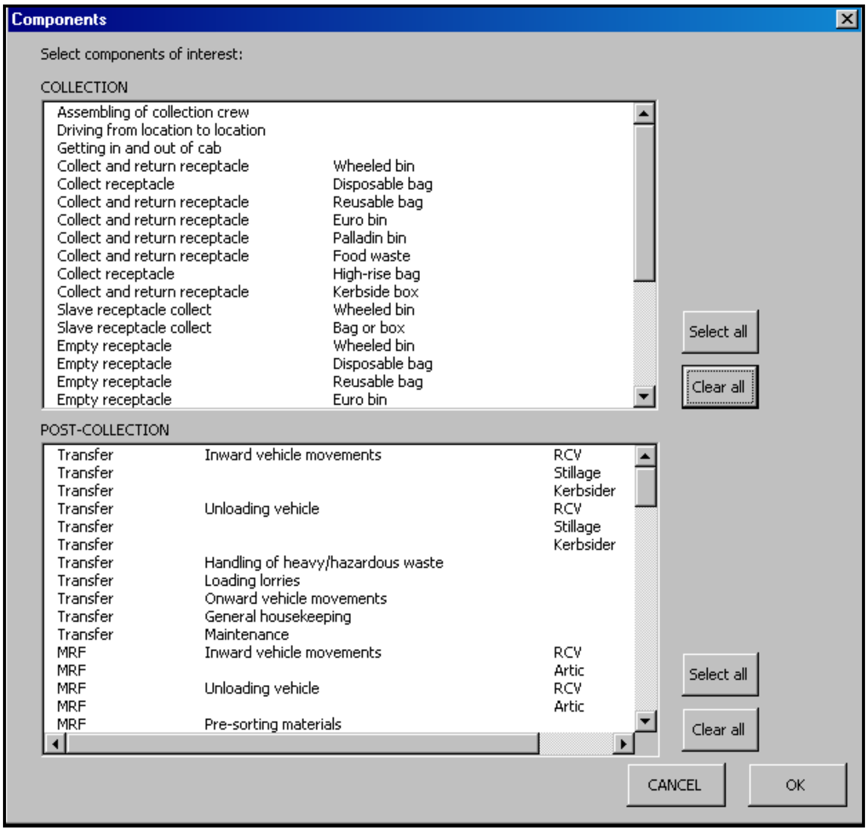
It is appreciated that it may be difficult to define how something falls in one of the distribution categories. However, pragmatism is required to be applied by the user. For example, for the mass in container, what is important is to separate out the average proportion of containers that contain very little waste and recyclables, from those that contain a significant amount such that they pose an increase in risk from a variety of hazards. The remainder can then be classed as average. Similar pragmatism must be applied to the housing density and environmental risk distributions.

5.3 SET-UP COMPONENTS

By selecting the '***Set-up components***' button on the *Control* worksheet the *Components* screen, as shown in Figure 17, is displayed. The purpose of this screen is to allow the user to define the overall system to be assessed. As discussed earlier (Section 4.4) the overall concept is one of building blocks whereby the system to be assessed is constructed from these building blocks, or components (activities). The components of interest can be simply selected by clicking on the relevant components.

When selection is complete select '***OK***' at the bottom right-hand side of the *Components* screen. This will then save the defined system and return the user to the *Control* worksheet. Clicking on '***CANCEL***' will return the user to the *Control* worksheet, without saving any selected components.

The components that can be selected are brigaded into two groups, one for *COLLECTION* activities and one for *POST-COLLECTION* activities. It is also possible to select all the components from one group by clicking on the relevant ***Select all*** button. To select components individually it is just a matter of clicking on the relevant components, and they will be highlighted in blue. Further components can be selected by using the scroll bars on the right hand side of each box. An individual selection can be removed by clicking on it, and the highlighting will disappear. Clicking on the relevant ***Clear all*** button will unselect all activities in the particular group.



Select components of interest:

COLLECTION

Assembling of collection crew	
Driving from location to location	
Getting in and out of cab	
Collect and return receptacle	Wheeled bin
Collect receptacle	Disposable bag
Collect and return receptacle	Reusable bag
Collect and return receptacle	Euro bin
Collect and return receptacle	Palladin bin
Collect and return receptacle	Food waste
Collect receptacle	High-rise bag
Collect and return receptacle	Kerbside box
Slave receptacle collect	Wheeled bin
Slave receptacle collect	Bag or box
Empty receptacle	Wheeled bin
Empty receptacle	Disposable bag
Empty receptacle	Reusable bag
Empty receptacle	Euro bin

POST-COLLECTION

Transfer	Inward vehicle movements	RCV
Transfer		Stillage
Transfer		Kerbsider
Transfer	Unloading vehicle	RCV
Transfer		Stillage
Transfer		Kerbsider
Transfer	Handling of heavy/hazardous waste	
Transfer	Loading lorries	
Transfer	Onward vehicle movements	
Transfer	General housekeeping	
Transfer	Maintenance	
MRF	Inward vehicle movements	RCV
MRF		Artic
MRF	Unloading vehicle	RCV
MRF		Artic
MRF	Pre-sorting materials	

Figure 17 *Components* selection screen

The components that can be selected are summarised in Table 1 for collection systems and Tables 2 to 8 for post-collection systems. Further detail on what these components are and the assumptions made in creating them can be found in Appendix B, Section B5.3. These components describe the main activities, but will not cover everything that occurs with a specific operation or at a specific site. For example, the main vehicle types that are likely as a result of kerbside collection are considered post-collection. Vehicles not part of the kerbside collection and onward processing are considered as outside scope.

One point to note with the components is that the collection and post-collection subsystems both have an emptying collection vehicle component. The collection 'Emptying collection vehicle' component is a generic activity that should only be used when post-collection subsystems are not being considered, otherwise the relevant post-collection emptying component would be more applicable.

Table 1 Collection components available for selection

Subsystem	*Component*	*Sub-component*
Collection	Assembling of collection crew at start of shift	-
Collection	Driving from location to location	-
Collection	Getting in and out of cab	-
Collection	Collect and bin return	Wheeled bin
Collection	Collect	Disposable bag
Collection	Collect and bag return	Reusable bag
Collection	Collect and bin return	Euro bin
Collection	Collect and bin return	Palladin bin
Collection	Collect and receptacle return	Food waste
Collection	Collect	High-rise bag
Collection	Collect and box return	Kerbside box
Collection	Slave receptacle collect	Slave wheeled bin
Collection	Slave receptacle collect	Slave bag/box
Collection	Empty	Wheeled bin
Collection	Empty	Disposable bag
Collection	Empty	Reusable bag
Collection	Empty	Euro bin
Collection	Empty	Palladin bin
Collection	Empty	Food waste
Collection	Empty	High-rise slave sack
Collection	Sort and empty	Kerbsider box
Collection	Sort and empty (same operative collects and sorts[5])	Stillage vehicle box
Collection	Sort and empty (separate operative sorts)	Stillage vehicle box
Collection	Empty	Slave wheeled bin

---

[5] *The difference between same operative collects and sorts and separate operative sorts is in the former case the same operator collects the receptical then sorts and empties it, whereas in the latter case an operative collects the receptical then passes it to a different operative who sorts and empties it.*

Subsystem	***Component***	***Sub-component***
Collection	Walking to and from collection point	-
Collection	Operating vehicle machinery	RCV compaction
Collection	Operating vehicle machinery	Kerbsider hopper empty
Collection	Emptying collection vehicle	-

Table 2 Transfer/bulking station components available for selection

Subsystem	***Component***	***Sub-component***
Transfer	Inward vehicle movements	RCV
		Stillage
		Kerbsider
Transfer	Unloading vehicle	RCV
		Stillage
		Kerbsider
Transfer	Handling of heavy/hazardous waste	-
Transfer	Loading lorries	-
Transfer	Onward vehicle movements	-
Transfer	General housekeeping	-
Transfer	Maintenance	-

Table 3 MRF components available for selection

Subsystem	*Component*	*Sub-component*
MRF	Inward vehicle movements	RCV
		Artic
MRF	Unloading vehicle	RCV
		Artic
MRF	Pre-sorting materials	-
MRF	Loading material onto conveyors and mechanical sorting	-
MRF	Manual sorting	-
MRF	Baling materials	
MRF	Storage of recovered factions	Fork-lift
		Shovel loader
MRF	Loading lorries	Fork-lift
		Shovel loader
MRF	Onward vehicle movements	
MRF	General housekeeping	
MRF	Maintenance	

Table 4 MBT components available for selection

Subsystem	*Component*	*Sub-component*
MBT	Inward vehicle movements	RCV
		Artic
MBT	Unloading vehicle	RCV
		Artic
MBT	Visual inspection of waste	-
MBT	Loading material into sorting drum and mechanical sorting	-
MBT	Loading material into a vehicle	-
MBT	Unloading transfer vehicle at compost tunnel	-
MBT	Loading material into hopper	-
MBT	Opening and closing doors of in-vessel	-
MBT	Transferring material between vessels and to maturation pad	-
MBT	Inserting temperature probes	-
MBT	Turning windrows	-
MBT	Loading material into screener/miller	-
MBT	Loading lorries	-
MBT	Onward vehicle movements	-
MBT	General housekeeping	-
MBT	Maintenance	-

Table 5 In-vessel composting components available for selection

Subsystem	*Component*	*Sub-component*
In-vessel	Inward vehicle movements	RCV
		Stillage
		Artic
In-vessel	Unloading vehicle	RCV
		Stillage
		Artic
In-vessel	Manual pre-sorting	-
In-vessel	Loading material into shredder	-
In-vessel	Loading material into bulk container	-
In-vessel	Opening and closing doors of in-vessel	-
In-vessel	Loading first vessel	-
In-vessel	Transferring material between vessels and to maturation pad	-
In-vessel	Inserting temperature probes	-
In-vessel	Turning windrows	-
In-vessel	Finished product taken to stockpiles	-
In-vessel	Screening material and bagging finished product	-
In-vessel	Loading lorries	-
In-vessel	Onward vehicle movements	-
In-vessel	General housekeeping	-
In-vessel	Maintenance	-

Table 6 Open windrow composting components available for selection

Subsystem	***Component***	***Sub-component***
Open windrow	Inward vehicle movements	RCV
		Artic
Open windrow	Unloading vehicle	RCV
		Artic
Open windrow	Manual pre-sorting	-
Open windrow	Loading material into shredder	-
Open windrow	Loading material into truck to be taken to windrows	-
Open windrow	Loading material onto windrow	-
Open windrow	Monitoring compost process (temperature/visual observations)	-
Open windrow	Turning windrows	-
Open windrow	Finished product taken to stockpiles	-
Open windrow	Screening material and bagging finished product	-
Open windrow	Loading lorries	-
Open windrow	Onward vehicle movements	-
Open windrow	General housekeeping	-
Open windrow	Maintenance	-

Table 7 Incineration components available for selection

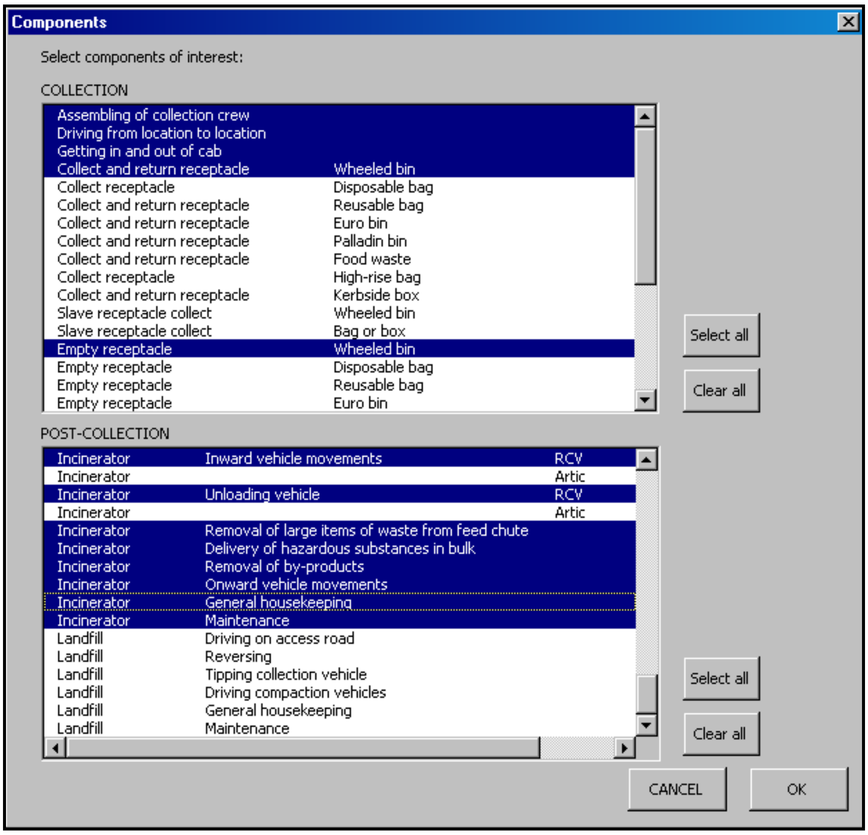
Subsystem	*Component*	*Sub-component*
Incineration	Inward vehicle movements	RCV
		Artic
Incineration	Unloading vehicle	RCV
		Artic
Incineration	Removal of large items of waste from feed chute	-
Incineration	Delivery of hazardous substances in bulk	-
Incineration	Removal of by-products	-
Incineration	Onward vehicle movements	-
Incineration	General housekeeping	-
Incineration	Maintenance	-

Table 8 Landfill components available for selection

Subsystem	*Component*	*Sub-component*
Landfill	Driving on access road	RCV
Landfill	Reversing	RCV
Landfill	Tipping collection vehicle	-
Landfill	Driving compaction vehicles	-
Landfill	General housekeeping	-
Landfill	Maintenance	-

5.3.1 Example system definition

Figure 18 shows an example of a system defined as collection of residual waste in standard wheeled bins, which is then taken direct to an incinerator.



Assembling of collection crew	
Driving from location to location	
Getting in and out of cab	
Collect and return receptacle	Wheeled bin
Collect receptacle	Disposable bag
Collect and return receptacle	Reusable bag
Collect and return receptacle	Euro bin
Collect and return receptacle	Palladin bin
Collect and return receptacle	Food waste
Collect receptacle	High-rise bag
Collect and return receptacle	Kerbside box
Slave receptacle collect	Wheeled bin
Slave receptacle collect	Bag or box
Empty receptacle	Wheeled bin
Empty receptacle	Disposable bag
Empty receptacle	Reusable bag
Empty receptacle	Euro bin

Incinerator	Inward vehicle movements	RCV
Incinerator		Artic
Incinerator	Unloading vehicle	RCV
Incinerator		Artic
Incinerator	Removal of large items of waste from feed chute	
Incinerator	Delivery of hazardous substances in bulk	
Incinerator	Removal of by-products	
Incinerator	Onward vehicle movements	
Incinerator	General housekeeping	
Incinerator	Maintenance	
Landfill	Driving on access road	
Landfill	Reversing	
Landfill	Tipping collection vehicle	
Landfill	Driving compaction vehicles	
Landfill	General housekeeping	
Landfill	Maintenance	

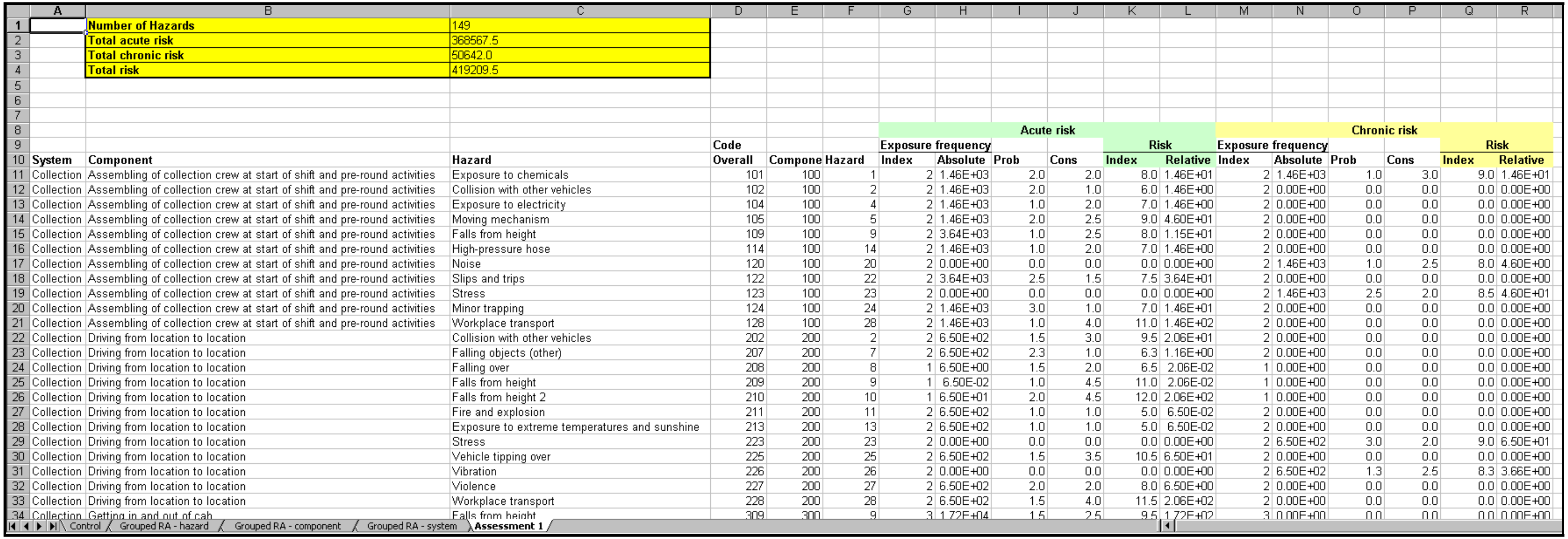
Figure 18 *Components* selection screen; residual waste collection in wheeled bins with disposal at an incinerator example

5.4 VIEW RESULTS

Once risk has been calculated using the ‘***Calculate risk***’ button the detailed risk ratings can be observed by selecting the appropriate worksheet tab, ‘***Assessment #***’. A portion of an assessment results screen is shown in Figure 19 and the key features of this worksheet are summarised below. It is noted that a ***Assessment #*** worksheet will only be present once the ‘***Calculate risk***’ button has been pressed.

Summary results are presented in the yellow box at the top of the screen. This shows the number of hazards rated, and the total relative acute risk, total relative chronic risk and total relative risk (chronic and acute combined).

Detailed risk rating information is presented from Row 9. This shows the assessment results for each system, component and hazard combination that have been assumed relevant for the selected components.



Number of Hazards	149
Total acute risk	368567.5
Total chronic risk	50642.0
Total risk	419209.5

						Acute risk						**Chronic risk**					
			Code			**Exposure frequency**				**Risk**		**Exposure frequency**				**Risk**	
System	**Component**	**Hazard**	**Overall**	**Compone**	**Hazard**	**Index**	**Absolute**	**Prob**	**Cons**	**Index**	**Relative**	**Index**	**Absolute**	**Prob**	**Cons**	**Index**	**Relative**
Collection	Assembling of collection crew at start of shift and pre-round activities	Exposure to chemicals	101	100	1	2	1.46E+03	2.0	2.0	8.0	1.46E+01	2	1.46E+03	1.0	3.0	9.0	1.46E+01
Collection	Assembling of collection crew at start of shift and pre-round activities	Collision with other vehicles	102	100	2	2	1.46E+03	2.0	1.0	6.0	1.46E+00	2	0.00E+00	0.0	0.0	0.0	0.00E+00
Collection	Assembling of collection crew at start of shift and pre-round activities	Exposure to electricity	104	100	4	2	1.46E+03	1.0	2.0	7.0	1.46E+00	2	0.00E+00	0.0	0.0	0.0	0.00E+00
Collection	Assembling of collection crew at start of shift and pre-round activities	Moving mechanism	105	100	5	2	1.46E+03	2.0	2.5	9.0	4.60E+01	2	0.00E+00	0.0	0.0	0.0	0.00E+00
Collection	Assembling of collection crew at start of shift and pre-round activities	Falls from height	109	100	9	2	3.64E+03	1.0	2.5	8.0	1.15E+01	2	0.00E+00	0.0	0.0	0.0	0.00E+00
Collection	Assembling of collection crew at start of shift and pre-round activities	High-pressure hose	114	100	14	2	1.46E+03	1.0	2.0	7.0	1.46E+00	2	0.00E+00	0.0	0.0	0.0	0.00E+00
Collection	Assembling of collection crew at start of shift and pre-round activities	Noise	120	100	20	2	0.00E+00	0.0	0.0	0.0	0.00E+00	2	1.46E+03	1.0	2.5	8.0	4.60E+00
Collection	Assembling of collection crew at start of shift and pre-round activities	Slips and trips	122	100	22	2	3.64E+03	2.5	1.5	7.5	3.64E+01	2	0.00E+00	0.0	0.0	0.0	0.00E+00
Collection	Assembling of collection crew at start of shift and pre-round activities	Stress	123	100	23	2	0.00E+00	0.0	0.0	0.0	0.00E+00	2	1.46E+03	2.5	2.0	8.5	4.60E+01
Collection	Assembling of collection crew at start of shift and pre-round activities	Minor trapping	124	100	24	2	1.46E+03	3.0	1.0	7.0	1.46E+01	2	0.00E+00	0.0	0.0	0.0	0.00E+00
Collection	Assembling of collection crew at start of shift and pre-round activities	Workplace transport	128	100	28	2	1.46E+03	1.0	4.0	11.0	1.46E+02	2	0.00E+00	0.0	0.0	0.0	0.00E+00
Collection	Driving from location to location	Collision with other vehicles	202	200	2	2	6.50E+02	1.5	3.0	9.5	2.06E+01	2	0.00E+00	0.0	0.0	0.0	0.00E+00
Collection	Driving from location to location	Falling objects (other)	207	200	7	2	6.50E+02	2.3	1.0	6.3	1.16E+00	2	0.00E+00	0.0	0.0	0.0	0.00E+00
Collection	Driving from location to location	Falling over	208	200	8	1	6.50E+00	1.5	2.0	6.5	2.06E-02	1	0.00E+00	0.0	0.0	0.0	0.00E+00
Collection	Driving from location to location	Falls from height	209	200	9	1	6.50E-02	1.0	4.5	11.0	2.06E-02	1	0.00E+00	0.0	0.0	0.0	0.00E+00
Collection	Driving from location to location	Falls from height 2	210	200	10	1	6.50E+01	2.0	4.5	12.0	2.06E+02	1	0.00E+00	0.0	0.0	0.0	0.00E+00
Collection	Driving from location to location	Fire and explosion	211	200	11	2	6.50E+02	1.0	1.0	5.0	6.50E-02	2	0.00E+00	0.0	0.0	0.0	0.00E+00
Collection	Driving from location to location	Exposure to extreme temperatures and sunshine	213	200	13	2	6.50E+02	1.0	1.0	5.0	6.50E-02	2	0.00E+00	0.0	0.0	0.0	0.00E+00
Collection	Driving from location to location	Stress	223	200	23	2	0.00E+00	0.0	0.0	0.0	0.00E+00	2	6.50E+02	3.0	2.0	9.0	6.50E+01
Collection	Driving from location to location	Vehicle tipping over	225	200	25	2	6.50E+02	1.5	3.5	10.5	6.50E+01	2	0.00E+00	0.0	0.0	0.0	0.00E+00
Collection	Driving from location to location	Vibration	226	200	26	2	0.00E+00	0.0	0.0	0.0	0.00E+00	2	6.50E+02	1.3	2.5	8.3	3.66E+00
Collection	Driving from location to location	Violence	227	200	27	2	6.50E+02	2.0	2.0	8.0	6.50E+00	2	0.00E+00	0.0	0.0	0.0	0.00E+00
Collection	Driving from location to location	Workplace transport	228	200	28	2	6.50E+02	1.5	4.0	11.5	2.06E+02	2	0.00E+00	0.0	0.0	0.0	0.00E+00
Collection	Getting in and out of cab	Falls from height	309	300	9	3	1.72E+04	1.5	2.5	9.5	1.72E+02	3	0.00E+00	0.0	0.0	0.0	0.00E+00

Figure 19 *Assessment #* worksheet – the results screen

Each column in this worksheet is discussed below:

Columns A to C – these contain descriptors of the particular system, component and hazard.

Column D – this is an integer code used internally in the tool to identify a specific system, component, hazard combination. It is the sum of the values contained in Columns E and F.

Column E – this is an integer code used internally in the tool to identify a specific component.

***Column F* -** this is an integer code used internally in the tool to identify a specific hazard.

Columns G to L – these show the acute assessment results for the specific system, component, hazard combination.

Columns M to R – these show the chronic assessment results for the specific system, component, hazard combination.

Each of the acute assessment columns are described below. It is noted that chronic columns are presented in the same way as the acute ones and are therefore not explicitly described.

Exposure frequency is expressed in two ways, firstly as an index or rating and secondly in absolute terms.

Column G (and Column M for chronic assessment) – exposure frequency index. The exposure frequency index is a measure of how often someone is exposed to the hazard over the time period and collection area of interest. Ratings of between 1 and 5 have been assigned to each hazard as shown in Table 9. They have been calculated based on the local input data (discussed in Section 5.2.2), modification factors for each component (which are presented in Section D2 of Appendix D) and hazard modification factors (which are presented in Section D4 of Appendix D). The two sets of modification factors are hard wired into the tool, but should be checked for their applicability. Small changes in these values will not have a significant effect on the exposure rating as this is only sensitive to order of magnitude changes. Section C3.1.1 of Appendix C describes how the exposure frequency is calculated and rated.

Table 9 Exposure frequency rating scale

Exposure frequency ranking	***Exposure frequency***[6]
1	N ÷ 1000 or lower
2	Up to N ÷ 100
3	Up to N ÷ 10
4	Up to N
5	*Greater than N*

---

[6] *N is a value assigned at runtime by the tool and equals either the 'Number of households' multiplied by the 'Number of collections per household' or 'Mass of waste/recyclables' depending whether a collection only or post-collection only assessment is being carried out. This allows the frequency rating to be equally sensitive when the tool is applied to either a small area or a large area.*

Column H (and Column N for chronic assessment) – absolute exposure frequency. This gives the absolute collective frequency of exposure to the hazard. It is the total number of times of exposure in the defined time period of interest (defined by the user). The frequency index is derived from these absolute values through use of Table 9.

Column I (and Column O for chronic assessment) – probability rating. This is a measure that given a person is exposed to the hazard, what is the probability that the person is harmed, i.e. it is a conditional probability of harm given exposure. Again ratings of between 1 and 5 have been assigned to each hazard as shown in Table 10. It is important to note that the descriptors and probabilities should not be used in an absolute sense. The value *C* shown in the conditional probability column is an arbitrary value. What is important is that a change in 1 on the rating scale changes the probability by an order of magnitude. The probabilities are hard wired into the tool for each hazard and have been assigned based on a multi stage approach utilising information and data where available, project team semi-structured brainstorming and industry workshops. Details on the assumptions made in rating each of the hazards are presented in Section D4 of Appendix D. Section C3.1.2 of Appendix C describes how the probabilities are calculated and rated. For the hazards shown in the output screen, the assumptions must be reviewed to ensure they are valid for the particular case being assessed.

Where the hazard has both a chronic and acute outcome two probability ratings have been derived, otherwise just a probability for the specific harm type (acute or chronic) has been derived.

Table 10 Probability rating scale

Probability ranking	***Conditional probability***	***Descriptor***[7]
1	*C* ÷ 10000 or lower	Rare
2	*C* ÷ 1000	Unlikely
3	*C* ÷ 100	Possible
4	*C* ÷ 10	Probable
5	*C* or greater	Likely

Column J (and Column P for chronic assessment) – consequence rating. The consequence rating is a measure of the most likely outcome following harm occurring as a result of exposure to the specific hazard. Ratings of between 1 and 5 have been assigned to each hazard; the rating scale is illustrated in Table 11. The scale is defined in terms of both acute and chronic outcomes. Assessment against either or both has been carried out where relevant.

The consequence ratings are hard wired into the tool for each hazard and have again been assigned based on a multi stage approach utilising information and data where available, project team semi-structured brainstorming and industry workshops. Details on the assumptions made

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[7] *The descriptors are relative and should not be treated as absolute.*

in rating each of the hazards are presented in Section D4 of Appendix D. For the hazards shown in the output screen, again, as with the probability ratings, the assumptions must be reviewed, by referring to Appendix D, to ensure they are valid for the particular case being assessed.

Table 11 Consequence rating scale

Ranking	*Descriptor*	*Acute effects*		*Chronic effects*
		Safety	*Health*	*Health*
1	Negligible	Slight, minor injury with no absence, or less	Minor health effect with no absence, e.g. fainting	
2	Low	Requires first aid treatment	Minor health effect requiring treatment	Short term reversible
3	Moderate	> 3 day loss time accident	Moderate health effect leading to > 3 day absence	Long term reversible
4	High	Major injury	Major health effect, e.g. permanent/ long term health effect	Long term irreversible
5	Very high	Single fatality	Fatality	Permanent severe disability/ fatality

Risk is expressed in two ways, firstly as an index or rating and secondly in relative absolute terms. By relative absolute risk it is meant that the measure of risk is proportional to the absolute level of collective risk, but not equal to it. This is referred throughout the report as relative risk.

Column K (and Column Q for chronic assessment) – risk index. The risk index has been calculated based on ratings for exposure frequency (Column G or M), probability (Column I or O) and consequence (Column J or P). The risk rating is calculated as:

$$\text{Risk} = \text{Exposure} + \text{Prob} + 2 \times \text{Cons} \qquad (1)$$

which is essentially a summation across the ratings, but with two consequence ratings. As explained in Section C3, Appendix C, this has been done to ensure that risk is equally sensitive to consequence as to the overall frequency (exposure and probability combined).

Column L (and Column R for chronic assessment) – relative risk. This gives a measure that is proportional to the absolute collective risk. A percentage change in this value will be the same as the percentage change in the absolute level of collective risk.

The risk rating is useful for comparing the level of risk from individual hazards, but cannot be combined to give the level of risk at the component, system or overall hazard level. It is also relatively insensitive to changes in exposure frequency. The relative risk can be combined to give a measure of overall risk at different levels. It is the relative risk that is presented in the other results worksheets discussed below.

In addition to the data shown in Figure 19 the *Assessment #* worksheet also contains a separate assessment of risk utilising a different rating scale. Columns T to AB essentially repeat Columns G to R discussed above, but different exposure indices have been assigned and therefore different risk indices have been calculated. This is only used for post-collection components, however. The reason for this is that if the rating scale is set based on the collection data then the post-collection component ratings are likely to be insensitive to changes in exposure frequency as collection activities can occur at a far greater frequency than post-collection activities. The second set of data therefore allows one to focus in on the post-collection components and see a more realistic risk profile. It is stressed however that where the risk from collection and post-collection components is being compared or combined then the first set of data must be used (columns G to R).

In addition to the results shown in the *Assessment #* worksheet, the results are also presented in different ways in the following worksheets. Each of these worksheets is discussed in more detail in the subsections below.

- ***Grouped RA – hazard*** (see Section 5.4.1): this shows the summed risk ratings for each of the hazard categories.
- ***Grouped RA – component*** (see Section 5.4.2): this shows the summed risk ratings for each selected component.
- ***Grouped RA – system*** (see Section 5.4.3): this shows the summed risk ratings for each selected waste and recyclables subsystem.

5.4.1 Grouped RA – hazard worksheet

A portion of the *Grouped RA – hazard* worksheet is shown in Figures 20 and 21. Rows 1 to 26, shown in Figure 20, give the local factor input values entered for each assessment (see Section 5.2 for a description of these). Rows 27 to 33, also shown in Figure 20, show whether user-defined inputs have been used for various options as set-up under the Advanced functionality, described in Section 5.5. Where TRUE is shown, then the default values contained in the tool have been used, else user-defined inputs have been used. Rows 34 to 65, shown in Figure 21, present the total level of risk (relative) as a function of each hazard category. The number of components assessed where the specific hazard category is relevant, the total acute risk for each hazard category and the total chronic risk for each hazard category are shown.

The results from each assessment are shown on the same worksheet. Assessment 1 is shown in Columns C to E, assessment 2 in columns F to H, assessment 3 in columns I to K, etc.

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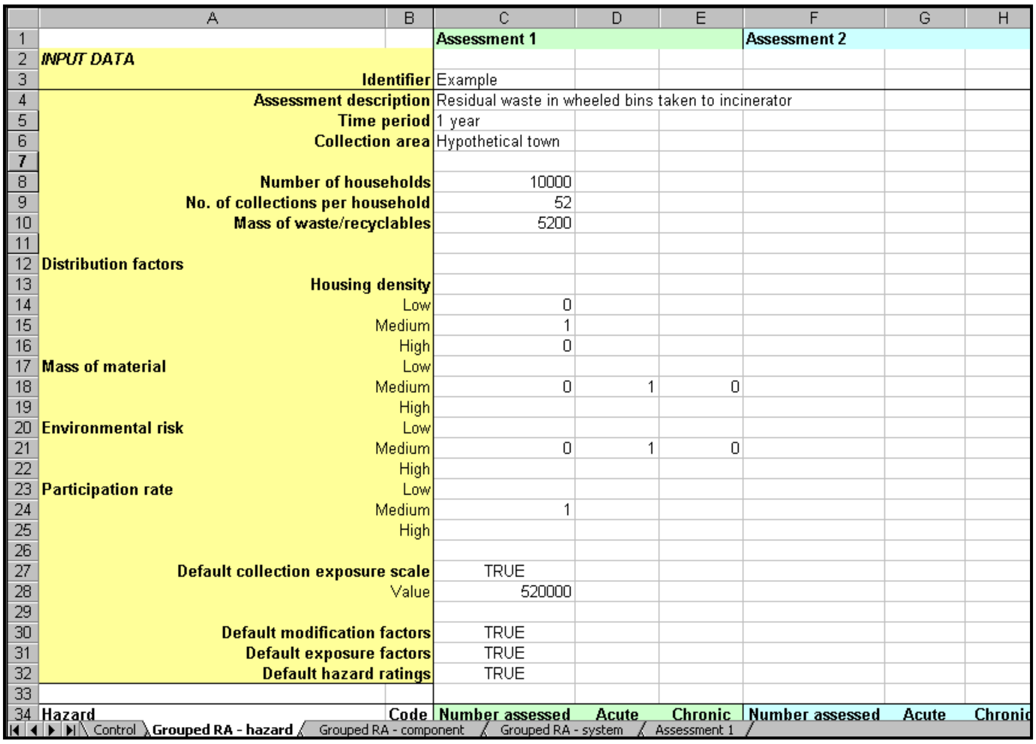
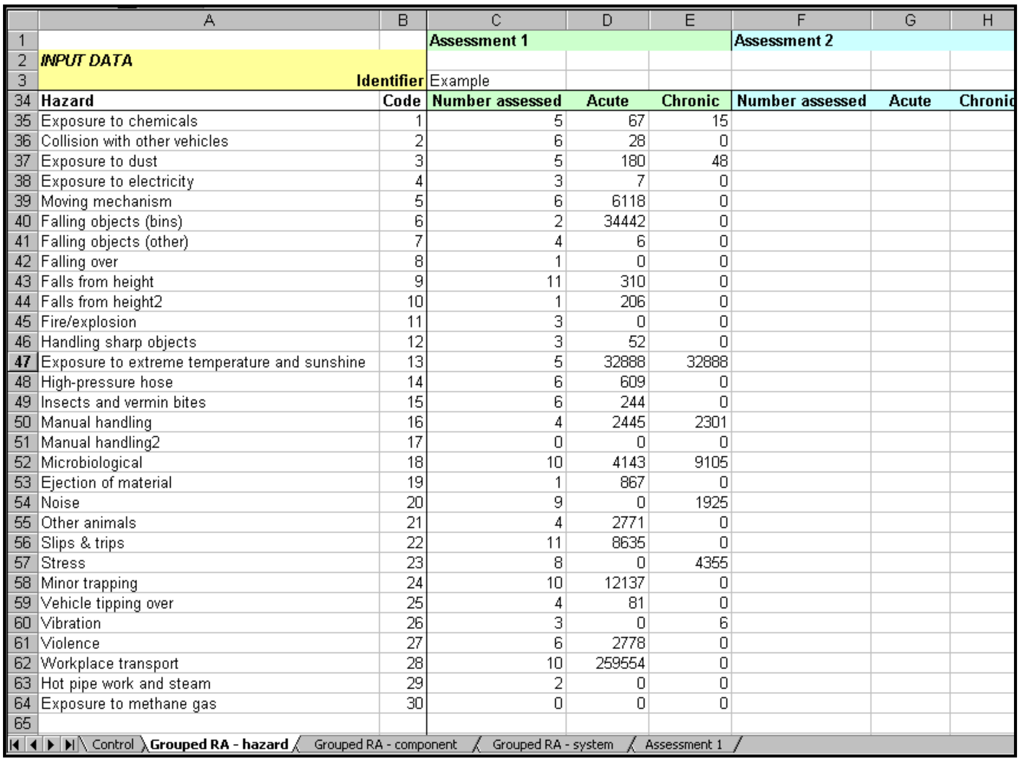
[8] *This is only non-zero for post-collection components.*



	A	B	C	D	E	F	G	H
1			**Assessment 1**			**Assessment 2**		
2	***INPUT DATA***							
3		**Identifier**	Example					
4		**Assessment description**	Residual waste in wheeled bins taken to incinerator					
5		**Time period**	1 year					
6		**Collection area**	Hypothetical town					
7								
8		**Number of households**	10000					
9		**No. of collections per household**	52					
10		**Mass of waste/recyclables**	5200					
11								
12	**Distribution factors**							
13		**Housing density**						
14		Low	0					
15		Medium	1					
16		High	0					
17	**Mass of material**	Low						
18		Medium	0	1	0			
19		High						
20	**Environmental risk**	Low						
21		Medium	0	1	0			
22		High						
23	**Participation rate**	Low						
24		Medium	1					
25		High						
26								
27		**Default collection exposure scale**	TRUE					
28		Value	520000					
29								
30		**Default modification factors**	TRUE					
31		**Default exposure factors**	TRUE					
32		**Default hazard ratings**	TRUE					
33								
34	**Hazard**	**Code**	**Number assessed**	**Acute**	**Chronic**	**Number assessed**	**Acute**	**Chronic**

Figure 20 *Grouped RA – hazard* worksheet rows 1 to 33



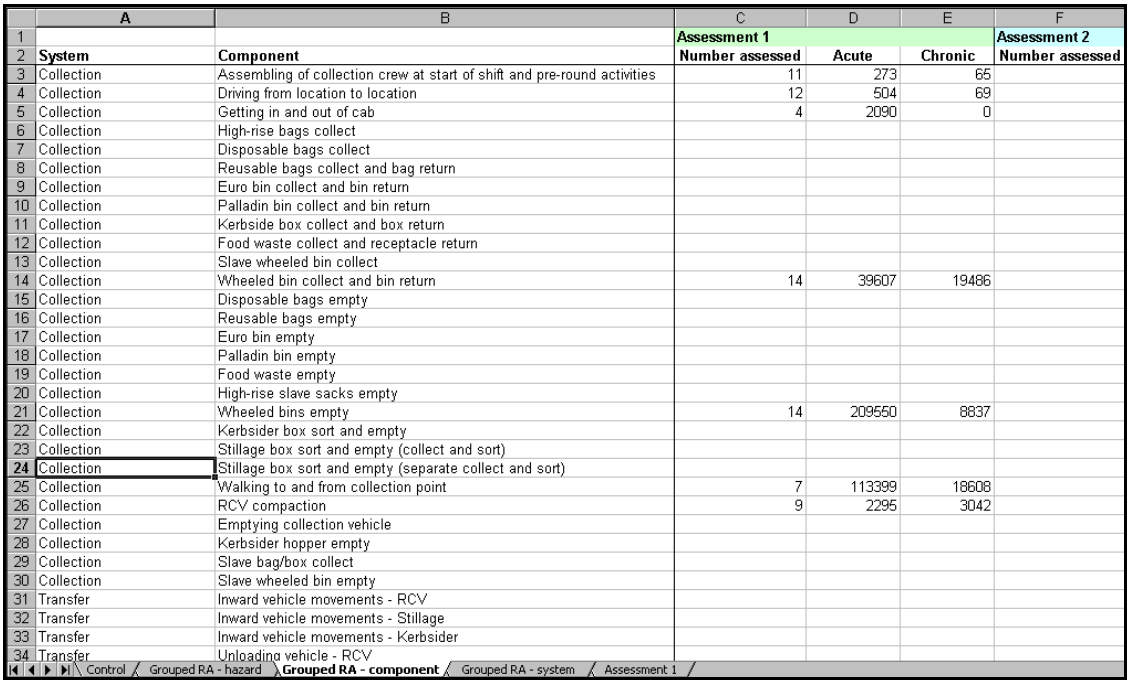
	A	B	C	D	E	F	G	H
1			**Assessment 1**			**Assessment 2**		
2	***INPUT DATA***							
3		**Identifier**	Example					
34	**Hazard**	**Code**	**Number assessed**	**Acute**	**Chronic**	**Number assessed**	**Acute**	**Chronic**
35	Exposure to chemicals	1	5	67	15			
36	Collision with other vehicles	2	6	28	0			
37	Exposure to dust	3	5	180	48			
38	Exposure to electricity	4	3	7	0			
39	Moving mechanism	5	6	6118	0			
40	Falling objects (bins)	6	2	34442	0			
41	Falling objects (other)	7	4	6	0			
42	Falling over	8	1	0	0			
43	Falls from height	9	11	310	0			
44	Falls from height2	10	1	206	0			
45	Fire/explosion	11	3	0	0			
46	Handling sharp objects	12	3	52	0			
47	Exposure to extreme temperature and sunshine	13	5	32888	32888			
48	High-pressure hose	14	6	609	0			
49	Insects and vermin bites	15	6	244	0			
50	Manual handling	16	4	2445	2301			
51	Manual handling2	17	0	0	0			
52	Microbiological	18	10	4143	9105			
53	Ejection of material	19	1	867	0			
54	Noise	20	9	0	1925			
55	Other animals	21	4	2771	0			
56	Slips & trips	22	11	8635	0			
57	Stress	23	8	0	4355			
58	Minor trapping	24	10	12137	0			
59	Vehicle tipping over	25	4	81	0			
60	Vibration	26	3	0	6			
61	Violence	27	6	2778	0			
62	Workplace transport	28	10	259554	0			
63	Hot pipe work and steam	29	2	0	0			
64	Exposure to methane gas	30	0	0	0			
65								

Figure 21 *Grouped RA – hazard* worksheet rows 34 to 65

5.4.2 Grouped RA – component worksheet

A portion of the *Grouped RA – component* worksheet is shown in Figure 22. Columns A and B list each system and component combination, as shown in Tables 1 to 8. The total level of risk (relative) is shown as a function of each component. Results are only shown where that particular component has been chosen as part of the assessment. The number of hazards assessed for each component, the total acute risk for each component and the total chronic risk for each component are shown.

The results from each assessment are shown on the same worksheet. Assessment 1 is shown in Columns C to E, assessment 2 in columns F to H, assessment 3 in columns I to K, etc.



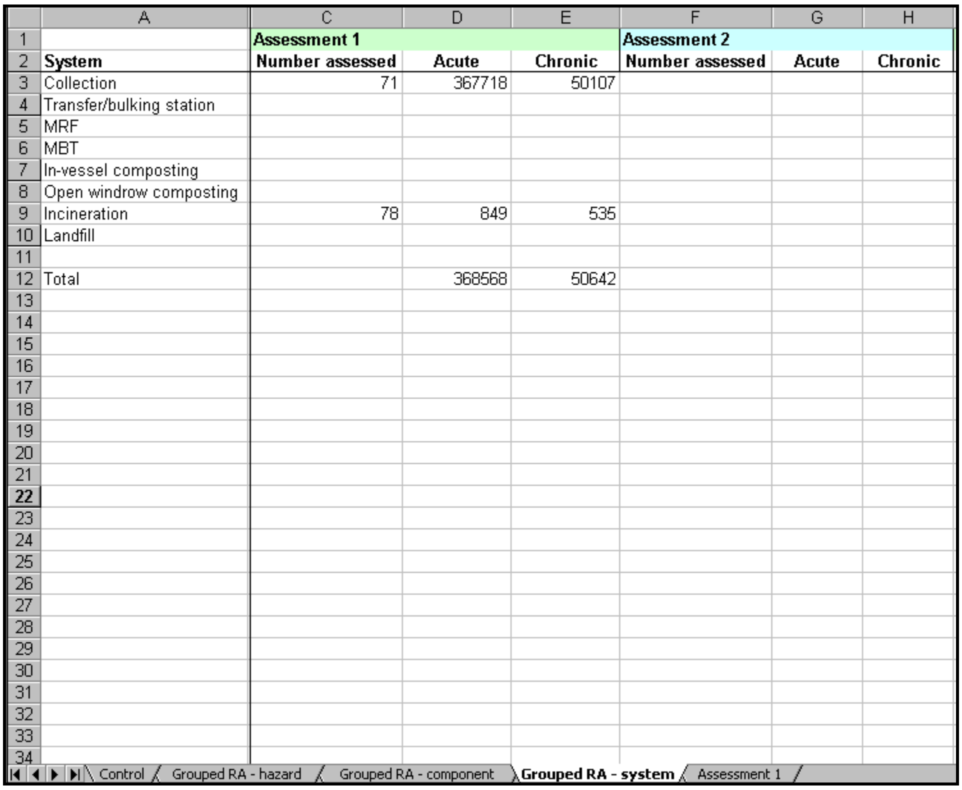
	A	B	C	D	E	F
1			**Assessment 1**			**Assessment 2**
2	**System**	**Component**	**Number assessed**	**Acute**	**Chronic**	**Number assessed**
3	Collection	Assembling of collection crew at start of shift and pre-round activities	11	273	65	
4	Collection	Driving from location to location	12	504	69	
5	Collection	Getting in and out of cab	4	2090	0	
6	Collection	High-rise bags collect				
7	Collection	Disposable bags collect				
8	Collection	Reusable bags collect and bag return				
9	Collection	Euro bin collect and bin return				
10	Collection	Palladin bin collect and bin return				
11	Collection	Kerbside box collect and box return				
12	Collection	Food waste collect and receptacle return				
13	Collection	Slave wheeled bin collect				
14	Collection	Wheeled bin collect and bin return	14	39607	19486	
15	Collection	Disposable bags empty				
16	Collection	Reusable bags empty				
17	Collection	Euro bin empty				
18	Collection	Palladin bin empty				
19	Collection	Food waste empty				
20	Collection	High-rise slave sacks empty				
21	Collection	Wheeled bins empty	14	209550	8837	
22	Collection	Kerbsider box sort and empty				
23	Collection	Stillage box sort and empty (collect and sort)				
24	Collection	Stillage box sort and empty (separate collect and sort)				
25	Collection	Walking to and from collection point	7	113399	18608	
26	Collection	RCV compaction	9	2295	3042	
27	Collection	Emptying collection vehicle				
28	Collection	Kerbsider hopper empty				
29	Collection	Slave bag/box collect				
30	Collection	Slave wheeled bin empty				
31	Transfer	Inward vehicle movements - RCV				
32	Transfer	Inward vehicle movements - Stillage				
33	Transfer	Inward vehicle movements - Kerbsider				
34	Transfer	Unloading vehicle - RCV				

Figure 22 *Grouped RA – component* worksheet

5.4.3 Grouped RA – system worksheet

A portion of the *Grouped RA – system* worksheet is shown in Figure 23. Column A lists each system. The total level of risk (relative) is shown as a function of each system. Results are only shown where that particular system has been chosen as part of the assessment. The number of hazards assessed for each system, the total acute risk for each system and the total chronic risk for each system are shown.

The results from each assessment are shown on the same worksheet. Assessment 1 is shown in Columns C to E, assessment 2 in columns F to H, assessment 3 in columns I to K, etc.



	A	C	D	E	F	G	H
1		**Assessment 1**			**Assessment 2**		
2	**System**	**Number assessed**	**Acute**	**Chronic**	**Number assessed**	**Acute**	**Chronic**
3	Collection	71	367718	50107			
4	Transfer/bulking station						
5	MRF						
6	MBT						
7	In-vessel composting						
8	Open windrow composting						
9	Incineration	78	849	535			
10	Landfill						
11							
12	Total		368568	50642			

Figure 23 *Grouped RA – system* worksheet

5.4.4 Interpretation of risk values

As discussed above risk is presented in two ways, as a risk index or rating and as a relative absolute value. Consideration is therefore needed on what both these mean and how they should be interpreted.

As collective risk has been calculated, not individual risk, it is not possible, and indeed inappropriate, to make a judgement about the acceptability of the total level of risk in isolation. As the size of an operation increases and so does the number of exposed workers, by definition the level of collective risk will also increase. This does not mean the level of risk is unacceptable. It is, therefore, only appropriate to compare the level of collective risk for the same collection area. It is not possible to say that a level of risk of *x* is acceptable or unacceptable.

However, for the same collection area the change in relative risk will indicate by how much the level of risk changes in percentage terms. For example if Assessment 1 generates a level of relative risk of 12000 and Assessment 2 generates a value of 18000, this means that the system in Assessment 2 has 50% greater collective risk.

In terms of risk rating or risk index, this provides a way of comparing the risk from individual hazards, and making a judgement about the level of that risk. Risk ratings less than 7 is indicative of a relatively low level of risk, between 7 and 13 of a moderate level of risk and greater than 13 a high level of risk. It is stressed, however, that these values are indicative and relate only to collective risk. A low collective risk could still relate to an unacceptable level of individual risk. An assessment of individual risk is outside the scope of this work, however.

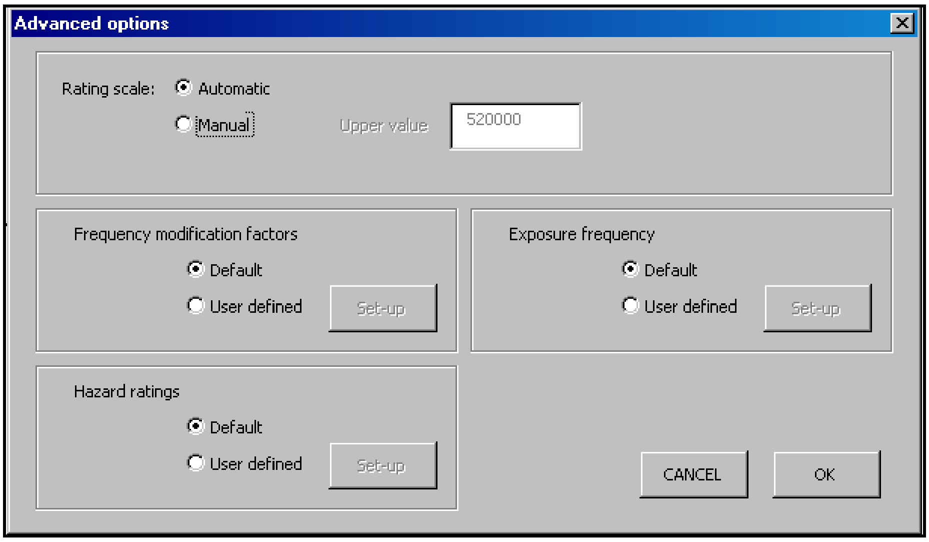
5.5 USER DEFINED DATA AND ADVANCED FUNCTIONALITY

By selecting the '***Advanced…***' button on the *Control* worksheet the *Advanced options* screen, as shown in Figure 24, is displayed. The purpose of this screen is to allow the user to choose between the default data contained within the tool or use, where defined, and set-up user specific hazard ratings and modification factors.

For the following either default or user defined options can be selected:

- Rating scale – this allows the range of the exposure frequency rating scale to be set (see Section 5.5.1);
- Frequency modification factors – this allows user defined frequency modification factors to be set up for each component (see Section 5.5.2);
- Exposure frequency – this allows a factor to be applied to the exposure frequency for each component (see Section 5.5.3); and
- Hazard ratings – this allows default probability and consequence ratings, and hazard modification factors to be applied to each hazard (see Section 5.5.4).

It should be noted that the user defined data can only be set-up if the *user defined* option (or *Manual* for the rating scale) have been selected.



Advanced options

Rating scale: ● Automatic
○ Manual   Upper value 520000

Frequency modification factors
● Default
○ User defined

Exposure frequency
● Default
○ User defined

Hazard ratings
● Default
○ User defined

Figure 24 *Advanced options* selection screen

When data entry is complete select '***OK***' at the bottom right-hand side of the *Advanced options* screen. This will then save the options chosen and return the user to the *Control* worksheet. Note these options will not affect the results until the '***Calculate risk***' button has been selected on the *Control* worksheet.

Clicking on '***CANCEL***' will return the user to the *Control* worksheet; any changes made to the options on the *Advanced options* screen will be discarded.

It is important that when running the tool with any user defined options selected that a sensitivity with the default values is also examined.

5.5.1 Rating scale

Default option for the rating scale is *Automatic*.

As discussed in Appendix C, Section C3.1.1, the tool by default automatically sets the exposure frequency rating scale at runtime and the upper range of this scale is determined by the input data (as discussed in Section 5.2). This enables the exposure rating scale to be as sensitive as possible for the specific application of the tool. However, it has a drawback in that it is then not possible to compare assessments where different local input data is used. To enable different assessments to be compared the exposure frequency scale can be fixed by selecting the *Manual* option and entering a value in the *Upper Value* box. The upper value is the exposure frequency above which a rating of 5 is assigned and defines *N* in Table 9.

Care must be taken when selecting an appropriate upper value because a value too high will lead to exposure ratings all being 5 and a value too low will lead to exposure ratings all being 1. Both circumstances would mean the assessment would be insensitive to changes in exposure.

5.5.2 Frequency modification factors

As described in Appendix C, Section C3.1.1, modification factors are required to adjust the baseline exposure frequency into an exposure frequency that is relevant for each component. A modification factor is therefore required for each component/activity. The baseline frequency for collection activities is the number of collections (for a defined area and a defined time period) and for post-collection activities is the total mass of waste collected (for the same area and time period).

The exposure frequency is calculated as follows:

Collection subsystems

Exposure frequency = number of households ×
number of collections (per defined period of time) ×
set-out rate (proportion) ×
activity specific modifier

Post-collection subsystems

Exposure frequency = tonnage of material (per defined period of time) ×
number of operations per tonne of material modifier

where the *number of households*, the *number of collections*, the *set-out rate* and the *tonnage of material per year* are LA specific inputs (discussed in Section 5.2) and the two modifiers are assumed to be generic, but can be defined by the user. The default modification factors and their derivation are presented for collection and post-collection components in Appendix D, Sections D2.2 and D2.3 respectively.

It is recommended that, as these default factors have been derived based on observations, project team estimates and limited discussion with different parts of the industry, the modification factors be reviewed for each application of the Risk Comparator Tool as there will be variation in these factors for any specific site or operation.

To set-up user defined frequency modification factors for each component the *User defined* option must be selected and the ***Set-up*** button pressed. It should be noted that the ***Set-up*** button is only activated if the *User defined* option is chosen. This then opens the *Frequency modification factors* screen, as shown in Figure 25. Two tabs are seen at the top of this screen, one for collection and one for post-collection. It is the frequency modification factor set-up screen for collection that is shown in Figure 25. That for post-collection is shown in Figure 26.

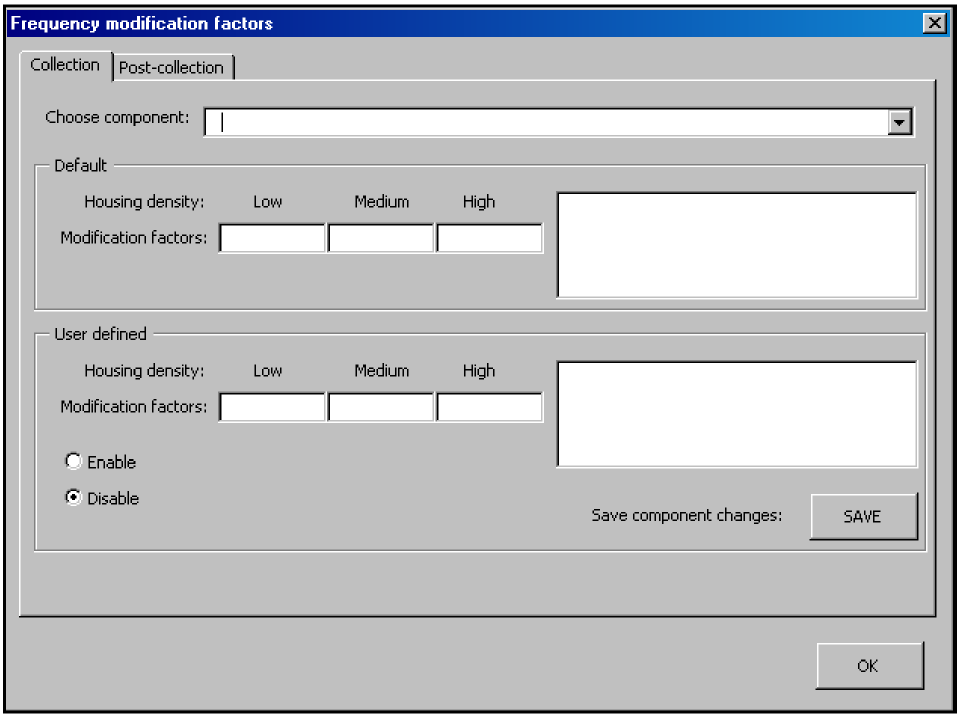


Figure 25 *Frequency modification factors* selection screen for collection components

5.5.2.1 Collection components

If the *Collection* tab on the *Frequency modification factors* screen is selected the set-up screen is as shown in Figure 25. In order to set up the frequency modification factors for a specific component the component must be selected by using the dropdown box. The components available within this dropdown box are those summarised in Table 1.

Following selection of a component the default modification factors for that component and assumptions made in their derivation will be shown in the *Default* area. User defined modification factors can then be entered for each of the three housing density categories and justification for these values also entered in the relevant boxes in the *User defined* area.

To enable the user defined exposure frequency modification factors for the specific component the *Enable* option must be selected.

Finally, to save the user defined information the ***SAVE*** button must be pressed. It is important that this is selected before choosing another component or before selecting ***OK,*** otherwise the information entered for that component will have been lost.

Modification factors can then be set up for further components as required by repeating the above. The tool can use a mixture of default and user defined frequency modification factors.

When data entry is complete pressing ***OK*** will close the *Frequency modification factors* screen.

5.5.2.2 Post-collection components

If the *Post-collection* tab on the *Frequency modification factors* screen is selected the set-up screen is as shown in Figure 26. In order to set up the frequency modification factors for a specific component the component must be selected by using the dropdown box as before. The components available within this dropdown box are those summarised in Tables 2 to 8. Setting up of post-collection modification factors is then the same as before. The main difference here is that only one factor per component is required as these are assumed to be unrelated to housing density.

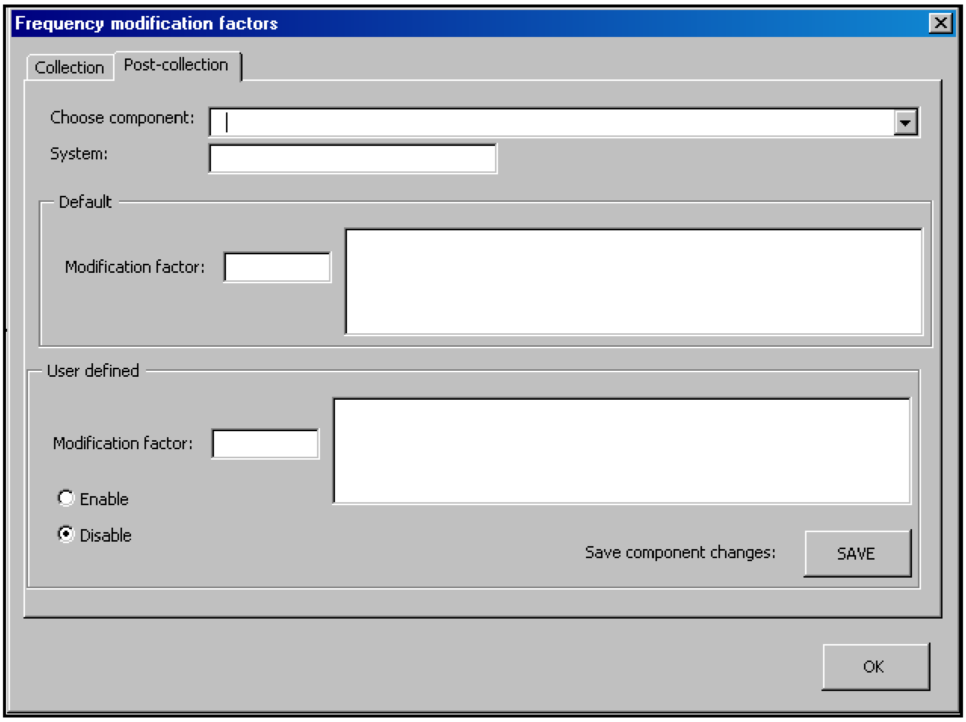


Figure 26 *Frequency modification factors* selection screen for post-collection components

5.5.3 Exposure frequency

In order to be able to select multiples of the same component or to be able to factor post-collection components to take account of different waste streams being dealt with by different processes and therefore only a fraction of the input mass being processed by specific components, a factor can be entered for each component. This is then multiplied by the calculated exposure frequency prior to the exposure rating being assigned. Default values of unity are assumed by the tool.

To set-up user defined exposure factors for each component the *User defined* option must be selected and the ***Set-up*** button pressed. It should be noted that the ***Set-up*** button is only activated if the *User defined* option is chosen. This then opens the *Exposure factors* screen, as shown in Figure 27. Two tabs are seen at the top of this screen, one for collection and one for post-collection. It is the frequency modification factor set-up screen for collection that is shown in Figure 27. That for post-collection is virtually the same and so is not shown or separately discussed here.

In order to set up the exposure factors for a specific component the component must be selected by using the dropdown box. The components available within this dropdown box are those summarised in Table 1 for collection and Tables 2 to 8 for post-collection.

Following selection of a component any pre-defined user defined value and assumptions made in its derivation will be shown; if nothing has been previously defined these boxes will remain blank. User defined exposure factors can then be entered and justification for these values also entered in the relevant boxes.

To enable the user defined exposure factors for the specific component the *Enable* option must be selected.

Finally, to save the user defined information the ***SAVE*** button must be pressed. It is important that this is selected before choosing another component or before selecting ***OK***, otherwise the information entered for that component will have been lost.

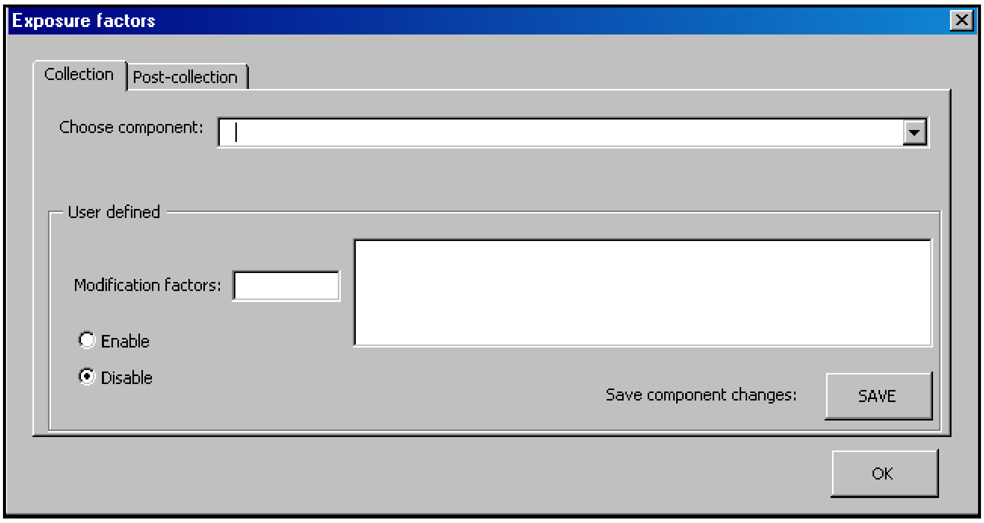


Figure 27 *Exposure factors* selection screen

Exposure factors can then be set up for further components as required by repeating the above. The tool can use a mixture of default and user defined exposure factors.

When data entry is complete pressing ***OK*** will close the *Exposure factors* screen.

5.5.4 Hazard ratings

The default hazard ratings in terms of probability and consequence and hazard frequency modification factors used by the tool are described in detail in Appendix D, Section D4 and Annex D3. Where these values are judged to be inappropriate, it is possible for the user to enter their own ratings.

To set-up user defined hazard ratings for each component-hazard combination the *User defined* option must be selected and the ***Set-up*** button pressed. It should be noted that the ***Set-up*** button is only activated if the *User defined* option is chosen. This then opens the *Set-up hazard ratings* screen, as shown in Figure 28. Two tabs are seen at the top of this screen, one for collection and one for post-collection. It is the hazard ratings set-up screen for collection that is shown in Figure 28. That for post-collection is shown in Figure 29.

5.5.4.1 Collection components

If the *Collection* tab on the *Set-up hazard ratings* screen is selected the set-up screen is as shown in Figure 28. In order to set up the hazard ratings for a specific component-hazard combination the component and hazard must be selected by using the relevant dropdown boxes. The components available within this dropdown box are those summarised in Table 1. The hazards available for selection are those that were identified as part of this work and are listed in Table 12.

Following selection of a component-hazard combination any user defined values are loaded onto the form. If no previous user defined values have been saved the default hazard frequency multiplication factor will be 1, the assumption boxes will be blank and the probability and consequence ratings will all be 0. User defined values can then be entered in the relevant boxes.

The hazard probability and consequence ratings are given for a number of scenarios, as represented by a different cell in the table. It is only those cells coloured white where a value is required to be entered. The values in the yellow cells are calculated based on the values in the white cells. Appendix C provides further detail on the scenarios and the calculation approach (Section C3.3). Chronic and acute probability and consequence ratings are required for 8 scenarios.

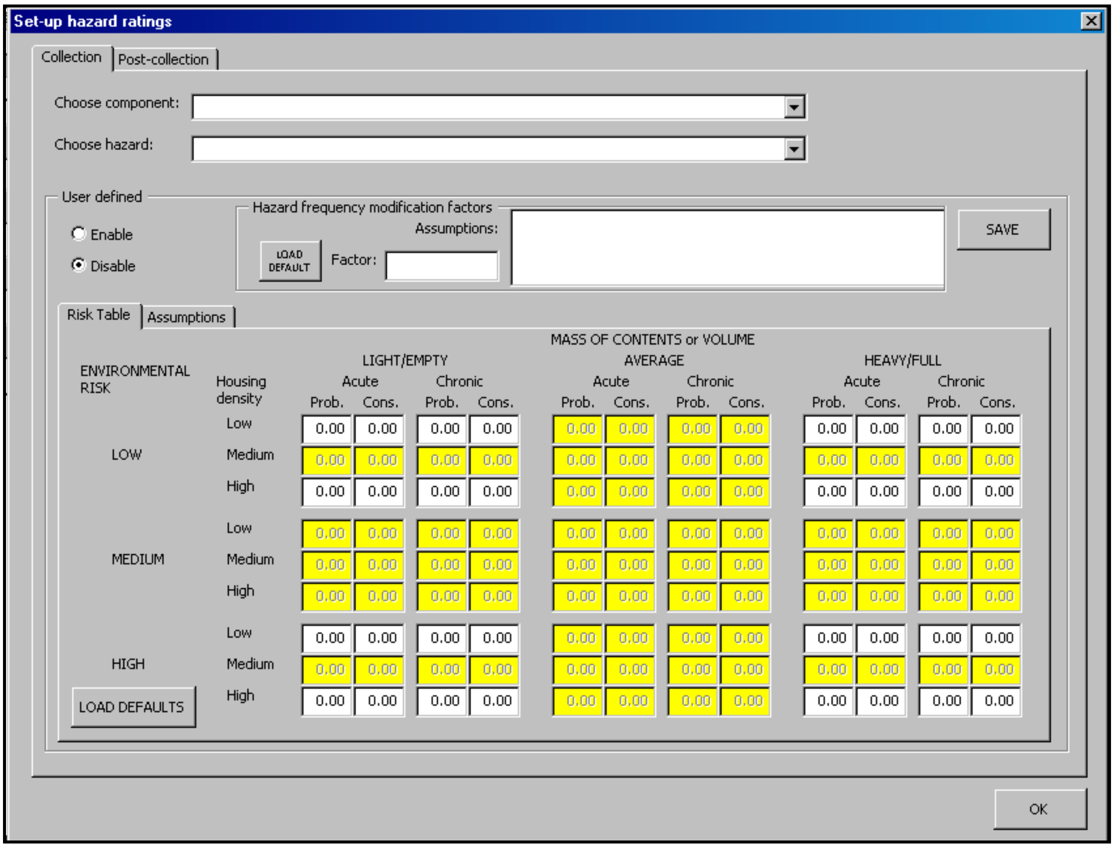
Justification for the user defined hazard frequency modification factors should be entered in the relevant box and justification for the user defined hazard probability and consequence ratings should be entered in the box accessed by selecting the *Assumptions* tab.

The default values for either the hazard frequency modification factors or probability and consequence ratings can be loaded by selecting the relevant ***LOAD DEFAULT*** button.

It is important that if the default hazard frequency modification factors are to be used, but user defined probability and consequence ratings that the default hazard frequency modification factors are loaded. Similarly if default probability and consequence ratings are to be used, but user defined hazard frequency modification factors that the default probability and consequence ratings are loaded.

To enable the user defined hazard ratings for the specific component-hazard combination the *Enable* option must be selected.

Finally, to save the user defined information the ***SAVE*** button must be pressed. It is important that this is selected before choosing another component-hazard combination or before selecting ***OK,*** otherwise the information entered for that component will have been lost.



○ Enable

● Disable

		MASS OF CONTENTS or VOLUME											
		LIGHT/EMPTY				AVERAGE				HEAVY/FULL			
ENVIRONMENTAL RISK	Housing density	Acute		Chronic		Acute		Chronic		Acute		Chronic	
		Prob.	Cons.	Prob.	Cons.	Prob.	Cons.	Prob.	Cons.	Prob.	Cons.	Prob.	Cons.
LOW	Low	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Medium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	High	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MEDIUM	Low	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Medium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	High	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HIGH	Low	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Medium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	High	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Figure 28 *Set-up hazard ratings* selection screen for collection components

Hazard ratings can then be set up for further component-hazard combinations as required by repeating the above. The tool can use a mixture of default and user defined hazard ratings.

When data entry is complete pressing ***OK*** will close the *Set-up hazard ratings* screen.

Table 12 Hazards

Hazard	***Notes***
Collision with other vehicles	
Ejection of material	
Exposure to chemicals	
Exposure to dust	
Exposure to electricity	
Exposure to extreme temperature and sunshine	
Exposure to methane gas	

Hazard	***Notes***
Falling objects (bins)	
Falling objects (other)	
Falling over	
Falls from height	
Falls from height2	This hazard category is included twice to capture both falls from Stillage and falls from riding on tailgate of RCV for the *Driving from location to location* component.
Fire/explosion	
Handling sharp objects	
High-pressure hose	
Hot pipe work and steam	
Insects and vermin bites	
Manual handling	
Manual handling2	This hazard category is included twice to capture both handling of the slave receptacle and handling of the householder’s receptacle for the *Slave receptacle collect* component.
Microbiological	
Minor trapping	
Moving mechanism	
Noise	
Other animals	
Slips and trips	
Stress	
Vehicle tipping over	
Vibration	
Violence	
Workplace transport	

5.5.4.2 *Post-collection components*

If the *Post-collection* tab on the *Set-up hazard ratings* screen is selected the set-up screen is as shown in Figure 29. In order to set up the hazard ratings for a specific component-hazard combination the component and hazard must be selected by using the dropdown boxes as before. The components available within this dropdown box are those summarised in Tables 2 to 8. Setting up of post-collection hazard ratings is then the similar to before, although much simpler as there are not the range of scenarios.

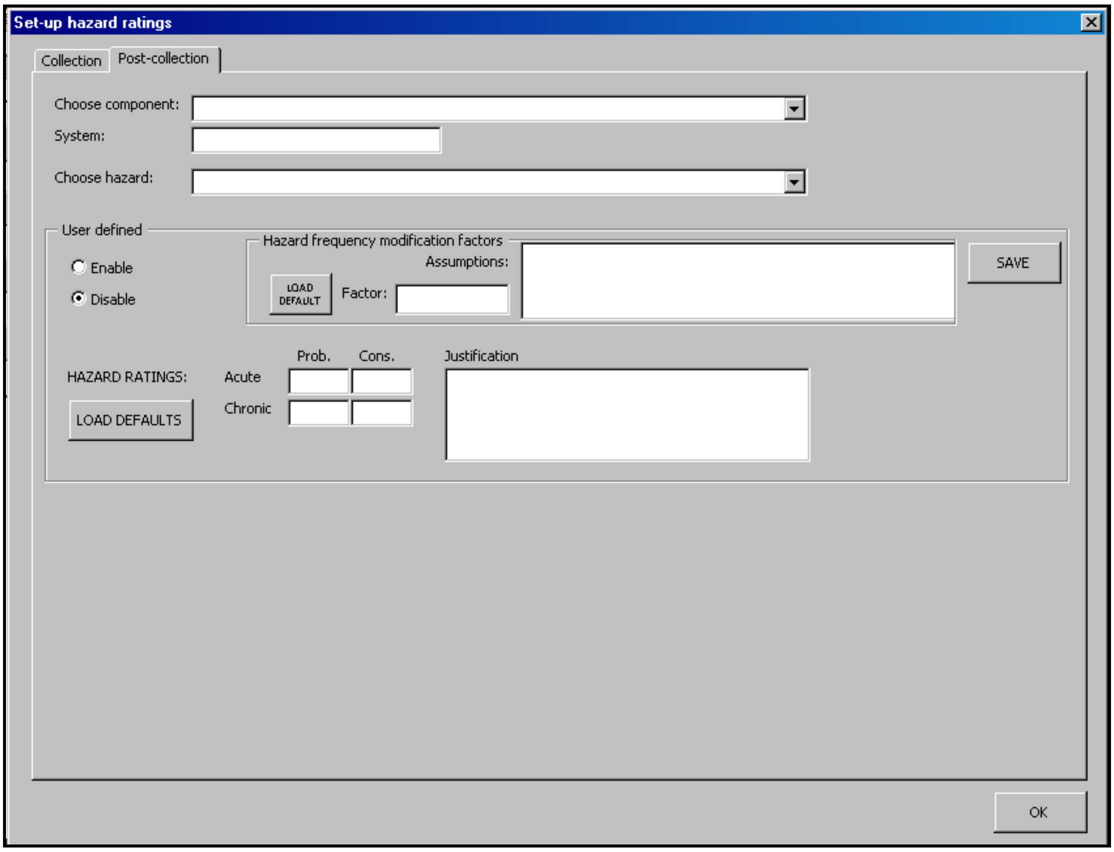


Figure 29 *Set-up hazard ratings* selection screen for post-collection components

5.6 USE FOR MORE COMPLEX CASES

For more complex scenarios, for example where a mixture of collection schemes are used as part of the overall process, e.g. wheeled bin with RCV for residual waste and boxes with Kerbsider for dry recyclables, each scheme is best assessed separately and the results combined by the user.

Where more than one of the same component is required, a multiplier can be included in the Exposure frequency part of the Advanced Options. For example, if there were two of the same receptacle to collect from each household a factor of 2 could be included for this particular component, and any related component, for example emptying the receptacle.

For circumstances where not all material is processed post collection, for example due to rejection of a proportion, an allowance can be made for this by again using the exposure frequency part of the Advanced Options. This time a factor less than 1 would be entered for those components affected. For example if 20% of the material delivered to a processing plant is rejected then a factor of 0.8 would have to be included for the relevant components that deal with the remaining (non-rejected) material.

6 COMMENT ON USE OF THE TOOL

In terms of making sense of the outputs from the Risk Comparator Tool, the following must be borne in mind:

- The risk ratings give a relative measure of collective risk. On no account should the risk ratings be treated as an absolute measure of risk. They are only intended to allow the risk profiles from different overall systems to be compared.
- Where user defined options have been used it is imperative that a sensitivity study is carried out. This should as a minimum include a comparison of the resultant profiles with default options.
- It is important to recognise that assumptions made in populating the tool may not be valid in all circumstances. It is therefore recommended that the default values are used for a base case assessment, but that these are modified with more appropriate values where necessary. A sensitivity to all the inputs should be carried out. In particular, assumptions made in the derivation of the following, which are used for the calculation of exposure frequency, should be reviewed for each application of the tool. The calculation of relative risk is sensitive to these assumptions.
    1. Component modification factors – see Section D2; and
    2. Hazard modification factors – see *Hazard modification factor* subsection for the specific hazard category within Section D4.
- The systems and components used by the tool have a limited, but defined scope. When interpreting the different risk profiles it is important that the assumptions regarding the chosen components, as described in this report, are fully understood.
- The hazard ratings produced by the tool must be considered alongside the justification of the default hazard ratings, described in Appendix D.
- There will be differences between the components or hazards for any specific system and the system as described by the tool. The components have been selected and the hazards rated by considering generic systems. Therefore, again careful consideration must be made as to the applicability of using this tool for any given system. However, as the aim of the tool is to allow differences between systems to be examined it is considered that as similar assumptions and detail have been made across the systems then as a comparative assessment the approach is valid.
- The risk profiles for individual subsystems should not be used in isolation. That is, care must be taken when examining only part of the waste and recyclables life cycle. The purpose of the tool is to allow the risk profiles to be compared for different systems across the full life cycle, from collection to disposal or reuse.
- Risk profiles are the important outputs from the tool, not summed risk. The summed risk ratings are only meant to give a high-level guide as to the level of collective risk for different systems, and should be used with extreme caution. It is the detailed risk profiles that should feed into any decision making process.
- It is important that the results from the tool are used as one health and safety input only in any decision making process. It would be inappropriate to come to any decision regarding a particular waste and recyclables management system based just on this, or any other, tool.

- Where results from the tool are passed to third parties it is imperative that users of the tool make clear to them all caveats on the tool's use.
- In the calculation of risk by the RCT it is assumed risk is proportional to the number of times a person is exposed to a hazard and not the length of time exposed. For most hazard categories this is a valid assumption, but for others, particularly those leading to chronic effects (exposure to dust, exposure to extreme temperature and sunshine, manual handling, microbiological, noise, stress and vibration) this is not a fully valid assumption. Therefore, caution should be exercised when interpreting the level of risk from such hazards. Notwithstanding this, it is considered an acceptable approximation to enable guiding principles to be derived about the importance of specific hazard categories.

Other areas requiring particular care, as highlighted earlier, include:

- Flats and bin stores – the number of households entered on the *Data entry* screen is the number of bins in a bin store or the number of individual flats for a door-to-door collection.
- The collection and post-collection components both have a emptying collection vehicle component. The collection 'Emptying collection vehicle' component is a generic activity that should only be used when post-collection subsystems are not being considered, otherwise the relevant post-collection emptying component would be more applicable.
- When user defined data is entered the user must click the SAVE button before clicking OK or selecting a different component or hazard category, otherwise the information entered will be lost.

7 CONCLUSIONS AND RECOMMENDATIONS

In order to address the aims and objectives of this work, that is to provide a means for Local Authorities, or organisations (including community organisations) that are responsible for delivering waste management services, to compare the level of health and safety risk from different waste and recyclables management systems for the full waste life cycle (not just collection), an Excel based tool has been developed. This tool, the Risk Comparator Tool, is described in this report, including guidance on its use. In addition, as part of populating the tool, the result of the hazard identification and risk assessment processes that were applied have been described. This includes justification for all assumptions made.

The Risk Comparator Tool is considered fit-for-purpose, although it cannot be guaranteed that it will work everywhere and is provided as-is without any ongoing support. It is the first version of the tool, and as such many improvements could be made, some of which are listed below. However, at this stage it was considered the best approach was to allow the tool to be used for a period of time, and its usefulness evaluated, prior to considering whether effort for further development can be warranted.

Notwithstanding the above comment, a fairly limited trial with four Local Authorities was undertaken. Some of the feedback from this trial has been incorporated into the tool's development, whilst other feedback is incorporated into the recommendations below. Across the trials Local Authorities suggested a variety of uses for the tool, which appeared to map well with the objectives for its development. Essentially these were:

- To help with strategic decision-making;
- An aid to the risk assessment process; and
- To increase visibility of internal/business processes (e.g. decisions between different systems proposed, or rationale behind rejection of a proposed system).

7.1 RECOMMENDATIONS

1. The ultimate aim of this project was to provide health and safety information that can be used alongside other factors, for example environmental targets, cost, politics and local availability of a particular system, to help make a balanced decision on the most appropriate overall waste and recyclables management system, taking appropriate account of health and safety. It is stressed, however, that determining how to balance other factors alongside the health and safety information is outside the scope of the current work. Therefore, it is recommended that further work is carried out to develop a decision making framework utilising the outputs from this work and the other factors.

2. The development of the Risk Comparator Tool has been limited to a defined range of waste and recyclables management systems, where a generic approach has been taken to describe each of these systems. Further consideration should be made following evaluation of the tool whether a wider range of systems or more differences within a specific system should be captured.

3. The data contained within the tool, i.e. hazards, hazard probability and consequence ratings, and modification factors have been derived based mainly on expert judgement, but using a range of approaches to increase the robustness of the data. They will therefore have inherent uncertainty. Accident data was investigated to support the assessments, although it was found that it was not sufficiently detailed to map onto the component and hazard breakdown as

adopted here. Where improvements in accident data classification occur from across the industry, this should be used in the future to update the judgments made.

4. The guidance presented in Appendix F should be considered by HSE and WISH for further development and publishing by HSE/WISH.

5. The following improvements to the Risk Comparator Tool should be considered:

- Developments to the output of the tool to make it easier to compare the risk ratings from different systems;
- Graphical and colour-coded output of the risk results;
- Increased flexibility to allow new components and hazards to be added;
- Functionality to allow summary reports to be produced; and
- Save assessment and load previous assessment functionality.

6. The Risk Comparator Tool should be used and evaluated by users over a period of time, say a year. Following this period a meeting between interested parties should be held to evaluate the usefulness of the tool and consider further developments.

8 ANNEX 1 – WORKED EXAMPLE

This Annex provides a worked example to illustrate how the tool is used to set up an assessment.

8.1 EXAMPLE 1

Waste collected together in wheeled bins and taken directly to an incinerator for disposal. It is assumed that the area being investigated has 10,000 houses, collection is weekly, therefore 52 collections, and 5,200 tonnes of material are collected from these houses over a year.

The houses in the area are assumed to distributed in terms of housing density as:

- Low density – 10%
- Medium density – 70%
- High density – 20%

The following set-out rates have been assumed:

- Low density – 100%
- Medium density – 90%
- High density – 90%

Mass in the container has been distributed as follows for each of the housing density categories.

For low density housing:

- Low mass – 0%
- Medium mass – 50%
- High mass – 50%

For medium and high housing densities (same distribution in mass assumed):

- Low mass – 20%
- Medium mass – 50%
- High mass – 30%

Environmental risk has been distributed as follows for each of the housing density categories.

For low density housing:

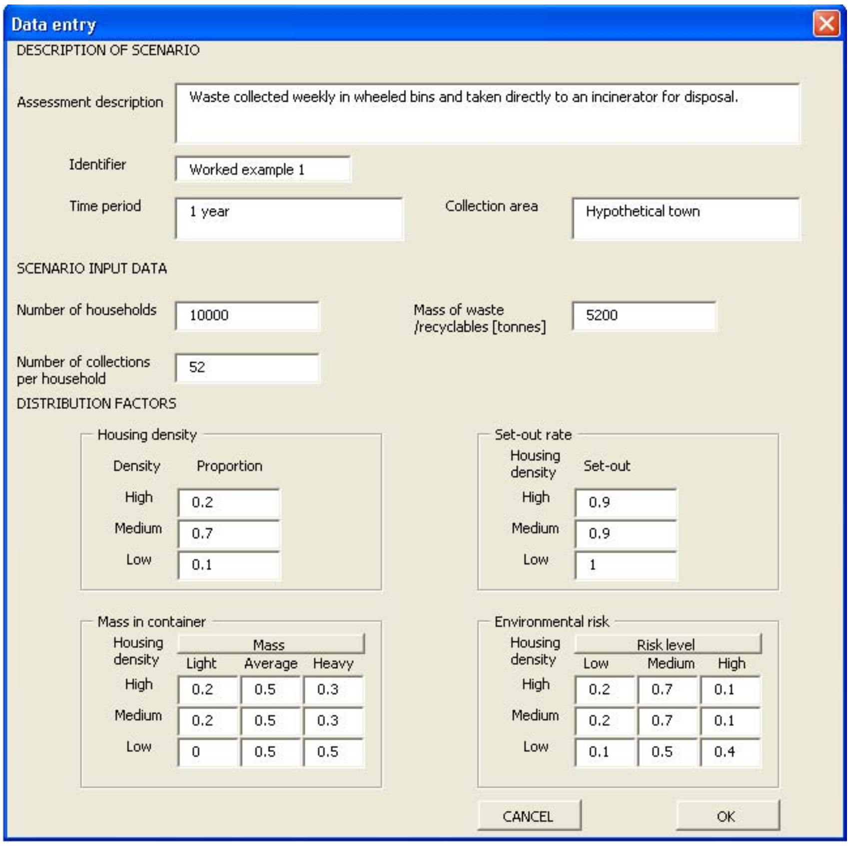
- Low mass – 10%
- Medium mass – 50%
- High mass – 40%

For medium and high housing densities (same distribution in mass assumed):

- Low mass – 20%
- Medium mass – 70%

- High mass – 10%

The information therefore entered into the Data entry screen is illustrated in Figure 30



Assessment description: Waste collected weekly in wheeled bins and taken directly to an incinerator for disposal.

Identifier: Worked example 1

Time period: 1 year

Collection area: Hypothetical town

Number of households: 10000

Mass of waste /recyclables [tonnes]: 5200

Number of collections per household: 52

Housing density

Density	Proportion
High	0.2
Medium	0.7
Low	0.1

Set-out rate

Housing density	Set-out
High	0.9
Medium	0.9
Low	1

Mass in container

Housing density	Mass		
	Light	Average	Heavy
High	0.2	0.5	0.3
Medium	0.2	0.5	0.3
Low	0	0.5	0.5

Environmental risk

Housing density	Risk level		
	Low	Medium	High
High	0.2	0.7	0.1
Medium	0.2	0.7	0.1
Low	0.1	0.5	0.4

Figure 30 *Data entry* screen for Example 1

The following components were selected for this example:

- Collection:
  - Assembling of collection crew at start of shift
  - Driving from location to location
  - Getting in and out of cab
  - Collect and bin return (wheeled bin)
  - Empty wheeled bin
  - Walking to and from collection point
  - Operating vehicle machinery (RCV compaction)
- Incineration:
  - Inward vehicle movements (RCV)
  - Unloading vehicle (RCV)
  - Removal of large items of waste from feed chute
  - Delivery of hazardous substances in bulk
  - Removal of by-products
  - Onward vehicle movements
  - General housekeeping
  - Maintenance

No advanced options were selected. Once the above has been entered and Calculate risk selected, the assessment for this base case will be produced.

8.2 EXAMPLE 2

In this example, an alternative weekly collection is made of dry recyclables using kerbside boxes with a Kerbsider which is taken to a bulking station and residual waste in wheeled bins using an RCV which is disposed of at an incinerator. Assuming this is applied to the same area as with Example 1, then it is assumed that there are 10,000 houses from which 5,200 tonnes of material are collected in total per year. As there are two collection schemes these require to be assessed separately, one for the dry recyclables collection, with 26 collections per year giving 1,700 tonnes of material collected per year, and one for residual waste collection again with 26 collections per year, with 3,500 tonnes of material collected per year.

As the same area is being assessed as Example 1, the same distribution in housing density and distributions in environmental risk can be assumed. However, different set-out rates and distributions in receptacle mass are assumed, which are summarised below.

The following set-out rates have been assumed:

	Dry recyclables	***Residual***
• Low density	50%	100%
• Medium density	60%	90%
• High density	60%	90%

Mass in the container has been distributed as follows for each of the housing density categories.

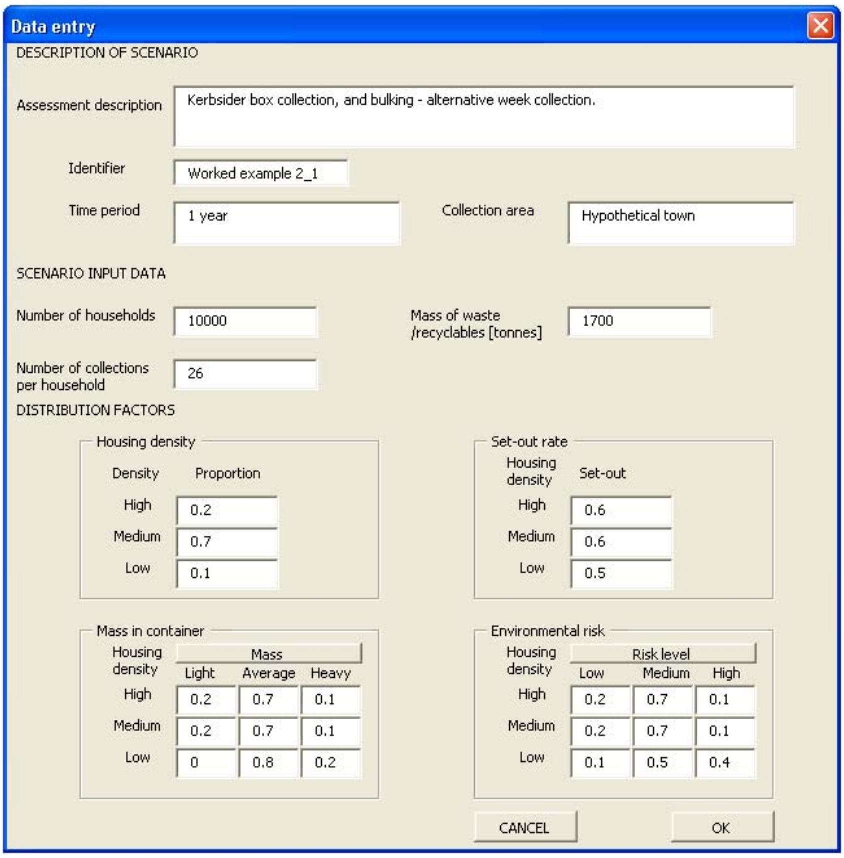
For low density housing:

	Dry recyclables	***Residual***
• Low mass	0%	0%
• Medium mass	80%	40%
• High mass	20%	60%

For medium and high housing densities (same distribution in mass assumed):

	Dry recyclables	***Residual***
• Low mass	20%	10%
• Medium mass	70%	40%
• High mass	10%	50%

The information therefore entered into the Data entry screen is illustrated in Figure 31 for the dry recyclables assessment and Figure 32 for the residual waste assessment.



DESCRIPTION OF SCENARIO

Assessment description: Kerbsider box collection, and bulking - alternative week collection.

Identifier: Worked example 2_1

Time period: 1 year

Collection area: Hypothetical town

SCENARIO INPUT DATA

Number of households: 10000

Mass of waste /recyclables [tonnes]: 1700

Number of collections per household: 26

DISTRIBUTION FACTORS

Housing density

Density	Proportion
High	0.2
Medium	0.7
Low	0.1

Set-out rate

Housing density	Set-out
High	0.6
Medium	0.6
Low	0.5

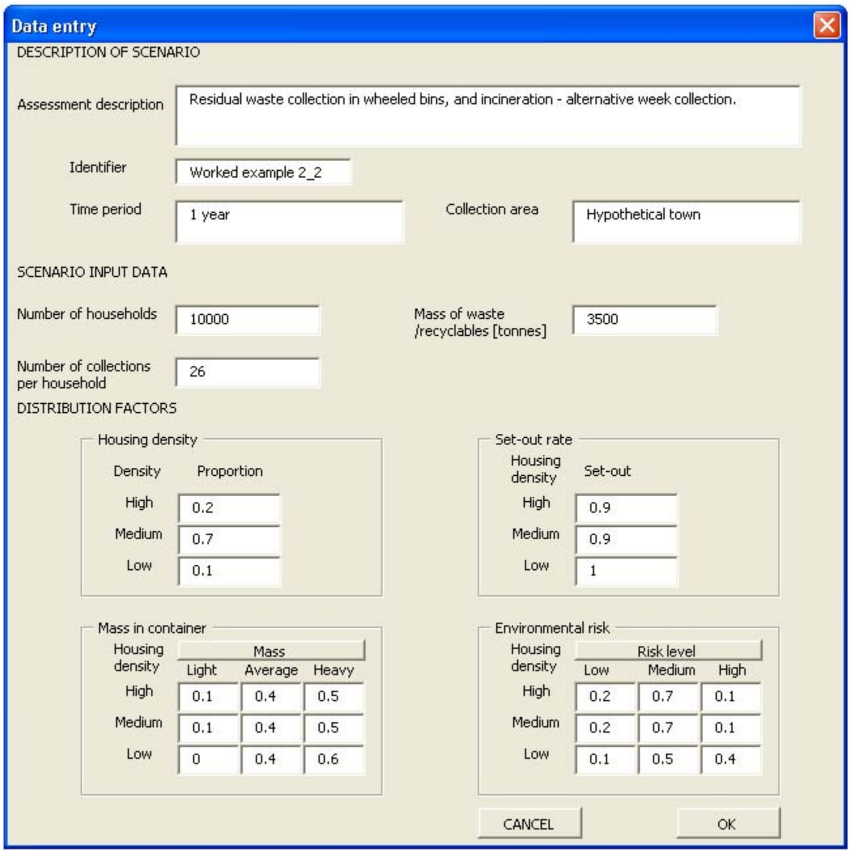
Mass in container

Housing density	Mass		
	Light	Average	Heavy
High	0.2	0.7	0.1
Medium	0.2	0.7	0.1
Low	0	0.8	0.2

Environmental risk

Housing density	Risk level		
	Low	Medium	High
High	0.2	0.7	0.1
Medium	0.2	0.7	0.1
Low	0.1	0.5	0.4

Figure 31 *Data entry* screen for Example 2 – dry recyclables



DESCRIPTION OF SCENARIO

Assessment description: Residual waste collection in wheeled bins, and incineration - alternative week collection.

Identifier: Worked example 2_2

Time period: 1 year

Collection area: Hypothetical town

SCENARIO INPUT DATA

Number of households: 10000

Mass of waste /recyclables [tonnes]: 3500

Number of collections per household: 26

DISTRIBUTION FACTORS

Housing density

Density	Proportion
High	0.2
Medium	0.7
Low	0.1

Set-out rate

Housing density	Set-out
High	0.9
Medium	0.9
Low	1

Mass in container

Housing density	Mass		
	Light	Average	Heavy
High	0.1	0.4	0.5
Medium	0.1	0.4	0.5
Low	0	0.4	0.6

Environmental risk

Housing density	Risk level		
	Low	Medium	High
High	0.2	0.7	0.1
Medium	0.2	0.7	0.1
Low	0.1	0.5	0.4

Figure 32 *Data entry* screen for Example 2 – residual waste

For the dry recyclables aspect, the following components were selected:

- Collection: Assembling of collection crew at start of shift
  Driving from location to location
  Getting in and out of cab
  Collect and box return (kerbside box)
  Sort and empty kerbside box (at Kerbsider)
  Walking to and from collection point
  Operating vehicle machinery (Kerbsider hopper empty)
- Bulking: Inward vehicle movements (Kerbsider)
  Unloading vehicle (Kerbsider)
  Loading lorries
  Onward vehicle movements
  General housekeeping
  Maintenance

For the residual waste collection, the same components as with Example 1 were selected.

No advanced options were selected. Each scenario would have to be run separately, producing two assessments. The overall risk is then the sum across the two assessments.

APPENDIX A IDENTIFICATION OF SYSTEMS FOR COLLECTION, TRANSFER, TREATMENT AND PROCESSING OF WASTE AND RECYCLABLES

A1 INTRODUCTION

The present appendix describes the work carried out for the first work package. In order to provide Local Authorities (LAs), and others, with guidance to select the optimum systems from a health and safety perspective, whilst meeting environmental targets, it is first necessary to identify what systems are currently in existence. This offers a means of understanding the present conditions under which the waste management industry operates. Thus, the objectives of Work Package 1 are as follows:

- Identify the full range of systems for collection, transfer, treatment and processing of household waste and recyclables, currently in use, and likely to be available in the future in the UK;
- Categorise the systems identified, making use of any existing industry classification schemes; and
- Determine a representative set of generic systems for detailed consideration in subsequent work packages.

A1.1 SCOPE

The scope of the present work package included consideration of the full range of existing and possible future systems for reuse, recycling, composting, recovery and disposal of household waste and recyclables. The following activities / operations were therefore within scope:

- Kerbside waste and recyclables collections;
- Household Waste Recycling Centres;
- ‘Bring bank’ sites;
- Bulky waste collections (e.g. furniture etc.); and
- Hazardous household waste collection.

The following elements were agreed to be outside the scope of the project:

- Collection of clinical household waste;
- Consideration of health and safety risks to individuals other than employees (e.g. members of the public); and
- Consideration of risks other than those to health and safety (e.g. environmental risks).

It should be noted that whilst the full waste life cycle is within scope of the project, most effort is focused at the collection and sorting phases, although later parts of the life cycle are still considered in some detail. The rationale for this approach is that most of the accidents occur at the front-end of the system, where most of the employees in the industry work. There is also greater variability and scope for choice with regards to the type of systems adopted with the collection and sorting phases, in comparison to later stages of the process.

A1.2 STRUCTURE OF APPENDIX A

The remainder of this appendix is structured as follows:

- Section A2 describes the methodology for collection and collation of information;
- Section A3 provides a broad overview of the entire system by which household waste and recyclables are collected, transferred, treated, processed for recycling, reuse or disposal;
- Section A4 covers systems for collection of waste and recyclables in more detail, focusing on kerbside collection, collection from areas of high housing density, and static collection facilities;
- Section A5 details transfer and sorting systems, discussing transfer stations and materials recycling facilities;
- Section A6 describes the broad range of processing methods, including recycling of paper, glass, metal and plastic, as well as composting and reuse of materials;
- Section A7 discusses energy recovery from incineration and anaerobic digestion;
- Section A8 considers disposal of waste through landfill;
- Section A9 highlights alternative technology in emerging systems for waste and recyclables management; and
- Section A10 recommends systems for further consideration in the later work packages.

A2 METHODOLOGY

A2.1 INFORMATION COLLECTION

A variety of sources were utilised in order to gather information on waste and recyclables systems in use or under development, as required to fulfil the objectives for Work Package 1. In order to ensure comprehensiveness of data collection, no restrictions were placed on the type of sources used to obtain information. The information was obtained through a variety of channels, including email and telephone contact, telephone and face-to-face interviews, and electronic literature searches. The following list describes the breadth of information sources utilised:

- ***Literature search*** – a search of relevant databases yielded 318 articles (see Annex A1 for search terms and databases used). Consideration of the abstracts identified 45 articles for further detailed study. The literature reviewed was drawn from a wide range of sources, including contributions from peer-reviewed academic research, policy documents, as well as environmental, safety, and public administration periodicals. International material was translated as appropriate. Findings from the literature review are amalgamated within the body text of the report where appropriate.

- ***Project Advisory Board members*** – members of the Project Advisory Board were contacted to request information regarding their personal knowledge of systems in use or under development, potential further contacts and key references. These individuals were useful sources of information, given their extensive knowledge of the industry and the range of schemes in operation throughout the UK.

- ***Industry representative bodies*** – these sources were identified as potentially useful for the purposes of information gathering, given their position within the industry. Information gathering meetings were arranged with personnel from the Waste and Resources Action Programme (WRAP) and the Chartered Institution of Wastes Management (CIWM). Contact was also made with staff from other government bodies, such as the Department for Environment, Food and Rural Affairs (DEFRA), and not-for-profit organisations, such as Ealing Community Transport (ECT), Tower Hamlets Community Recycling Consortium (THCRC), and the Community Recycling Network (CRN).

- ***Local Authorities*** – views were obtained from relevant staff within a sample of 18 Local Authorities (LAs) regarding the systems they currently operate for waste and recyclables management (see Annex A2 for full list). An initial request for information was made to a large number of LAs via the HSE extranet. Contacts provided by members of the Project Advisory Board were also utilised. The LAs sampled represented a good mix of rural, suburban and urban housing densities, and geographical locations and sizes, to ensure that the variety in system types utilised was captured adequately. In addition, selected results from a 2005 WRAP survey of LA collection systems were used to provide further details about systems operated by those LAs not contacted directly.

- ***Industry project team members*** – the HSL project team also incorporated industry personnel from Premier Waste and Veolia Environmental Services, formerly known as Onyx. These individuals were contacted to elicit further descriptions of the systems they currently operate. Contact was also made with personnel from other private sector companies outside of the project team, such as Biffa and Viridor.

- ***DEFRA waste implementation team*** – in order to gather information about potential new technologies in the waste and recycling field, the DEFRA waste implementation team was contacted. This provided information on a range of new waste treatment technology companies that had applied for DEFRA funding to produce pilot plants to demonstrate their viability.

- ***Health and Safety Laboratory staff*** – in order to draw on existing expertise within HSL, a number of relevant personnel from outside the project team were contacted. This provided additional theoretical and practical input regarding health and safety within the waste and recycling industry.
- ***Internet searches*** – searches of the Internet using topic related keywords were performed to ensure that additional information, not gained from the above sources, was not overlooked.

A2.2 INFORMATION COLLATION

A2.2.1 Existing industry classification systems

Given the vast amount of information collected and the wide range of potential systems available, it was necessary to consider the manner in which to structure the information in the most usable and clear format. Initially, efforts were made to identify and utilise any existing industry classification systems. At present, as far as the project team were able to determine, there are no recognised industry standards for classifying systems in existence within the UK.

In lieu of industry classification, the pyramid structure used within the waste hierarchy (see Section 1.1 of the main report) was considered to offer the most widely recognised industry description of waste management options within the information obtained. Therefore, efforts were made to draw upon relevant elements of this hierarchy, with respect to the latter stages of the reuse, recycling, energy recovery and disposal, as a means of categorising the information obtained.

The HSL project team also collaborated with personnel from Waste and Resources Action Programme[9] (WRAP) in deciding how to structure the information obtained. WRAP are also in the process of producing a classification scheme, albeit with a focus on performance and cost variables rather than health and safety, although there still existed a considerable degree of overlap between the two projects. This process helped to ensure a degree of consistency and industry agreement in the approach and terminology used.

A2.2.2 Classification of system information

In order to represent and categorise the wide range of schemes in operation throughout the UK in the most usable manner, it was decided to produce a series of high-level flowcharts, detailing the flow of waste and recyclables from start to finish as described above. A pictorial representation of the information was considered to be more accessible, allowing the reader to follow through the sequence from collection to endpoint as desired. The flowcharts could then be supported by supplementary text, adding contextual richness to the overview, and ensuring that important factors influencing each system element were not overlooked.

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[9] *WRAP (Waste & Resources Action Programme) was established in 2001 in response to the UK Government's Waste Strategy 2000 to promote sustainable waste management. WRAP's initial programmes of work concentrated on creating stable and efficient markets for recycled materials and products for the 100 million tonnes of waste accounted for by commercial, industrial and municipal waste.*

A2.2.2.1 System start and end points

In classifying the systems available for waste and recycling management, it was important to clearly define the start and end points.

Consensus exists within the information collected that the start point for any system should be the point at which the material becomes waste, in accordance with the following EU definition: "Waste is any substance or objects that the holder discards or intends to discard or is required to discard" (EU Directive 75/442/EC). It should be reiterated however, that the present project is focusing solely on household waste.

Discerning a suitable end point for the waste / recyclable in each system was more difficult, as this is open to individual interpretation. After discussion with a number of stakeholders, it was agreed that for the purposes of the present work package, the system end point occurred either when:

- The recyclable had been processed into a raw material (i.e. where it becomes ready to be remade into a product again); or
- The waste had been processed in either incineration or landfill.

A2.2.2.2 Elements within the system

Five key system stages were identified within the life cycle of waste and recyclables, which form the backbone of the classification, and consequently the present appendix. The last three stages of the classification follow the bottom levels of the pyramid outlined in the waste hierarchy, as a means of promoting consistency with a format acknowledged in industry. Whilst not included in the waste hierarchy, the first two stages demand inclusion and consideration, as these represent the means and format in which the waste reaches the later stages.

The five stages are detailed below, with examples of the types of activities that fall within each stage.

1. Collection (kerbside collection, static facilities)
2. Transfer and Sorting (bulking facilities, Materials Recycling Facilities)
3. Processing (reuse, recycling, composting)
4. Energy Recovery (incineration with energy recovery, anaerobic digestion)
5. Disposal (landfill)

These stages should not be viewed as discrete entities, rather as different foci of parts of the same *overall* large system of waste and recyclables management, due to the significant degree of overlap. Also, it should be understood that the above list does not necessarily reflect the sequence in which the waste or recyclables move through the system. For example, for certain waste types, the 'collection' stage may be directly followed by 'disposal', avoiding the interim stages.

A2.2.2.3 Types of waste

Where appropriate, the five key stages were further broken down by type of waste, as the different types of waste can follow different paths through the system, diverging and converging at various points. Therefore, it is not necessary to detail the progress of each type of waste at every single point in the overall system as there may be commonalities within a system for a number of similar waste types. For example, use of the generic term 'dry recyclables' rather than distinguishing between paper, plastic, and so forth. In order to structure the classification, waste has been separated into 6 discrete categories devised in agreement with staff from WRAP:

- ***Dry recyclables*** – resources collected for recycling, such as paper and cardboard, aluminium and steel cans, glass, plastic, scrap metal, and textiles;
- ***Residual household waste*** – common waste generated by homes that remains after diversion programs have been used to remove recoverable materials;
- ***Food waste*** – uneaten food and food preparation wastes from residences (raw and cooked);
- ***Garden waste*** – organic waste such as grass clippings, tree cuttings, leaves etc which arise from gardens;
- ***Bulky household waste*** – large, hard to handle waste items, including furniture, white goods, such as fridges, and brown goods, such as televisions;
- ***Hazardous household waste*** – any material discarded by a household which is difficult to dispose of or which puts human health or the environment at risk because of its chemical or biological nature; such as batteries, oil, paints, and asbestos.

A2.2.2.4 Caveats of the classification system

It is important to underscore the point that the significant degree of possible variations identified within system elements means that they do not easily lend themselves to “classification” per se. The systems identified are frequently multidimensional entities, particularly as regards collection, which result in a myriad of paths through from start to finish.

As there is considerable scope for variability regarding all system stages, it can be difficult to try to convey the individual contexts in which LAs and private companies are operating. Therefore, although this report has endeavoured to cover as much as possible, it is acknowledged that certain atypical operations may have been omitted.

Lastly, particularly toward the end of the waste and recyclables life cycle, there is a tendency for processing and disposal methods to constitute highly technical scientific procedures. A detailed discussion of these processes is neither of relevance to or within the scope of the current report. The emphasis is placed on the earlier collection and sorting systems, reflecting the greater occupational risk inherent in these stages. Therefore only a simple overview of each processing and disposal method has been provided, to ensure completeness of the classification system.

A3 CURRENT SYSTEMS OVERVIEW

Figure A1 below provides a broad overview of the *entire system* by which household waste and recyclables are collected, transferred, processed for recycling or reuse, or disposed of. The various pathways through the system reflect the different types of waste / recyclables produced initially by the user.

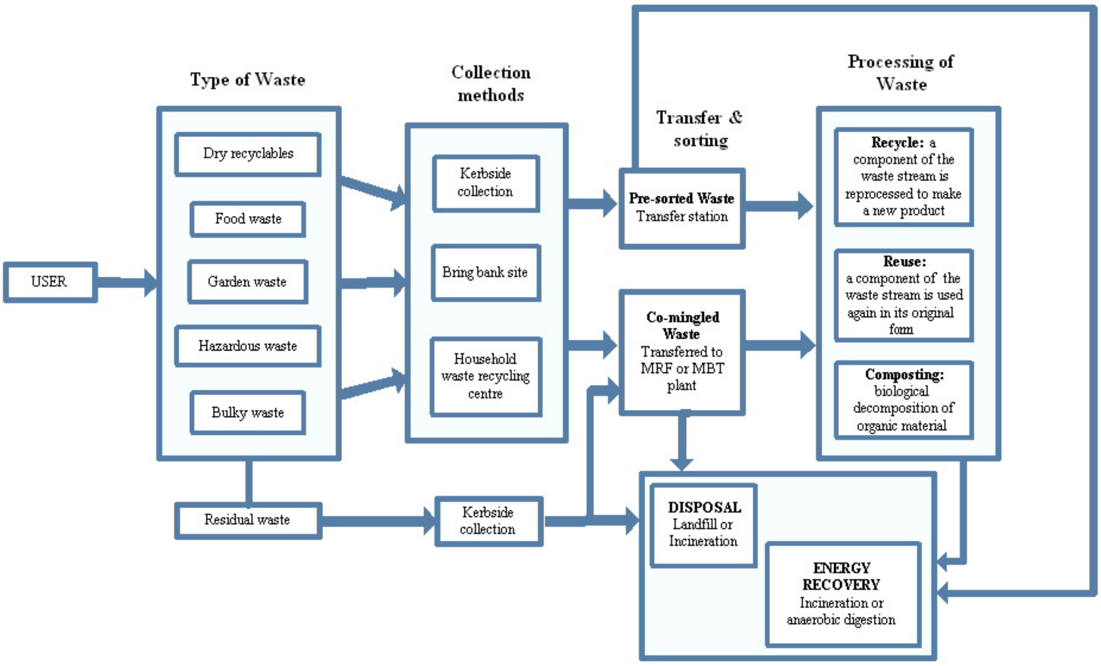


Figure A1 Entire waste and recycling system overview

The structure of the information collated in the report considers the five main system stages as detailed previously: collection, transfer and sorting, processing, energy recovery and disposal. The variation within specific stages of each system with respect to type of waste, and other potentially influential factors are also described.

A4 COLLECTION

A4.1 INTRODUCTION

Those Local Authorities charged with the responsibility for kerbside collection of household waste within its area are known as Waste Collection Authorities (WCAs). There are 376 WCAs in England and Wales who are responsible for collecting waste from nearly 22 million homes and some businesses (Reference 6). The majority of this collection activity is in the form of kerbside collection (see Section A4.2), although in some instances WCAs are required to collect from difficult to access properties, such as high-rise flats, where different collection systems are required (Section A4.3). LAs also provide static facilities, such as ‘Bring Banks’ or Household Waste Recycling Centre sites, to which members of the public can deliver surplus household waste and recyclables to directly (Section A4.4). Collection activity may be performed by in-house LA collection teams, external companies under contract to the LA, or community not-for-profit groups.

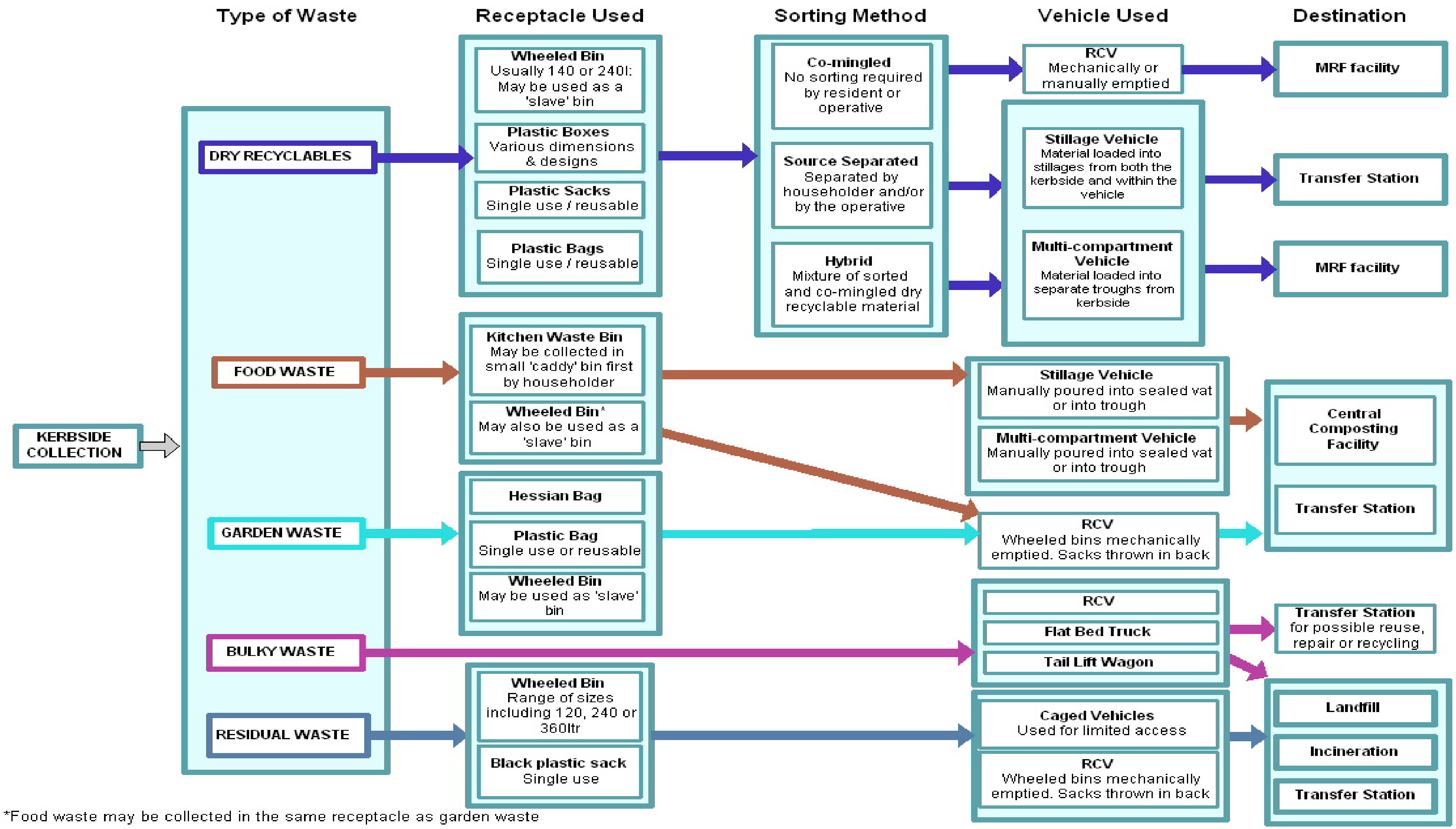
Waste Disposal Authorities (WDAs) are those LAs responsible for the management of the waste collected and delivered to it by constituent collection authorities. As part of this responsibility, the WDAs manage Household Waste Recycling Centre sites. In unitary authorities, the LA performs both collection and disposal functions. The processing and / or final disposal of the waste is usually contracted to the private sector waste management industry.

There are many reasons for LA selection of a particular type of collection infrastructure. The amount and composition of waste gathered in collection schemes can vary dependent on a number of factors including seasonality, temperature, climate, local geography and land use, method and location of disposal used by the authority, demographics, ethnicity and culture, housing type, socio-economic factors and type of current services provided (Reference 7). These factors may be reflected to some degree in the adoption of different collection systems by LAs, which must be appreciative of local conditions, in terms of housing type, accessibility and storage space, and the context in which the collections are taking place. However, it is likely that the main drivers behind collection system choice are practicality, percentage of recycling required, and cost of system implementation and maintenance.

A4.2 KERBSIDE COLLECTION

Figure A2 overleaf provides a non-specific overview of the stages commonly involved in the kerbside collection systems of various types of waste from the householder, whilst the following overview attempts to capture some of the scope for variation. It should be noted that hazardous household waste has not been included in the flowchart, due to the scarcity of kerbside collection schemes in operation to receive this type of waste.

Despite variation, all kerbside collection systems are common in that they employ operatives to collect receptacles of waste or recyclables, transfer them either directly or indirectly into a collection vehicle, and transport them to another location. Kerbside collection is defined as “the removal of waste and recyclables from the roadside edge, i.e. at the property boundary” (Reference 7).



*Food waste may be collected in the same receptacle as garden waste

Figure A2 Overview of kerbside collection systems

A4.2.1 Specific variations in collection system by type of waste collected at kerbside

A4.2.1.1 Residual household waste

Receptacle used**:** At present, residual waste is primarily collected in plastic wheeled bins, commonly 240 litre capacity, but in a range of sizes including 120 l, 140 l, 240 l and 360 l capacity depending on the number of residents in the household (over 5 people commonly means entitlement to a larger 360 l bin, or an extra 240 l bin). As an alternative, some LAs still operate a black plastic sack collection. In some rare instances, the old-style of round non-wheeled dustbin without sacks may still be used.

Loading method**:** Wheeled bins are mechanically emptied into refuse collection vehicles (RCVs). Plastic sacks are commonly physically thrown into the back of an RCV by collection operatives, or may be loaded into an intermediate 'slave' wheeled bin, which is mechanically lifted and emptied into the RCV once full. In some LAs, a mixed collection of bins and sacks is performed. Where properties still have old-style round non-wheeled dustbins, householders are asked to put their plastic sacks out for collection in the dustbin, which acts as a store for the sacks, whilst being filled. During collection, the sacks are then removed from the dustbin and thrown into the back of the RCV, rather than manually lifting and emptying the whole dustbin. For a more detailed discussion of the handling issues relating to residual waste collection, with particular reference to musculoskeletal disorders, the reader is referred to Reference 9.

Vehicle used**:** Rear-loading RCVs with packer plate compaction facilities are most commonly used to collect the residual household waste. Also used in some examples are top-loading compartmental vehicles, which have several separate compartments served by a bin lift. Where possible, larger tonnage capacity vehicles will be utilised, as this reduces the number of collection rounds required. In urbanised areas, where there may be narrow streets and limited space for turning, yet high waste production, RCVs may still be employed, but either with a reduced capacity, or a smaller wheel-base and higher compaction area.

In more rural settings, where access may be limited, smaller caged vehicles or transit vans may be used to pick up sacks of residual waste. The waste may either be transported directly for disposal, or be cross-loaded. This involves a rendezvous between the smaller pick-up vehicles and a larger RCV to transfer the material. Transfer occurs either manually, or in some cases, using a scissor lift to reduce manual handling requirements.

Split body vehicles are also sometimes employed, whereby separate waste streams may be loaded into separate compartments of the vehicle. This allows for simultaneous collection of waste and recyclables on the same collection round. The section split may be vertically from front to the rear of the vehicle, known as a 'Twin Pack'. Alternatively, the vehicle may have a separate section behind the cab serviced by a bin-lift, and a single section at the rear, known as a 'Duo'. Both these types of vehicles have the capacity for independent emptying of each compartment. Lastly, the 'One Pass' vehicle has a conventional refuse collection body to the rear of the vehicle, but this body is split vertically to customers' requirements. It also has a recycling box behind the cab serviced by a bin-lift.

Collection frequency**:** Waste is normally collected on a weekly basis, although some London LAs operate a twice-weekly collection system. Other LAs collect on a fortnightly basis, rotating between residuals collection one week and recyclables the next, often because there is only one collection vehicle available for that round. Alternate weekly collection is becoming more common across all housing types, with at least 100 LAs now having fortnightly collections to a greater or lesser degree.

***Destination*:** Once the collection vehicle is full, it may be taken directly to either a landfill site, an incinerator, or to a transfer station, depending on the facilities available nearby. Waste is typically unloaded through tipping from the body of the collection vehicle. Where smaller vehicles are employed, it may be necessary to manually unload the waste, although this is rare.

A4.2.1.2 Dry recyclables

There is huge variation in the details of the collection systems operated for dry recyclables between different LAs. Although capturing the minutiae of all these systems is beyond the scope of this work, they can be broadly categorised with respect to the degree to which the recyclables are segregated. There are three main types of kerbside recycling collection: co-mingled, source separated and hybrid.

Results from a 2005 survey of 353 LA dry recyclables kerbside schemes performed by WRAP suggests that around 28% of the LAs surveyed operated a co-mingled collection scheme, 59% used a kerbside sorting scheme, whilst 13% of LAs operated a partial sorting / hybrid scheme.

***Co-mingled*:** Co-mingled (or mixed) collections involve a number of different types of recyclable materials collected freely mixed together in the same container. Some LAs will not accept co-mingled glass, as this cannot be separated easily at a later point. Most commonly, wheeled bins are used, often between 140 and 240 l capacity, although some LAs also use plastic boxes, bags and single-use sacks. The boxes used can vary significantly with respect to capacity, ranging from 35 l to 70 l (most commonly 50-55 l), and design, in terms of shape and handle provision.

Wheeled bins are emptied mechanically into a rear-loading or top-loading RCV. Single use sacks may be thrown into an RCV. Boxes, and reusable bags and sacks may be emptied directly into the RCV or bulked up at a “slave” wheeled bin, before being mechanically emptied, depending on the design of the vehicles available. In some instances, a caged collection vehicle may be used, for reasons of practicality, cost, or if physical constraints do not permit access of an RCV. Once full, the vehicle transports co-mingled materials to a materials recycling facility (MRF) for unloading and segregation.

Source separated: Source separated collections involve the recyclables being separated by type of material at point of collection. In some instances, the householder sorts each recyclable into different containers provided by the LA, which are emptied into different compartments on the collection vehicle by its operatives. More commonly, the recyclables are sorted from the same receptacle by the operative at the kerbside. These are placed into different compartments on the vehicle. Again, a range of receptacles may be provided for this type of collection scheme, including sacks, wheeled bins, bags, and most commonly plastic boxes.

There are a number of different types of recycling vehicle utilised for source separation, although it should be understood that there also exists further significant variation in terms of compartment and overall capacity, vehicle dimensions, and exact loading technique (for a more detailed discussion see Reference 10).

Multi-compartmental vehicles are commonly used for sorting at the kerbside. Here, the operatives sort the different materials into specific troughs, which are mounted on to the nearside of the vehicle. On collection, each material is sorted directly into a separate compartment. Dependent on vehicle design, operatives may rest the receptacle on a ledge on the side of the vehicle, hook the edge of the receptacle over a lip on the vehicle, or support the receptacle themselves during unloading (Reference 10). Once each trough is full of recyclable, it can be emptied into the main body of the vehicle. Each compartment of the vehicle can be individually tipped at the relevant recycling facility (Reference 11).

Stillage system vehicles are commonly modified flatbed vehicles, fitted with cages or boxes. The number and size of cages carried can be varied to match the number and quantities of materials to be collected. The operatives can unload material into stillages from the kerbside, or gain access to the body of the vehicle for loading via steps (References 11 and 10). The vehicle is off-loaded at the recycling facility by means of a fork-lift truck.

Where receptacles are provided for a single stream of recyclables, an RCV may be utilised during collection. This may be a split bodied rear, side, or top loader, with separate compartments within the body of the vehicle for different recyclables. Such vehicles are well suited for segregated waste presented in wheeled bins.

Some LAs are operating schemes for kerbside source-separation recycling using pedestrian controlled vehicles (PCVs). PCVs are specially designed vehicles for collecting recyclable materials from densely populated urban areas where access can be an issue. There is a range of different PCV designs, depending on the type of collection required. Commonly, recyclables may be hand-sorted by material type into bags in different compartments fixed to the PCV. These bags may then be deposited at designated drop-off points for transfer into a larger collection vehicle, commonly either by manual handling or using a Hi-ab lift.

***Hybrid*:** Hybrid collection involves a mixture of separated and co-mingled dry recyclable material. Here, there exists a huge scope for variation within the combinations of receptacles used (for example: 2 bins, 1 bin and 1 bag, 1 bin and 1 sack, 2 sacks, and so forth). Commonly, plastics and cans are mingled together in the same receptacle, and emptied into the same trough or stillage on the recycling vehicle for subsequent sorting at an MRF (see Section A5.2). The same types of vehicles as outlined above are utilised, depending on the particular receptacles used.

***Collection frequency*:** Frequency of kerbside collection of dry recyclables varies considerably, with LAs offering a weekly, fortnightly or monthly collection. The most common collection is fortnightly, reflected in 72% of the 353 LAs responding to the WRAP survey, with weekly being the second most common (24%). This variation is liable to reflect density of housing, size of receptacle provided, and other types of collection scheme offered by the LA. Collections are typically performed on the same day of the week as the residual waste collection, to increase the likelihood that householders will participate.

A4.2.1.3 Garden waste

***Receptacle used*:** Biodegradable waste is one of the heaviest fractions to collect. Several methods can be utilised, with wheeled bins being the most commonly used. Primarily normal 240 l capacity wheeled bins are utilised, although in some instances these may be aerated to help initiate the composting process. Mainly, these are mechanically emptied into rear-loader RCVs. These RCVs may have a screw plate compaction system in order to break up the waste and aid the subsequent composting process.

In some instances, single use sacks or bags are provided for collection, often made of paper, or biodegradable plastic. Alternatively, reusable sacks made from Hessian or polypropylene may be supplied to householders. Such receptacles are either manually loaded directly into the back of an RCV, or consolidated in a ‘slave’ wheeled bin, prior to mechanical emptying.

Collection frequency**:** There exists a significant degree of variation with regard to collection frequency of garden waste depending on the season (more frequent collections are made during summer months) and also how many households have gardens within the collection area (collections may not be required in highly urbanised areas). Some LAs collect garden waste all year round, others only for 8 months, and yet others not at all. Commonly, collections are fortnightly.

Collection charge**:** Some LAs may ask for a fee for collection of bulky items of garden waste, although this is not normally required for wheeled bin or bag collection due to the likely detrimental effects on participation rates. Charging can be used as a mechanism to decrease the amount of material presented and to help cover collection costs. Free collections can result in excessive amounts of garden waste being collected.

A4.2.1.4 Food waste

Receptacle used**:** Food waste may be co-mingled in the same receptacle as garden waste, normally a 240 l wheeled bin, although 120 l and 180 l bins were also identified. Alternatively, there are a small, but growing number of schemes encouraging the householder to separate the food waste, through provision of a smaller lidded kitchen waste bin. These vary in capacity from 20-55 l, with most being towards the lower end of the scale. In addition, some LAs also provide a small (5-10 l) ‘caddy’ bin, which householders keep in their kitchen to scrape food waste into. Once this receptacle is filled, the householder transfers it into a larger kitchen waste bin, which is left at the kerbside for collection.

Loading method**:** Wheeled ‘biodegradable’ waste bins are typically mechanically emptied into rear-loading RCVs. During collection of specific kitchen waste receptacles, these may be manually emptied into an intermediary ‘slave’ wheeled bin, which once full is emptied into a specific sealed compartment on a collection vehicle. As an alternative, these containers may be manually poured directly into this compartment of the recycling vehicle.

Vehicle used**:** Rear-loading RCVs will be used if food waste is collected in the same wheeled bin as garden waste. Where specialised kitchen waste receptacles are provided, these may be emptied into a stillage vehicle (possibly requiring the operative to climb inside the vehicle to unload) or a specific trough on a multi-compartment vehicle from the kerbside (which when full tips into a larger main compartment). Compacting vehicles are not required in this instance due to the dense nature of the material being collected.

Collection frequency**:** Separate food waste collections are usually weekly. If co-mingled with garden waste, the collection frequency is either weekly or fortnightly, with a fortnightly collection the more common option.

Destination**:** The type of biodegradable waste collected will depend upon available treatment facilities within or near to the LA. If solely garden waste is collected, it will typically be taken to a centralised composting facility, for use in an open windrow composting procedure[10] (see Section A6.8.1). However, should food waste be included within the collection, the material collected is unsuitable for this type of composting, because of the Animal By-Products Regulations 2003 (Reference 12) requirements to inactivate potential pathogens, and therefore must be composted in-vessel instead (see Section A6.8.3).

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[10] *Historically this has been the case, but since the 250 m rule from the Environment Agency on distance to receptors more composting is being carried out in-vessel (undercover).*

A4.2.1.5 Bulky household waste

For collection of bulky household waste, such as furniture and white goods, householders are normally required to leave any bulky waste they wish to dispose of at the edge of their property boundary for collection, although some LAs offer a service of collecting bulky items from within the property. Some LAs may ask for a supplementary fee for collection of bulky household waste items.

The bulky waste is usually collected using a flatbed truck or box van. It may either be manually handled into the vehicle, or more commonly positioned through using a tail-lift. If in good condition, items such as furniture and white goods may be taken onward for reuse, repair or recycling. Items unfit for these purposes, or other waste, is taken for landfill or incineration. In this case, the waste may be loaded directly into the back of an RCV, dependent on vehicle design (such as the height of lifting chairs), or into a caged vehicle if access is restricted.

A4.2.1.6 Hazardous household waste

Hazardous Household Waste (HHW) consists of a range of unusable or unwanted consumer products containing many of the same chemicals found in industrial hazardous waste. HHW includes paints, oils, batteries, household cleaners, DIY and garden chemicals, automotive products, batteries, and fluorescent lights (Reference 13).

There are relatively few LA kerbside collection schemes in operation for items of HHW; hence householders bring most HHW to Household Waste Recycling Centre sites instead (see Section A4.4.2). Community and voluntary groups run many of the existing collection schemes. Some examples identified include ‘Community Re>Paint’, which aims to divert unwanted, surplus paint from the waste stream, offers some kerbside collections in certain areas. In a few instances, LAs collect household batteries from the kerbside as part of multi-material kerbside collections (Reference 14). Special bags may be supplied for this purpose, to allow collection alongside other recyclable materials. WRAP is currently running pilot collection schemes in the UK. Large items of household hazardous waste can also be collected through prior arrangement with the LA.

A4.2.2 Assisted collection services

In certain instances where LAs assess that it is required, householders can arrange to have their waste and recyclables picked up by collection operatives directly from their doorstep (front or back door). This type of collection is commonly available from property inhabited by elderly, infirm or disabled householders who are unable to take their waste receptacle to the kerbside. These schemes are available for both the collection of residual household waste in wheeled bins and for receptacles of recyclables. Where a box service is provided the level of assisted collections can be higher than that for wheeled bin collections because of the additional difficulty some householders have lifting boxes.

A4.3 COLLECTION FROM AREAS OF HIGH POPULATION DENSITY

In heavily urbanised areas, with a high population density, there are often different systems in place for collection of waste and recyclables. For example, collection systems for high and low-rise flats, houses of multiple occupancy, and housing estates, are constrained by difficulties in accessing the property with conventional collection vehicles. Thus, the logistics of collecting materials are likely to be more challenging than in areas of street level housing. A brief overview of the types of collection systems used is provided in Figure A3.

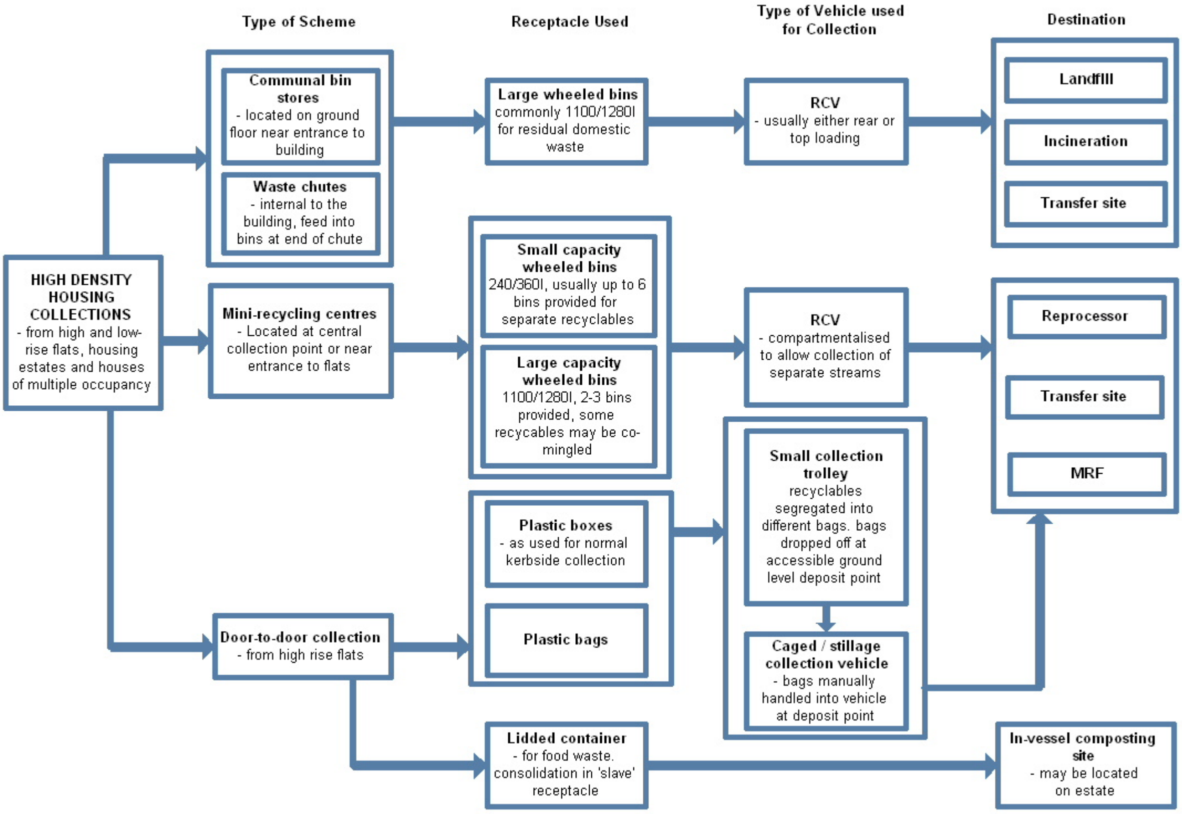

Figure A3 Overview of high-density housing collection systems

A4.3.1 Communal bin stores

At blocks of flats, it is obviously unsuitable to provide individual wheeled bins for each householder for residual waste collection. Therefore, larger communal receptacles are often provided to service multiple residents for residual household waste, in what are known as communal bin stores. The communal bin stores are commonly located on the ground floor, often outside the building to allow best access for collection operatives.

A number of large wheeled bins are normally provided, varying in size from 360 l through 660 l to 1200 l. The size, design and quantity of bins is dependent on the number of householders being catered for, the collection vehicles available, and the design of the bin store in which they are located (Reference 9). The bins are emptied at an appropriate service interval, most commonly weekly. Most commonly, a rear-loading RCV will be utilised, although in some cases an overhead lift vehicle may be used if there is sufficient space.

A4.3.2 Mini recycling centres

For collection of recyclables, the same logistical collection difficulties apply when collecting from areas of high population density, hence a range of alternative systems have been implemented (Reference 15).

Most commonly, clusters of bins, known as mini-recycling centres, may be provided for specific types of recyclables for householders to fill. The mini-recycling centres may either be located at central collection points on land forming part of the housing development, or located close to the entrance, inside or outside, of individual blocks of flats, or in the basement (in a similar location to the communal residual waste bin stores). Health and safety requirements, space constraints and other demands on available space, vehicle access, existing refuse collection provision, convenience, security, and noise are all factors commonly taken into account in selecting a location for the mini-recycling centres.

Receptacles used**:** There is a large degree of variation with respect to the number and size of containers provided, depending on how many different streams the householders are expected to separate the recyclables into, and the number of flats catered for. Where smaller 240 l or 360 l wheeled bins are provided, there may normally be up to 6 different bins for different recyclables, sometimes placed within a locking framework to minimise the likelihood of vandalism. Alternatively, 2-3 larger wheeled 1100 l or 1280 l bins may be provided, some for separate recyclable streams, and others for co-mingled recyclables, generally locked to purpose built walled or fenced hard standing bays. In some schemes identified, residents are provided with the means to carry their recyclables to the mini-recycling centre, such as boxes, reusable plastic sacks, or bags, often with handles for ease of transport.

Collection method**:** For central and near-entrance containers, the priority is to collect efficiently while avoiding overflows. Such containers are often emptied upon request or when full. Often contractors seek the cooperation of caretakers or cleaners who monitor the recycling containers and inform the contractor when they require collection.

Most commonly, bins of recyclables are mechanically emptied into RCVs, if space is available. The 240 l and 360 l bins may be emptied into a compartmentalised top, side, or rear loader, allowing multiple recycling streams to be transported simultaneously. The 1100 and 1280 l bins are often rear loaded onto a [modified] RCV. In one LA-operated scheme, containers are lined with removable, reusable woven sacks. On collection, the full sacks are winched from the bins using a crane-equipped flatbed truck, without moving the bins. The bins are then relined with empty sacks.

Following collection, materials are taken to either a transfer station, MRF, or direct for reprocessing.

A4.3.3 Door-to-door collection schemes at flats

A small number of innovative door-to-door collection schemes for recyclables have been introduced in LAs with a high proportion of residents living in flats, in order to help to achieve recycling targets. Door-to-door collections are defined as collection of materials from individual households within blocks of flats where residents place materials at their front door (Reference 3). In terms of convenience, door-to-door collection is in effect providing a kerbside equivalent system to residents living in flats. Generally, door-to-door collection schemes are operated either by LAs or through community enterprises. A brief overview of some of the typical systems identified is provided below, with the predominance of London-based schemes reflecting the higher prevalence of high-rise flats in this city.

In one London Borough (LB) door-to-door scheme delivered by a community recycling enterprise, residents are asked to set out recyclable material in standard kerbside boxes at their doorstep on a weekly collection day. Collection operatives pass through each block, manually emptying the box contents into durable woven bags. The bags are transferred to street level by lift or, where necessary, by stairs. Here they are deposited for manual loading onto a larger cage or stillage collection vehicle, for subsequent transfer to a local sorting and bulking facility (Reference 15).

In another LB door-to-door scheme, residents are asked to leave material in small-sized ‘consolidation’ bags. These are sorted at source by recyclable type into a multi-compartment trolley by operatives. Once each compartment is full, it is emptied into the main body of the trolley. When the trolley is full, it is taken to ground floor level via the lift, and then the separate bags of recyclable are removed and deposited at set points around the estate. These are manually handled into a larger capacity vehicle, which is able to access the deposit location (Reference 15).

A door-to-door collection scheme specifically providing recycling services for elderly people has been introduced in one LB. In an effort to assist elderly people to participate in recycling, and to avoid problems of vandalism, a small-scale door-to-door collection has been initiated on one estate where nearly 20% of the dwellings constitute sheltered warden-assisted accommodation for elderly people. Baskets set out by residents are emptied into bulk recycling containers already sited on the estate by cleaners (Reference 15).

Currently two LBs operate biodegradable waste collection schemes at blocks of flats. For food waste, residents are provided with a small, lidded container, a biodegradable liner and bags of flakes containing micro-organisms, which they mix with the food waste. This slows the putrefaction process and prevents unpleasant odours from developing. All food waste collected from the estate is composted on-site using an automatic in-vessel composting facility. Cardboard, which is also collected from residents, is added to enhance the carbon content (Reference 15).

A4.3.4 Residual waste chutes

Some blocks of flats have waste chutes built into the core of the building. Residents place sacks of residual waste into the chute, located on their corridor, which falls down into large open [Palladin] bins located at the end of the chute. These are usually managed by a building caretaker, and are emptied either on a regular basis, or once full. A rear-loading or front-loading RCV will commonly be used to service these bins.

Recycling chutes were not used to collect recyclable waste by any of the LAs surveyed, although the feasibility of modifying existing refuse chutes to accommodate the separate collection of recyclables has been investigated. At least one authority has considered modifying chutes to accept sealed bags of co-mingled recyclable material for subsequent sorting. Others have considered electronic adaptations of chute systems in which push buttons at each chute hopper would control either a segmented bin on a turntable or a nozzle fitted to the end of the chute, hence different materials could be directed into appropriate containers. Costs associated with undertaking the work, and maintenance, reliability and management issues have so far precluded any trials or installations.

A4.3.5 Inclusion in existing kerbside collection schemes

It should also be noted that in many LAs that have a high proportion of flats, a proportion of flats may be included in existing kerbside collection schemes. Approaches to assessing which types of flat are suitable for kerbside collection vary widely and each LA adopts an approach to fit in with existing collection infrastructure and capacity. Guiding factors in determining kerbside provision include number of units per block, total number of floors within blocks of flats, or the floor level of the individual flat. Where kerbside collection was suitable, residents are provided with reusable or sacrificial sacks, bags, or a box which can be presented for collection at the kerbside, depending on the scheme.

A4.4 STATIC COLLECTION FACILITIES

A4.4.1 Bring banks

Bring banks are facilities provided by LAs for householders to deposit recyclable materials into separate containers at centralised recycling collection points. They are, in essence, larger versions of the mini-recycling centres described previously. Materials collected vary to include all or some of the following: paper, glass (usually separated, although can be mixed), cans, plastics including bottles, clothes and textiles, shoes, compostable green waste, wood, engine oil, batteries, metals, and tetra-pack containers.

Bring banks are commonly located in convenient and accessible locations, such as car parks at supermarkets, community centres, pubs, leisure centres and other public areas. Although owned by LAs, external contractors often service the sites. Figure A4 below offers a generic description of the system stages within bring bank sites.

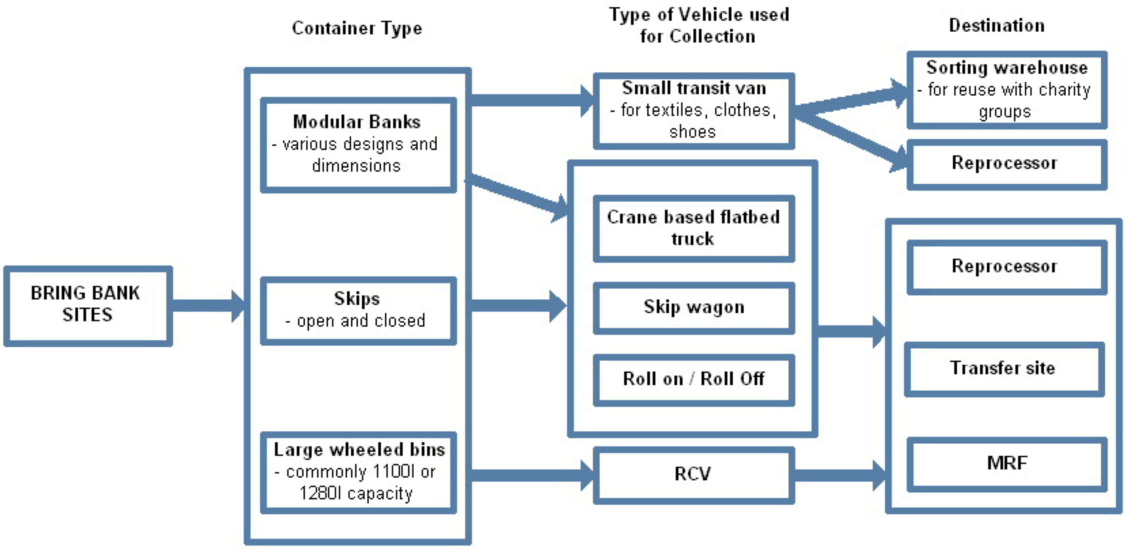

Figure A4 Overview of system stages at bring banks

Receptacles used: The receptacles, or banks, used can vary considerably from site to site, depending on the type and range of recyclables collected. Commonly available are large, modular or bell-shaped banks with apertures to slot the recyclable through. In some designs, these banks contain 1280 l wheeled bins, into which materials feed directly. Large, enclosed rectangular metal or plastic containers, often with an operable drawer to insert material are also typical. In some instances, separate large wheeled bins with 1100 l or 1280 l capacity, or skip containers may be available.

Collection method: Once full, the large enclosed banks of recyclables are commonly removed either using a skip wagon, a crane-equipped flatbed truck, or a roll-on roll-off with cable hooks to lift the full container and replace it with an empty one. In some cases a large fine net or propylene sack is placed inside some of the receptacles, which is removed on emptying using a hook lift, rather than moving the whole container. Wheeled bins are commonly tipped mechanically into rear-end loading RCVs, although front-end loading RCVs are also used on occasion for larger bins. The collected recyclables may be taken to either a transfer station, an MRF, or direct to the reprocessor.

Textiles, clothes and shoes are usually emptied from their receptacle by hand and placed in a small-sized van. These may then be transported to sorting warehouses, and / or charity shops, for pre-sorting and reuse, putting them to another use after they have fulfilled their original function. Alternatively, they may be taken to specialist textile merchants to be reprocessed into upholstery for furniture or industrial wiping cloths.

A4.4.2 Household Waste Recycling Centres

Household Waste Recycling Centres (HWRCs), or Civic Amenity sites as they are also known, are provided by LAs for the disposal of excess household and garden waste free of charge. Although often owned by LAs, external contractors frequently run them. Unlike bring bank sites, HWRC sites also cater for more bulky waste such as furniture, tyres, refrigerators, electronic products, and waste from DIY activities. HWRC sites can vary significantly with respect to size, design, types of receptacles and types of waste and recyclables that householders can bring to deposit. Figure A5 below offers a generic description of the elements within HWRC sites, and the following overview attempts to capture some of the scope for variation.

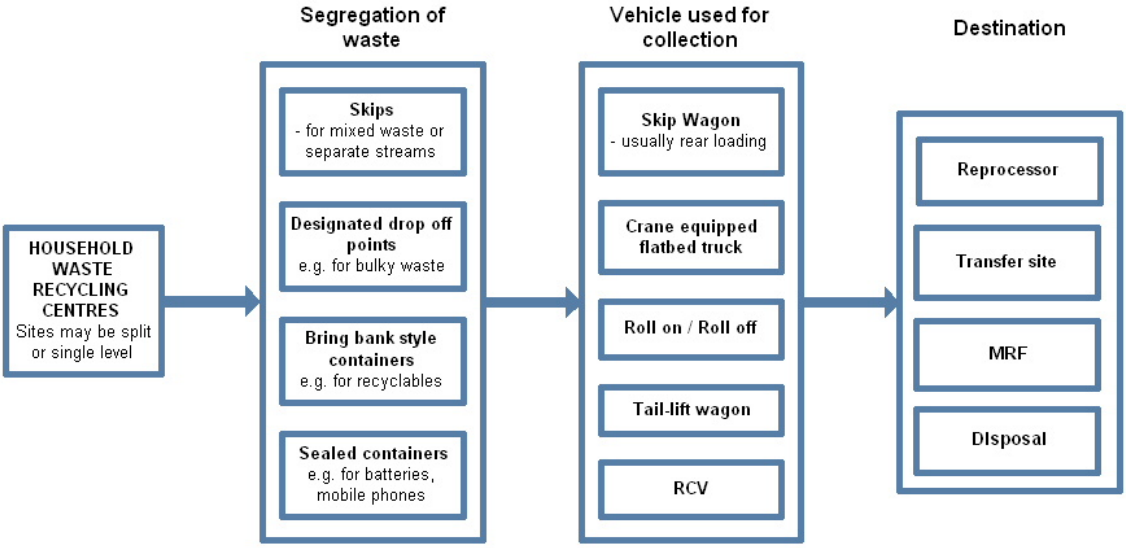

Figure A5 Overview of system stages at Household Waste Recycling Centres

***Receptacles used*:** Sites are typically operated with open skips with a capacity ranging from 10 yd^3 up to those with a capacity of 50 yd^3. These skips may be either open top, walk-in, or designed with an appropriate sized aperture for the type of waste deposited. In addition, many sites utilise smaller local collection banks (such as those described in Section A4.4.1) for textiles, bottles, cans, paper and so forth, as well as smaller waterproof containers for items such as batteries and mobile phones.

***Segregation and collection of waste*:** Some sites use very little segregation of waste, utilising skips for users to deposit mixed wastes. More sophisticated sites separate the waste stream further, where possible, by employing different skips for different types of waste, for example:

- ***Green garden waste skips*** – garden waste (such as grass, hedge and shrub clippings, old plants, weeds and leaves) collected in the designated skips is taken to composting centres or anaerobic digestion facilities.
- ***Inert waste skips*** – designated skips are provided for inert waste such as soil and rubble. This waste is taken to processing centres where it is sorted and crushed to produce fines and aggregate that can be used in landscaping and construction work.
- ***Scrap metal skips*** – designated skips are provided at some sites for small items of scrap metal.

In most sites, the various skips are typically serviced when required by using an appropriate vehicle, assisted by the site attendant during the collection operation. Some HWRC sites have overhead compaction systems that can be used to compact the material within the larger skips.

In addition to the provision of skips, many HWRC sites have areas of the site set aside (without receptacles) for householders to deposit different bulky items in a separate waste stream, for example:

- ***Furniture*** – many HWRC sites have areas set aside for the disposal of household furniture items, some of which will be bought by merchants or collected by charitable organisations. Wooden furniture that cannot be resold or reused may be taken for processing at an MRF.
- ***Scrap metal, electrical equipment*** – there are also typically areas set aside for the disposal of scrap metal, and electrical equipment, such as fridges and washing machines. The Waste Electrical and Electronic Equipment (WEEE) Directive places an obligation on manufacturers to collect and recycle WEEE. One consequence of this is that the LAs may be required to provide facilities at HWRC sites to receive such items from householders in the future.
- ***Resale area*** – several sites have an area set aside within the site for the sale of materials to members of the public.

Once a deposit area has reached capacity, a fork-lift truck is used to place the items on either a tail-lift wagon or a larger vehicle, possibly an RCV, through which they are transported for disposal/reprocessing.

In addition to skips and designated areas, many sites utilise smaller local collection banks for dry recyclables, such as textiles, plastic bottles, cans, paper and so forth. Contractors service these banks, commonly collecting them by crane onto a flatbed truck, before taking them directly to transfer / bulking facilities, MRFs or for reprocessing.

Most sites have collection facilities for a basic range of household hazardous waste (HHW) material, usually paint, lead-acid batteries, chemicals and asbestos. In addition, some authorities accept fluorescent tubes, gas cylinders, oil, and mercury/cadmium batteries.

For batteries, smaller waterproof containers are normally provided for collection. Scrap merchants / contractors tend to collect these in bulk, taking the whole container away when full and replacing it with a new one.

Some schemes have been effectively implemented for collection of HHW at HWRC sites, such as ‘Community Re>Paint’. This scheme aims to divert unwanted, surplus paint from the waste stream and redistribute it free of charge for reuse within the community. HWRC-based collection points, most commonly a walk-in skip, allow householders to donate surplus paint.

The paint is then sorted before being redistributed to community groups and people on low incomes.

As regards collection of oil, the recently implemented oil care campaign (OCC) scheme was identified, which aims to improve the oil-recycling infrastructure in the UK and to encourage the general public to take their waste engine oil to oil recycling banks. These banks are often located at HWRC sites (Reference 13).

***Site design*:** HWRC sites may vary in their level of sophistication, and in terms of whether they adopt a single or split level design (Reference 16).

- ***Single Level*** – at the more basic end of the spectrum, sites are often single level, typically consisting of a concrete yard upon which skips (commonly 10 yd^3) are placed. Here, householders may be required to park some distance away from the appropriate receptacle and carry the material over. Alternatively, they may park at the edge of a receptacle and physically handle their waste into the container. Walk in skips or ramps may also be provided. Typically, rear-end skip loader vehicles collect the skips when full to service such sites.
- ***Split Level*** – many larger more developed and more heavily used sites employ a split level design allowing the use of larger capacity (typically 40-50 yd^3) skips. Such a design involves the public depositing waste at the highest level of the site, either over the edge of a skip or down chutes into the skips located at a lower level. Some sites employ compactors that roll up and down the waste compacting it within the skip therefore increasing its capacity. Once full the skips are removed by hook lift vehicles and transported to either landfill or recycling centres. Split-level designs are the preferred option and new sites being built tend to be based upon this design.

A second common feature allied with split-level design is the provision of a one-way traffic system with separate entry and exit routes. One-way traffic management systems help to streamline traffic flow during busy periods, and channel visitors past recycling skips first to ensure that they deposit recyclable waste first. A further feature of larger sites is the separation of the public from the areas used for servicing skips. This reduces the chances of accidents whilst manoeuvring, and allows more effective management of skip servicing.

A5 TRANSFER AND SORTING

A5.1 TRANSFER STATIONS

Transfer stations provide an intermediary point between the collection of material and subsequent processing or disposal. The operation of waste transfer stations where wastes can be bulked up allow for more efficient long distance transport. A number of tasks may be performed at a transfer station, depending on the type of waste or recyclable arriving on-site, and the vehicle in which it is transported. A brief overview of the types of systems used at transfer stations is provided below in Figure A6.

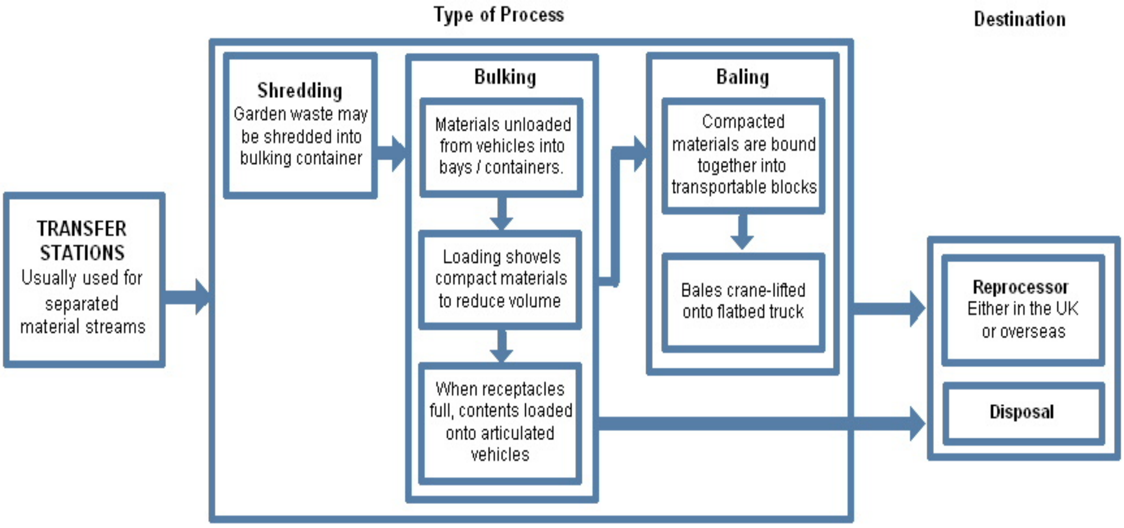

Figure A6 Overview of system stages at transfer stations

Bulking: The bulking process involves piling materials at the transfer station until a sufficient amount has built up to be transferred on to a secondary destination. This most commonly involves stockpiling of recyclables, but also occurs with residual household waste.

For recyclables, the manner in which material is unloaded is dependent on the vehicle used for collection. Here, the recyclables have usually already been separated into different streams. For caged-stillage recycling vehicles, the stillages full of recyclable are often unloaded using a rotating head fork-lift truck. Multi-compartment recycling vehicles tip the contents of individual containers from within the body of the vehicle. Some recycling vehicles have bottom opening stillages with flaps that can release materials into containers beneath.

Materials are tipped either into concrete bays or large containers or skips (up to 50 yd^3). Loading shovels are used to compact the material within the bays. Food waste has to be tipped undercover into a closed container when bulking in order to comply with the requirements of the Animal By-Products Order. Once each receptacle is full, it is loaded onto articulated lorries and transported to their next destination. If the material is stockpiled openly in a bay, it may be loaded onto the lorry using a shovel loader.

Baling: Baling is the process by which compacted materials are bound together in transportable blocks. It is only suitable for certain recyclables such as metal, plastic and paper. Most often, a single type of material is baled together, although on occasion cans and plastics are baled together if they have not been source separated. Once baled, materials may be crane-lifted onto a flatbed vehicle for transportation to the appropriate processing facility.

Shredding: Garden waste may be unloaded from the collection vehicle into a shredder, which feeds into a bulking container. This will then be loaded onto an appropriate vehicle for transfer to a composting facility once the container is full.

A5.2 MATERIALS RECYCLING FACILITIES

Materials Recycling Facilities (MRFs), or Materials Reclamation or Recovery Facilities, as they are also known, are specialised plants that separate, process, grade and store solid waste fractions, prior to onward dispatch to reprocessors (Reference 17). MRFs can vary significantly in terms of the number of sorting processes utilised, and the level of sorting automation. Separation of materials in some MRFs is conducted almost totally by hand, whereas others are fully automated. Figure A7 below offers a very generic description of the elements within MRFs.

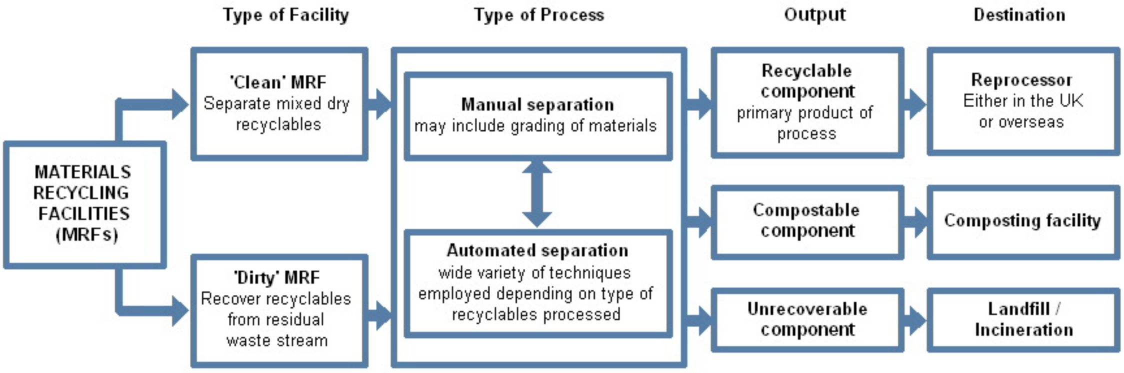

Figure A7 Overview of system stages at MRFs

A generic MRF will generally comprise the following stages: provision for weighing inbound and outbound materials, reception and storage of incoming materials, processing of wastes, and storage of recovered materials and process residues (Reference 17). However, there are two specific types of MRFs: “Clean” or “Dirty”. A very brief overview of the types of processes commonly involved in each facility is provided below.

A5.2.1 Clean MRFs

Clean MRFs are used to separate mixed dry recyclables into their constituent components, prior to baling and dispatch to reprocessors. Clean MRFs handle materials collected through bring banks and kerbside collection schemes. They can be designed to process individual components (e.g. aluminium cans), mixtures of individual components (e.g. co-mingled tin, glass, and aluminium containers), or both. Consequently, they can be divided according to the degree of mixing or co-mingling of the components, and also the number of processing lines dedicated to processing the different source-separated mixtures (Reference 18). Thus, there can be significant variation within designs of individual MRFs.

Typically, mixed recyclables travel along a series of conveyors (normally belts), and the specific fractions are gradually removed, either by hand, through mechanical sorting equipment, or a combination of the two methods. Processing is increasingly automated replacing manual labour, particularly in the larger throughput plants (Reference 17). However, many MRFs employ people to work on either side of a conveyor in a ventilated chamber.

Whilst the human involvement at an MRF may vary with the design of a specific facility, it typically involves three principal manual sorting tasks: pre-sorting, final sorting, and grading (Reference 19). Pre-sorting involves operatives at picking stations reaching onto a conveyor belt and removing obvious contaminants in the recyclable material. Plastic bags are removed and placed into the bag tearing chutes, so that material within can be re-fed into the process. Large non-recyclable contaminants are removed and disposed of as waste. At final sorting stages, operatives remove all smaller items from the single recyclable stream, commonly paper or plastic, that are not desired within that stream. During grading, the operatives separate specific items from the conveyor of a certain grade, which are dropped through openings into bins beneath the room (for a more detailed discussion of the musculoskeletal disorder risks associated with manual sorting at MRFs see Reference 19).

The mechanical sorting equipment used in an MRF can vary. This will normally include shredders, crushers, screens, and densifiers (e.g. balers). Disc screens separate paper and card into different grades. Ferrous metals, such as steel, are separated using overband magnets. For non-ferrous metal, such as aluminium, eddy current separation and linear motor separation techniques may be used. Plastics are identified and separated from the waste stream using techniques such as x-ray, electrostatic charge, infrared analysis and flotation. The equipment used for sorting specific recyclable types is discussed in greater depth in Section A6.

When sufficient recyclables have been collected, the containers into which they have been separated are typically emptied into the hopper of a baler. The baler compacts and ties the bales, which are then taken to a storage area, prior to onward transport to a reprocessor. The location of the reprocessor may either be within the UK, or overseas, depending on the availability of markets.

A5.2.2 "Dirty" MRFs

Dirty MRFs are facilities that accept mixed waste rather than recyclables that have been separated from the residual waste stream. They recover recyclable materials, and/or a compostable fraction directly from unsorted dustbin waste. As with clean MRFs, the design of dirty MRFs can be either simple or complicated.

In addition to the types of technology outlined above, dirty MRFs can incorporate processors to open plastic bags and sacks, to free their contents for segregation and potential recovery. Dirty MRFs sometimes also use trommel screens[11] with knives to puncture and tear open bags. It should be noted that clean MRFs that accept bagged material also require similar equipment. Dirty MRFs need to be combined with secondary treatment and processing options for the organic waste separated, such as composting or anaerobic digestion. A combustible fraction of the waste may be converted to dry fuel in the form of pellets, whilst the unrecoverable fraction of the waste stream is compacted into containers before being transported for disposal by landfill.

The main disadvantage of a dirty MRF is that the recovered materials are not as clean as those recovered from source separated wastes because they have been in contact with other materials, particularly food scraps, in the dustbin. These facilities produce greater quantities of less

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[11] *Trommel screens are used for cleaning and classification of a wide variety of materials. The screen can be fitted with a range of screen opening sizes and types to sort different materials.*

desirable materials, achieving recyclable capture rates of no more than 20%, while around half the remainder is combustible and around one third compostable (Reference 18). There are also health and safety issues relating to the release of bioaerosols on the picking lines and tipping floors when mixed wastes are involved[12].

A5.3 MECHANICAL BIOLOGICAL TREATMENT

Mechanical Biological Treatment (MBT) is a generic term encompassing a very wide range of technologies that aim to process waste by a mixture of biological and mechanical separation. It involves the integration of several processes commonly found in other waste management sites such as MRFs and composting plants, all or just some of which may be present at a particular MBT site (Reference 20).

MBT incorporates aspects of both sorting and processing, and therefore could sit equally well in the discussion of either presented in the report. However, for the purposes of clarity, MBT is discussed here within the section on ‘sorting’ (in accordance with DEFRA definitions – Reference 20), although it should be understood that processing technologies (covered in more detail in Section A6) are also of relevance. It should also be understood that this section offers only a very brief overview of what are actually a series of very complex processes. A complete discussion of this falls beyond the scope of the current project.

MBT plants are designed to handle raw household solid waste, through a process that makes materials available for recycling, whilst stabilising the remaining fraction of the waste, which may be landfilled or converted into electrical power or heat in a combustion plant. In its simplest form MBT provides a drying and bulk reduction operation for mixed waste prior to landfill. In more complex waste management systems the biodegradable fraction can subsequently be treated in anaerobic digestion and / or composting plants, and the highly calorific fraction made into a refuse derived fuel for energy recovery.

There are two principal MBT type operations, dependent on which part of the process is utilised first (Reference 20).

Mechanical Biological Treatment: Following unloading of waste from refuse collection vehicles into a reception area, mixed waste is first sorted through a series of mechanical treatment operations into recyclable materials (e.g. glass and metal), refuse derived fuel (RDF) and an organic rich fraction (green waste, card etc). RDF typically comprises materials with good combustion properties, such as paper, card, and textiles. The organic fraction is biologically treated to reduce the volume and stabilise it so it can be used as a soil conditioner. There is also a reject fraction that requires landfill disposal (Reference 20).

Biological Mechanical Treatment: Mixed unsorted waste is first homogenised by a biological treatment process, such as partially composting, and drying out the waste. It is then screened and sorted using mechanical processes into recyclables, RDF and / or soil conditioner streams. There is also a reject fraction that requires landfill disposal. RDF may be sent for processing in either a dedicated facility, such as an incinerator or may be used as a fuel in an existing industrial process. Where the RDF is used together with another fuel in an industrial application, this is known as co-combustion (Reference 20).

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[12] *It is noted that there are also bioaerosol issues with recyclable waste, for example from residues left in plastic milk containers, although this is considered to be less of an issue than at dirty MRFs.*

A6 PROCESSING

A6.1 INTRODUCTION

This section incorporates details of a wide range of activities that fit within the reuse and recycling levels of the waste hierarchy. Following prevention and minimisation of waste production, these are the most preferable waste management options. Only a brief overview of the systems by which individual types of recyclables are recycled is provided.

For the purposes of this discussion, the processing of waste is classified into recycling, reuse or composting. Processing is considered to begin when the material from the MRF, transfer station or intermediary organisations arrives at the processing site. The processing stage may be considered as completed at the point where the waste or recyclable is converted into a raw material, ready to be made into a new product.

A6.2 REUSE OF MATERIALS

In terms of the waste hierarchy, the reuse of materials to prevent them entering the waste stream is a highly preferable option. A range of materials may be suitable for reuse, including textiles, clothes, shoes, furniture and some electrical goods.

For items such as furniture and white goods, following collection, an assessment of quality will be conducted, followed by repair and testing where appropriate. Subsequently, items may be redistributed to low-income families or community groups or sold through charity shops or private enterprises. Many of the reuse schemes fall under the auspices of the Furniture Reuse Network (FRN), the national coordinating body for over 300 furniture and appliance reuse and recycling organisations in the UK. Other schemes are operational for assessing and re-using unwanted donated mobile phones (Reference 13). In terms of textiles and clothes, once collected from the kerbside, bring bank or CA site, items may be transported to sorting warehouses. Here, they are quality sorted for donation to charities, either within the UK or abroad, or disposal if unfit to be reused.

A6.3 PAPER RECYCLING

During 2004, 4.6 million tonnes of recovered paper were delivered to UK mills, whilst 2,587 tonnes were exported. The UK average paper collection rate currently stands at 56.9% with the European collection rate at an average of 57.3% (Reference 22).

After the paper is collected it needs to be sorted, graded, and baled prior to its transportation to a paper mill. The process of recycling waste paper is summarised in Figure A8[13]. LAs and waste management organisations either pre-sort the paper at collection or the paper is co-mingled with other waste and subsequently separated at an MRF. There are then two options available; the waste may be transported directly to the paper mill from the transfer station or MRF, or it is sent to a paper merchant for grading or export. The option chosen by the LA is likely to be dependent upon the location of the paper merchant/mill, the type of paper required and the availability of facilities for grading.

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[13] *Figure A8 shows reprocessing of paper for completeness, even though this is part of the paper processing industry and not the waste management industry.*

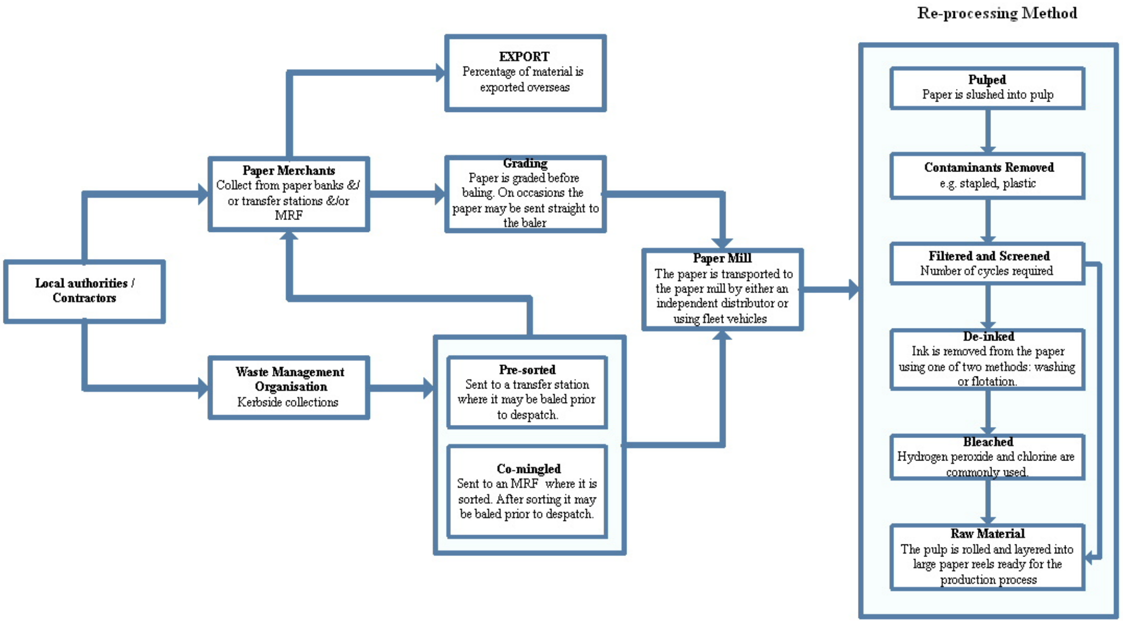

Figure A8 Overview of waste paper recycling process

Paper merchants mainly collect from paper bring banks, transfer stations or MRFs, and will often have facilities to grade the paper. The paper grading process generally involves the paper being loaded onto a moving conveyor belt where trained workers will pick out the different grades. The sorted and graded paper is then ready to be baled for transportation. The baling press compacts the loose paper into a bale that typically weighs between 500 to 1000 kg. As the bale is ejected out of the machinery it is tied with a heavy duty baling wire (Reference 23).

The method used to reprocess paper is dependent upon the type of raw material required. Therefore, the de-inking and bleaching of the paper may not be required. The de-inking can be done in one of two ways, flotation or washing. Flotation involves air being passed through the pulp, producing foam, which will hold at least half of the ink and can be skimmed off. If washing is used to de-ink the paper, chemicals are added to the paper as it is pulped. The chemicals separate the ink from the paper and allow it to be washed away in the large amounts of water used. If the waste paper is bleached then hydrogen peroxide and chlorine are commonly used, though the former is more acceptable as it breaks down into water and oxygen on disposal (Reference 24).

The contaminants removed during the recycling process (the pins, staples, adhesives etc.) create a sludge that may be burned for energy recovery, put into landfill or used for other industrial purposes.

A6.4 GLASS RECYCLING

Currently, around 1,400,000 tonnes of glass is landfilled each year. The recycling rate for glass in the UK in 2003 was 38% (Reference 25). Glass bottles and jars are collected either at the kerbside or via bottle banks. Generally, reprocessing plants require colour-separated glass. However, some plants are able to accept mixed glass. The pre-sorted waste, broken or crushed glass bottles or jars, described as cullet, are transported from the collection point either to transfer stations, or directly to the reprocessing plant. Where glass is collected co-mingled with other waste, it is sorted at an MRF. Figure A9 provides an overview of the glass recycling process.

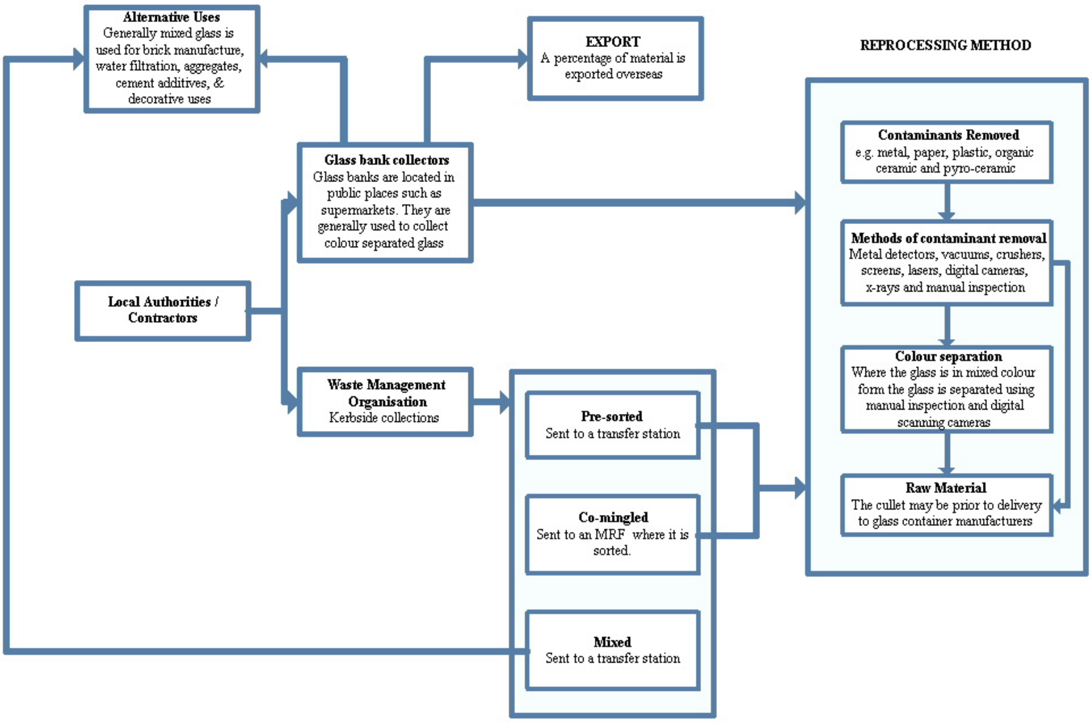

Figure A9 Overview of the glass recycling process

At the reprocessing plant all unwanted materials that may be present, such as paper and metal, are removed using a combination of manual inspection, magnets, giant vacuums and lasers to ensure the cullet is clean. Some recycling plants have colour separation facilities which use manual inspection and digital scanning cameras to separate mixed colour glass. Once the cullet is cleaned and separated it is often crushed before being sent to container manufacturers, where it is mixed with soda ash, sand and limestone and fed into a furnace.

An alternative to reprocessing is to export the cullet, particularly green cullet, for making into containers or it may be used for aggregates, cement, sand blasting, or water filters. Where the cullet is being used for construction purposes, it does not need to be clear of contaminants. Therefore it does not need treating and can be transported direct to the recycling site.

A6.5 METAL RECYCLING

LAs commonly collect steel and aluminium tins and cans for recycling, although an increasing number now accept foil and aerosol cans. There is approximately 105,000 tonnes of aluminium packaging available for recycling, comprising of 70,000 tonnes of drinks cans and 23,000 tonnes of foil, with the balance being made up of aerosols and closures. In 1998 approximately 182,000 tonnes of steel packaging were recycled in the UK (Reference 1). Aluminium and steel packaging has an intrinsic high value and coupled with the requirement to meet recycling targets, it is increasingly being collected through kerbside and bring bank schemes.

Figure A10[14] illustrates the flow of scrap metal from collection through to reprocessing back into a raw material. Prior to the metal reaching the reprocessing stage it needs to be separated into its constituent components such as steel or aluminium. The sorting of the metals may occur at an MRF, or at a dedicated sorting plant operated either by a LA, waste organisation or community/private organisation.

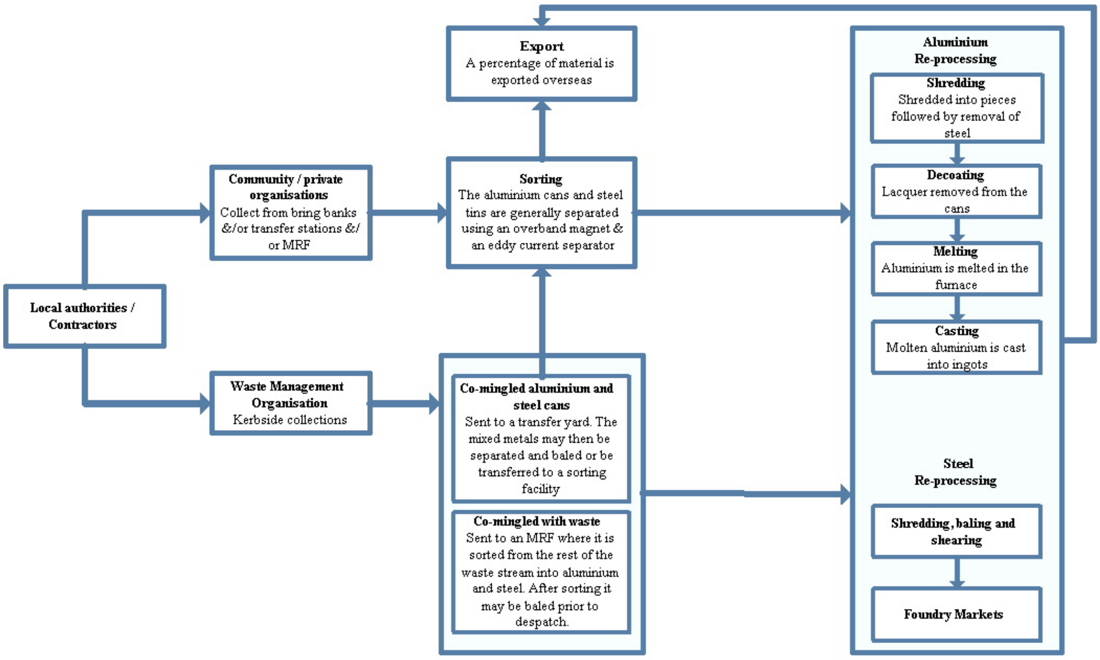

Figure A10 Overview of the metal recycling process

Metal packaging, consisting mostly of tins and cans, is likely to be sorted into aluminium and steel using an overband magnet and an eddy current separator. The method involves placing the tins and cans onto a moving conveyor belt where they are carried under an overband magnet. An overband magnet is a large rotating magnet that hangs above the tins and cans and attracts the steel cans sorting them into a separate cage. The remaining material continues down the conveyor to the eddy current separator. This uses a rotor comprised of metal blocks to ‘throw’ aluminium from the conveyor (Reference 26). The metal packaging may then be baled and transported to a reprocessing site or exported. The reprocessors may also purchase some of the scrap metal for export purposes.

Aluminium reprocessing goes through a simple cleaning and remelt process before it is ready to be made into ingots. The reprocessing of aluminium generally involves a four-stage process: shredding, decoating, melting and casting. When the aluminium cans arrive they are shredded into pieces and passed through a magnetic drum separator to remove any remaining steel. The lacquer and decoration is then removed from the cans by blowing hot air through the shreds. The hot shreds are fed into a furnace to melt the aluminium. The alloy composition is checked and the metal is treated to remove non-metallic particles before casting. The ingots are cast by pouring the molten aluminium into moulds. As the metal flows into the mould, jets of cool water being pumped around the mould chill it causing a solid outer shell to form. The ingots

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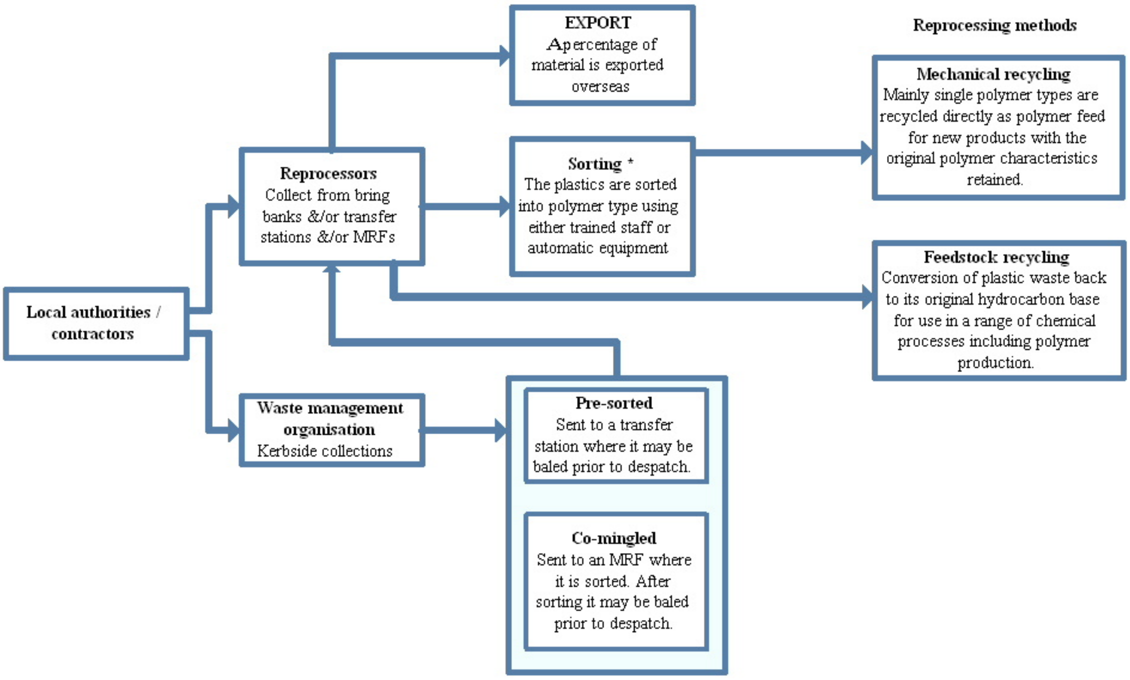
[14] *Figure A10 shows reprocessing of aluminium and steel for completeness, even though this is part of the metals processing industry and not the waste management industry.*

may then be shipped to a mill for rolling into a sheet form, which can be used to produce new cans.

A6.6 PLASTIC RECYCLING

It is estimated that in 2004, 36,000 tonnes of post-consumer plastic packaging were recovered from the household waste stream with approximately 450,000 tonnes of plastic entering the waste stream (Reference 27). There are an increasing number of LAs providing plastic collection services. However, there will be some who have opted against recycling plastics from an economic viewpoint due to the high volume to low weight ratio and the proximity of reprocessors (Reference 28).

The flow of plastics in the waste stream is illustrated in Figure A11[15]. Where plastics are collected co-mingled at the kerbside they will be sorted at an MRF or MBT facility. The sorted plastic can be sent straight to the processor although it is likely that it will be baled to reduce the volume prior to transportation. Some of the waste plastics collected will be shipped abroad, mainly due to cheaper labour and reprocessing costs (Reference 28).



*Some of the plastics received by the reprocessor may have already been sorted at the MRF

Figure A11 Overview of the plastic recycling process

There are two methods of recycling plastic: mechanical and feedstock recycling. The mechanical recycling of plastics requires the plastics to be sorted into polymer type and/or colour prior to reprocessing. The plastics are either sorted by trained staff or automatically, using techniques such as x-ray fluorescence, infrared and near infrared spectroscopy, electrostatics and flotation. This level of sorting may be undertaken at the reprocessing plant or

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[15] *Figure A11 shows reprocessing of plastic for completeness, even though this is part of the plastic processing industry and not the waste management industry.*

some MRF facilities. In the UK, trained personnel currently perform most of the sorting. Following sorting, the plastic is either melted down directly and moulded into a new shape, or melted down after being shredded into flakes and then processed into granules called regranulate (References 24 and 29).

Feedstock recycling is a comparatively new technology and can be subdivided into two categories: processes that involve the breakdown of mixed plastics to produce a ‘naptha’ feedstock and processes based on de-polymerisation of specific polymers. Feedstock recycling plants are in use in Europe. However, in the UK, all commercial plastic reprocessing is currently based on mechanical recycling (Reference 30).

A6.7 HOUSEHOLD HAZARDOUS WASTE RECYCLING

The type of processing within a household hazardous waste (HHW) stream varies with the specific material, dependent on its toxicity or other hazardous chemical and physical characteristics. Materials may be exchanged, bulked, lab packaged, or simply stored prior to shipment to a treatment, storage or disposal facility (Reference 31). Due to the wide range of types of waste that constitute the category of HHW, and the variety and depth of technology available for processing them into recyclables, a discussion of the detail of these processes lies beyond the scope of the present report.

A6.8 COMPOSTING

The creation of compost from biodegradable household waste through either home or centralised composting schemes is key to achieving the targets set out in the Landfill Directive. The success of both home composting and centralised schemes is dependent upon the separation of biodegradable waste from other waste (Reference 32). About 5% of household waste was composted centrally in 2002/03, although an increasing number of LAs are establishing centralised composting schemes. Recent figures suggest that 56% of non-metropolitan authorities, and 20-25% of metropolitan and London authorities have established centralised schemes (Reference 32).

Centralised composting schemes involve the collection and processing of various biodegradable wastes including food and garden waste separated by the householder. The quality of the finished compost product is graded according to its organic purity for marketing purposes, which must satisfy compost standard PAS 100. Elimination of physical contaminants, such as glass, stones and plastic, is the main pre-requisite for the production of compost for sale. Glass is extremely difficult to screen out and a small amount renders it difficult to sell directly to the public and impossible to sell through major distribution chains. Other contaminants are generally less common in the waste stream and are also more easily screened.

A number of systems exist which are designed to compost biodegradable waste, all aiming to provide optimal environmental conditions for aerobic micro-organisms to degrade the biodegradable materials. The different processes are considered only very briefly below, as a more detailed description falls beyond the scope of this project, and an overview of the process is illustrated in Figure A12.

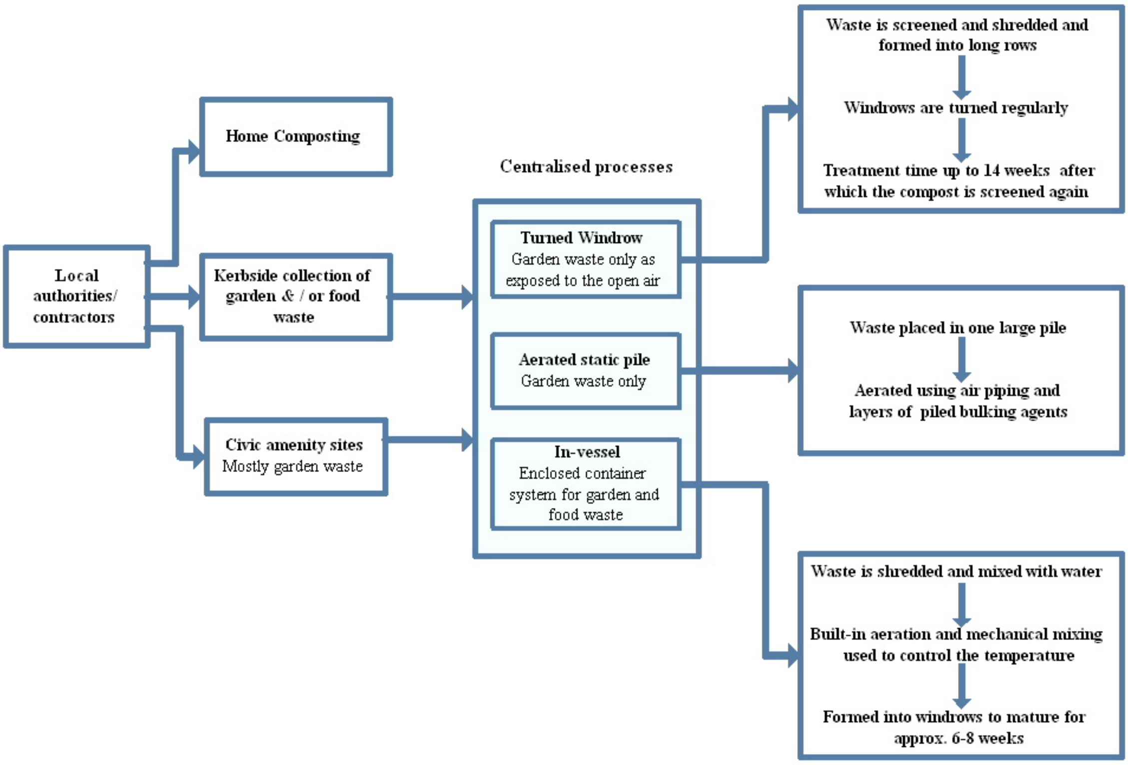

Figure A12 Overview of the composting processes

A6.8.1 Turned windrow

The majority of centralised composting schemes use the turned windrow method, which is the simplest and cheapest composting method, and at present, windrow composting is the most prevalent composting technique used in the UK. If the biodegradable waste collected is only garden waste, without any food waste, it may be processed in an open air windrow facility. The windrows may also be formed in roofed buildings, or with partial roof cover. Here, incoming waste is initially screened, shredded and formed into long rows, known as windrows. The windrows are turned regularly to ensure an even mixture, to provide aeration and to control temperature and moisture in the composting process (References 33, 20 and 34). Treatment times are relatively long, lasting up to 14 weeks, because in windrowing the temperature is not constantly maintained within the optimal range. After this period, the composted material is screened again to remove any large or incorrectly sorted objects. The quality of the finished product is graded according to its organic purity for marketing purposes, with the degree of contamination dictating future usage of the composted material.

A6.8.2 Aerated static pile composting

Compost may also be formed into static pile windrows. In aerated static pile composting, air piping is laid under the pile to reduce the need to mix every day. A homogenous mixture of biodegradable waste can be mixed together in one large pile instead of rows. To aerate the pile, layers of loosely piled bulking agents (e.g. wood chips, shredded newspaper) are added so that air can pass from the bottom to the top of the pile. The piles also can be placed over a network of pipes that deliver air into or draw air out of the pile (Reference 34). A controlled supply of air enables construction of large piles, which require less land than the windrow method.

A6.8.3 In-vessel composting

In-vessel composting systems are utilised where food waste is collected along with garden waste. There is limited experience of in-vessel composting in the UK to date but it is a growing area of biodegradable waste treatment (Reference 20). In-vessel facilities have enclosed container systems, which reduce potential problems of odour and the release of airborne bacteria/fungal spores. The raw biodegradable waste is initially shredded, then mixed with water if required and maintained within the in-vessel, often with built-in aeration and mechanical mixing equipment, until it reaches an appropriate temperature. There are several types of in-vessel composting reactors, a discussion of which is outside the scope of this report. Subsequently, the waste may be formed into windrows for maturation over a period of 6-8 weeks, following which it becomes compost (Reference 35).

A7 ENERGY RECOVERY

A7.1 INCINERATION

Incineration is the combustion of waste under controlled conditions to reduce waste volume and, in some cases, produce energy (Reference 3). Incineration reduces the volume of waste to be disposed of by up to 90% and leaves a bottom ash that can be landfilled or used in the construction industry as aggregate or fill and in the manufacture of breezeblocks.

The technology to burn waste has developed significantly, and the energy released from burning waste is often recovered to generate electricity, steam and / or hot water for industrial or domestic use (References 36 and 37). There are a variety of grate and furnace systems which form the vast majority of existing and new incineration facilities for household waste management in the UK and overseas.

A7.1.1 The Incineration Process

An overview of the incineration process is illustrated below in Figure A13.

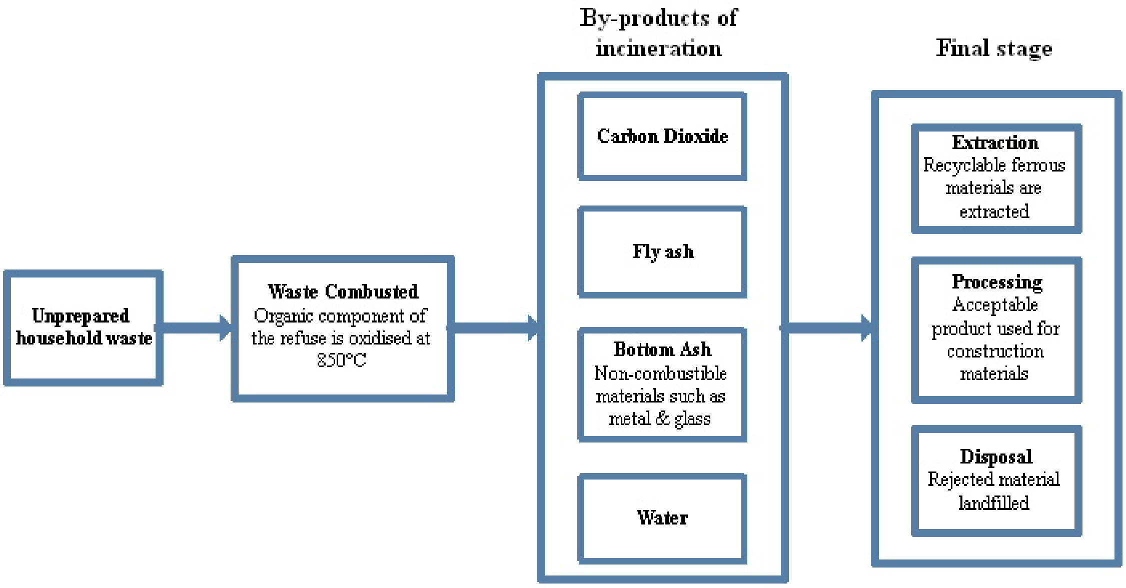

Figure A13 Overview of incineration process

Waste is delivered to the plant by road or rail and unloaded into a waste bunker. To ensure an even heat input, waste is mixed in the storage bunkers before being loaded by a grab into the grate feed chute. The waste then falls onto a grate system that passes it through combustion units. Although various designs are available (see below for further details), all have the purpose of mixing and moving the burning waste through the furnace so that by the time it is discharged into the ash collection facility all combustible material has been burnt. Air is introduced beneath and above the grate in carefully controlled amounts to complete proper combustion, with occasional additional natural gas or oil fuelling to maintain specified combustion conditions (References 20 and 3).

Hot gases from a secondary chamber are directed to a boiler to recover heat. Combustion gases are cleaned, to stringent standards, using various designs of flue-gas cleaning equipment prior to discharge to air through an exhaust stack, a description of which falls beyond the scope of this current brief overview. The main component of the solid residue produced is grate, or bottom ash, an inorganic, sterile material containing approximately 10-15% ferrous metals. After it is discharged from the grate, it is quenched in water before magnets separate metals for recycling. The remaining bottom ash is then disposed of to landfill or used in construction. Fly ash, or fine particulates in the gas stream and reagents such as lime or activated carbon, is also produced from particulate removal during gas cleaning. It is conditioned with water and can be pre-treated to reduce or immobilise potentially harmful constituents. Pre-treated ash is then disposed of as hazardous waste in designated landfills, engineered to prevent the potential pollution of the environment.

Most modern incineration plants initially sort the household waste to remove recyclable materials and wet putrescible materials. The combustible residue is then shredded and either burnt directly as a course refuse derived fuel (cRDF) or compressed into pellets, known as densified RDF (dRDF). This process and burn approach can potentially integrate well with recycling schemes.

A7.1.2 Fluidised bed combustion

Fluidised bed combustion provides heat to high-efficiency gas turbines and is used in electrical power generation. Before the waste is incinerated, non-combustible components are removed and the waste shredded to produce coarse refuse derived fuel (cRDF), which has a higher calorific value than the untreated waste. The cRDF is fed into a fluidised bed combustor. A constant flow of air is pumped through the base so that the solid waste and minerals are kept in motion. The motion breaks up the fuel and mixes it well throughout the combustor, making it easier to burn and maintaining uniform temperatures (Reference 3).

A7.2 ANAEROBIC DIGESTION

Anaerobic digestion is used to reduce the bulk of biodegradable waste by converting it into a relatively stable solid residue, or digestate, similar to compost. Unlike composting, this process requires an oxygen-free environment in order for the specialised bacteria to function (Reference 20). Anaerobic digestion is included in a discussion of energy recovery waste management options, as the biogas by-product of this process can be used for energy generation.

Of the household waste materials collected, only biodegradable material that is easily degraded (such as foodstuffs) and paper are ideally suited to anaerobic digestion, as are certain types of garden waste such as grass cuttings. Isolation of wastes that are more easily degraded may be achieved through separate collection but the success of this is dependent on how well householders exclude contaminants from the biodegradable wastes. Alternatively, the biodegradable waste can be separated at an MRF (Reference 38).

Anaerobic digestion breaks down biodegradable materials within a vessel (Reference 39) and requires an oxygen-free environment for the specialised bacteria to function. Figure A14 illustrates the generalised process of anaerobic digestion.

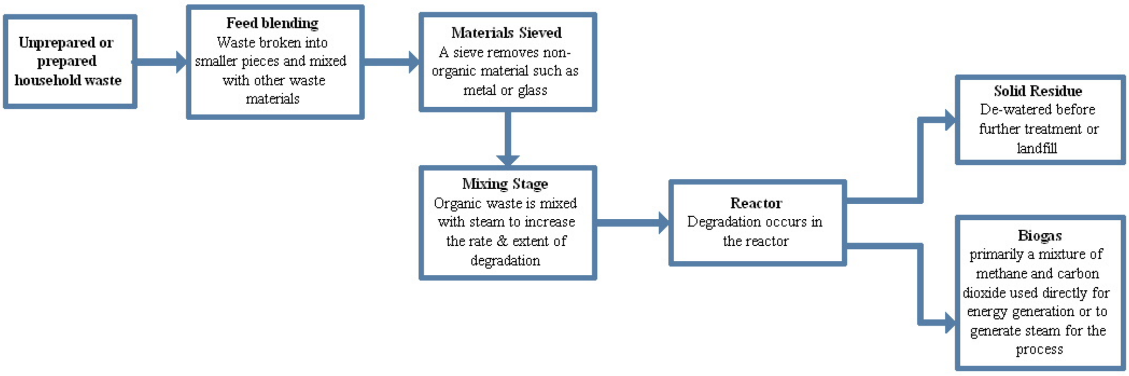

Figure A14 Overview of anaerobic digestion

The process generally involves using pre-sorted suitable biodegradable materials to maintain the quality of the product. The biodegradable material is then shredded and blended with other waste products such as sewage sludge. Following this a sieve removes some of the unwanted materials, such as metal and glass, from the waste stream before passing it to the mixing stage.

In the ‘mixing stage’ the waste is mixed with steam and an inoculum to initiate microbial activity, before being fed into a reactor, in which degradation occurs (Reference 38). This produces a combustible gas known as ‘biogas’ and a ‘digestate’. The ‘biogas’ is a mixture of methane and carbon dioxide that can be directly used for energy generation or to generate steam for the process (Reference 20). The digestate that is produced may be used as soil conditioner following further composting treatment, or can be disposed of into landfill, dependent on the degree of contamination, which is influenced by whether the biodegradable waste was separated initially during collection (Reference 37).

A8 DISPOSAL

A8.1 LANDFILL

Despite its presence at the bottom of the waste hierarchy as one of the least desirable options for waste management, the majority of UK waste is still disposed of directly to landfill as it is often the least costly option (References 40 and 41). Landfill also constitutes the final disposal route for wastes arising from other waste management options that appear higher in the hierarchy such as incinerator ash and MRF rejects. The vast majority of landfill sites are owned by private organisations although in a few instances the sites are LA owned.

Each landfill site in the UK is licensed (and/or permitted) to accept only certain types of waste. This varies from those that can accept only inert wastes such as concrete, to those that can accept a wide range of commercial, industrial and several can accept hazardous wastes.

The diversion of biodegradable household waste, such as paper, card, kitchen and garden waste, from landfill is a key objective under the Landfill Directive. In addition, declining void space for landfills, and the large investment required for new facilities, means that many LAs are increasingly considering alternative treatment options such as composting, anaerobic digestion and energy-from-waste incineration to deal with this waste stream (Reference 32).

***Landfill process*:** Waste collected for disposal at landfills may be taken directly to a landfill site, or transported to a transfer station for bulking up with other waste into large vehicles, including articulated lorries, barges and trains, before being taken for disposal. Once at the landfill, the vehicles are weighed, and the weight and type of waste in each load is noted. This information helps to ensure effective management of the site and to minimise the potential for environmental pollution (Reference 37). Once the waste has been deposited into the section of the landfill site that is being filled, it is then compacted using a heavy compaction vehicle (commonly a bulldozer or landfill compactor) that drives back and forth over the deposited material. This process ensures that the waste is reduced in volume as far as possible, maximising the void and helping to physically break up the waste, thus aiding the waste degradation process. Finally, the deposited material is covered with a layer of material such as soil at the end of each working day, to limit the potential for pest infestation and littering of the surrounding area. This process is illustrated in Figure A15.

As an alternative to landfill, in order to combat the decreasing number of suitable void spaces for landfill, landraising, where waste is deposited on the ground surface to build up a waste disposal site, has become more prevalent (Reference 37).

***By-products of the landfill process*:** When biodegradable wastes such as paper and waste food are disposed of in the anaerobic conditions of a landfill site, breakdown by bacteria produces landfill gas and soluble chemicals. The soluble chemicals combine with liquids (e.g. from rain) in the waste to form landfill leachate, which comprises mainly dissolved organic material, chlorides, ammonia and soluble metals. Due to its chemical composition, leachate is potentially polluting to land, surface waters and groundwater.

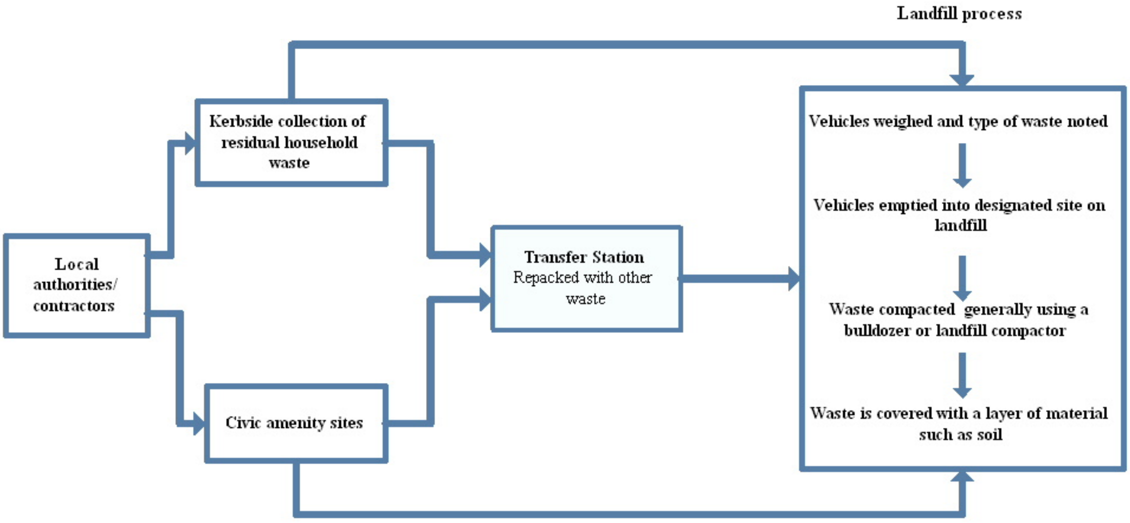

Figure A15 Overview of the landfill process

In contemporary landfill sites, complex 'lining' and 'capping' systems are engineered to contain and abstract the landfill gas and leachate. A complete discussion of these systems falls beyond the scope of the present project. Landfill gas is also controlled through the use of gas abstraction systems. This gas is either flared to atmosphere or utilised by generating electricity or heat.

A9 EMERGING SYSTEMS

Information regarding emerging systems for collection, transfer, processing and disposal of waste and recyclables was also sought as part of this work package, drawing upon material sourced from within the UK and abroad. Much of the material identified was specific to the latter stages of the waste life cycle, reflecting advances in composting, MBT, and incineration technology. A brief summary is outlined below.

A9.1 COLLECTION

A number of innovative waste collection receptacles were identified. Some of these are being used widely, others being trialled in small pilot schemes, whereas still others are yet to be introduced. One example is the 'Urba' plastic container for food waste, which utilise a handle-based lid-locking mechanism, for reduced spillages and improved handling. The 'Hybrid' system currently being used in one LA consists of remodelled wheeled bins, each with three removable compartments or drawers, designated for particular types of material. This allows collection of up to three different materials per bin and further bins can be added to increase overall capacity. The system was custom-developed to provide a solution for medium sized blocks of flats, where limited space availability can be a barrier to the introduction of convenient recycling facilities. In a similar theme, the 'Quattro-Select' is a modified wheeled bin for use in kerbside recycling. The main body of the bin is split into 4 compartments for different recyclables, which may be mechanically emptied into different waste streams at source. Other developments include the use of bin inserts which sit inside the wheeled bin, and 'piggy back' bins which are containers of about 35 litres capacity which hang on the outside of wheeled bins. These may be used to separate recyclables from the residual waste stream.

There may be further technical innovations with respect to wheeled bin design. For example, one waste container manufacturer introduced a radio-frequency container identification system to allow accurate inventory and real-time tracking of the location and condition of containers. This system is claimed to be more durable and accurate than barcode-based technologies.

Some schemes in Denmark and Spain were identified whereby underground waste disposal systems have been implemented. Here, waste is deposited into a chute and transported via suction either directly to a nearby sorting facility or removed at a more distant point and transported to the MRF. Whilst this may offer a plausible option for waste management for some new housing developments, the costs associated with retrofitting to existing urban settings, particular with a high housing density, make it unlikely to be readily implemented.

A9.2 PROCESSING

The DEFRA waste implementation team provided information on a range of new waste treatment technology companies that had applied for DEFRA funding to produce pilot plants to demonstrate their viability. Due to their range and multitude, rather than a description within this report, the reader is directed to the "New technologies demonstrator programme' (Reference 1) for more details.

With regard to composting, the alternative composting process of vermicomposting utilises earthworms to break down biodegradable material in order to convert it to other useful materials such as compost (Reference 37). This form of composting is currently not highly prevalent within the UK, but is used by some community sector projects.

Gasification and pyrolysis are two emerging advanced thermal treatment (ATT) processing technologies attracting considerable UK interest as alternatives to more traditional mass-burn incineration (References 20 and 17). Gasification technologies are not new, although its application to waste feedstocks is still being developed. Gasification involves heating wastes in a low-oxygen atmosphere to produce a gas with low energy content for burning in a turbine or engine that is coupled to an electricity generator. Pyrolysis is the thermal degradation of waste, commonly carbon materials and refuse-derived fuels, in the absence of air to produce gas, oil and solid char fractions. Char can be recovered for use as a fuel through gasification or disposed of, whilst gas and oil can be processed then combusted to generate electricity. Experience of these ATT technologies is relatively scarce in the UK and overseas (Reference 20). There is however future potential for ATT systems to be components in an integrated waste management strategy.

A new set of processes is being developed that utilise steam to degrade the waste rather than biological processes. These share many characteristics with the MBT technologies in that the sorting processes generate a range of products for further processing. The steam is injected into the waste in an autoclave, often under pressure, such that the waste degrades very quickly allowing the separation into the biodegradable fraction, plastics and metals and reject fractions. In this case, the fuel fraction and biodegradable fraction are combined into a single fraction that can be either burnt or composted/digested as the market demands. There are also other markets and uses being investigated for this material. It should be pointed out that these processes are at the early stages of development and are likely to take some time to reach full-scale commercial development (Reference 43).

A10 DISCUSSION

A10.1 SELECTION OF SYSTEMS FOR FURTHER CONSIDERATION

In order to fulfil the third objective of the work package, it was necessary to determine a representative set of generic systems for detailed consideration in subsequent work packages. On the basis of the vast amount of information collated for the first work package and discussions with the Project Management Board and Project Advisory Committee, a sample of 12 systems was selected for further detailed examination in terms of their constituent components. The systems chosen were as follows:

Collection

- Wheeled bin
- Boxes with kerbside sorting (using both Kerbsider and Stillage vehicles)
- Bags
- Small bins (e.g. for food waste)
- Communal bin stores (for use by a specific defined population)
- Door-to-door collections from flats

Transfer / sorting

- Transfer stations
- Materials Recycling Facilities (MRFs)

Processing

- Composting (both windrow and in-vessel)
- Mechanical Biological Treatment (MBT)

Energy recovery

- Incineration

Disposal

- Landfill

A10.2 RATIONALE FOR SELECTION

As there is a wide range of different systems within each life cycle stage, it was first acknowledged that it was not practical to assess every different system in detail as part of this project due to time and cost constraints. Therefore, it was necessary to select as ‘representative’ a set of systems for detailed analysis as possible, although in the context of such variability, this was not a simple task. Therefore, a number of factors were considered in selecting the systems, which assisted in justifying the inclusion or exclusion of a particular system. These factors were as follows:

- Most workers involved;
- Most occupational accidents;

- Highest individual risk;
- Most HSE concern;
- Widely used throughout the UK;
- Include majority of different components;
- Ease of access to systems (e.g. project partners/offers of assistance); and
- Parts of life cycle where it is possible to choose between different systems.

It was agreed that the majority of the emphasis should be placed on collection systems, as this is where both greatest variability in system types and prevalence of health and safety risks are present. For collection, it was agreed that focusing on a range of types of receptacle, such as wheeled bins, boxes and bags, would allow maximum coverage of the systems currently in use within the UK. Following discussion with the Project Advisory Committee, it was decided that observation of the collection of boxes without kerbside sort would not be of significant benefit, given that this system is not widely utilised, and the system components could be surmised from other observations. In addition to the receptacle-based systems, specifically considering collection from flats was felt to be of utility, given that this operation is likely to become more prevalent in the future.

For the latter parts of the waste life cycle, where there is great variability in specific systems, for example across different MBT systems, the more complex examples of the system were chosen for observation. Therefore, the elements of the simpler systems were implicitly examined.

A11 ANNEX A1 – LITERATURE SEARCH DETAILS

A search of the literature was performed using the following terms in the article title:

Any 1 (or more) of:	***Plus any 1 (or more) of:***	***Plus any 1 (or more) of:***
Systems	Waste	Collection
Methods	Household	Collecting
Processes	Residual(s)	Transfer
Schemes	Recyclables	Treatment
	Recyclate	Treating
	Materials	Processing
	Hazardous	Reuse
	Organic	Recycling
		Anaerobic digestion
		Disposal
		Disposing
		Composting
		Mechanical treatment
		Biological treatment
		Handling
		Management

The following databases were searched using the keywords listed above:

Paperchem; PIRA; RAPRA; Wasteinfo; Pascal; Environmental Sciences; Ante; Chemical Engineering and Biotechnology Abstracts; Chemical Safety Newsbase; Compendex; Healsafe; NTIS; Pollution Abstracts; Accompline; Aluminium and Glassfile; Oshrom; CISDOC; HSELINE; NIOSHTIC; OSHLINE; and RILOSH.

A12 ANNEX A2 – LOCAL AUTHORITIES CONTACTED

In total, a sample of 18 Local Authorities (LAs) provided information regarding the systems they currently operate for waste and recyclables management. These were:

- Barking and Dagenham London Borough Council
- Birmingham City Council
- Camden London Borough Council
- Congleton Borough Council
- Gateshead Metropolitan Borough Council
- Denbighshire County Council
- East Riding of Yorkshire Council
- Newport City Council
- North Shropshire District Council
- Pembrokeshire County Council
- Pendle Borough Council
- Rochdale Metropolitan Borough Council
- Rotherham Metropolitan Borough Council
- St. Edmundsbury Borough Council
- Stevenage Borough Council
- Tameside Metropolitan Borough Council
- Wakefield Metropolitan District Council
- Wirral Metropolitan Borough Council

APPENDIX B DESCRIPTION OF ACTIVITIES AT OBSERVED SYSTEMS

B1 INTRODUCTION

This appendix describes the work carried out for the second work package. In order to be able to carry out a risk assessment on the different waste and recyclables management systems it is first necessary to breakdown the systems into a number sub-systems and activities. Thus, the objectives of Work Package 2 are as follows:

- Observe a range of systems, covering the areas highlighted in Appendix A, Section A10.1;
- Breakdown the systems into a number of activities; and
- Propose components to be assessed within the Risk Comparator Tool.

The scope of the present work package is, therefore, limited to the range of systems proposed in Section A10.1.

It is noted at this point that the activities described in this appendix are based on observations and discussions and that these, in some cases, may be representative of bad practice. This has been captured as it is important that any assessment of risk takes account of the real situation and not a hypothetical situation. However, it is stressed that the discussions in this appendix must not treated as a endorsement of any approach or, indeed, as allowed practice.

B1.1 STRUCTURE OF APPENDIX B

The remainder of this appendix is structured as follows:

- Section B2 describes the approach taken to derive the components;
- Sections B3 and B4 provide a task analysis of the observed systems, including some commentary on unobserved variations; and
- Section B5 proposes components to feature in the Risk Comparator Tool.

B2 METHODOLOGY FOR CREATION OF COMPONENTS

For each system under consideration the following approach was taken for the creation of system components:

- Any relevant documentation, including operating procedures, health and safety procedures, risk assessments, accident data and training records were requested, and, where provided, were reviewed;
- Observations were made of the systems in practice;
- Discussions with people with experience of the systems were held; and
- The above information was analysed to produce generic system components.

The areas explored during the discussions covered variations in the normal, observed, operations; Section B2.1 summarises the areas explored.

In terms of collection systems the approach taken to the observations was to monitor the action of individuals whilst performing the collection task from start to end, rather than focusing on activity at the vehicle. In terms of post-collection, the approach taken was to follow the process from material in to material out. Observations were carried out over a sufficiently long period of time in order that the operatives forgot the observers were there and so were not overly influenced by their presence. This increased the likelihood of, where relevant, 'on the job' custom and practice variations, including typical shortcuts and bad practice, being captured.

From this information a task analysis of each system was completed, which is presented in Section B3 for collection systems and in Section B4 for post-collection systems. It is stressed that the description of the activities is based on the limited number of systems observed and, therefore, any specific system in practice may differ to that presented. However, this is not too critical as the vision is to be able to define a wider range of systems by selecting from components from across the systems. The following waste and recyclables management systems were observed:

- Collection of residual waste in wheeled bins and, to a lesser extent, disposable black sacks, using an RCV that takes the collected waste directly to an incinerator.
- Collection of green waste in large reusable sacks, using an RCV, and emptying at an open-windrow composing site.
- Collection of dry recyclables and food waste with kerbside sorting using a stillage vehicle. Dry recyclables were collected in boxes and food waste in small food bins. A mixture of on-vehicle and kerbside sorting was used. Contents were unloaded at a transfer station.
- Collection of dry recyclables in boxes with kerbside sorting using a Kerbsider vehicle; contents were unloaded at a transfer station.
- Collection of dry-recyclables using slave sacks, door-to-door from flats. Vehicle contents were unloaded at an MRF.
- Collection of residual waste from large wheeled bins into an MRF and contents taken to an incinerator.
- Operation of two MRF plants.
- Operation of an MBT plant.

- Operation of in-vessel and open windrow composting sites.
- Operation of an incinerator.
- Operation of a landfill site.

The aim of the observations and task analysis was to provide sufficient understanding of the activities involved to enable a detailed hazard identification study and risk assessment to be ultimately carried out. The recommended components then form the building blocks of the Risk Comparator Tool. It is from these components that the system to be assessed is defined.

B2.1 DISCUSSION AREAS

This section lists the areas explored during discussion with operatives and supervisors and during the observation of the systems referred to above.

One of the aims of the discussions and observations was to identify any ‘on the job’ custom and practice variations to system operating procedures. Some of the factors and discussion areas listed below were used to try and elucidate this information.

Collection system factors:

- Type of receptacle: size, capacity, type, design;
- Type of vehicle: tonnage capacity, type, cab facilities;
- Number of staff on the round: collection operatives, driver (whether tasks are interchangeable);
- Practice of picking up from both sides of road;
- Average time spent collecting by each member of staff;
- Average time spent in vehicle by collectors;
- Number of times getting in and out of cab (each side);
- Average length of shift;
- Method of work used, e.g. task and finish compared with contracted start and finish times;
- Any reversing activities (precautions used: CCTV, banksmen [signalling system], reversing bleepers);
- Average distance travelled during round;
- Frequency of collection, e.g. weekly or biweekly;
- Type of collection area, e.g. rural or urban;
- Average number of households included in a round (dependent upon property density);
- Type of road – speed limit (30 mph, 30-60 mph, over 60 mph);
- Type of housing – detached, semidetached, terraced, tenements;
- Socio-economic characteristics of population;
- Presentation rate – average number of houses who participate each week;
- Capture rate – amount collected per week (tonnes);

- Point of emptying vehicle – set points on round / when vehicle is full;
- Level of experience of staff;
- Training provided (new-starters / refresher);
- Personal protective equipment (PPE) worn (work suit, high-visibility clothing, safety boots, safety gloves);
- Distance travelled to primary destination;
- Location of primary destination; and
- Type of primary destination (e.g. transfer site / MRF / disposal).

Post-collection system factors:

- Method for entering site: e.g. log book of arrival, intercom;
- Method of reporting arrival – who to;
- Method of emptying truck (empty direct into grate, empty into yard then bulldoze into grate, use crane to dump into grate);
- Number of staff required to empty truck;
- Number of site personnel involved in waste delivery, incineration process etc;
- Emergency procedures;
- Permit to work systems;
- Time taken for RCV to enter and leave the site;
- Workplace transport used;
- Method of composting; and
- Method of waste product disposal.

Discussion with operatives / supervisors:

- Rationale behind certain types of behaviour (time saving?);
- Factors not observed / non-routine situations to take into consideration;
- Weather variation (severe conditions – rain, snow, ice, gales);
- Possible reduced / increased staffing levels;
- Seasonal variation in amount of waste produced (e.g. after bank holidays, Christmas, in student / tourist areas);
- Other levels of urbanisation / types of housing not observed;
- Differences in participation in schemes;
- Different terrain / sloping ground;
- Changes from operating procedures for certain conditions; and
- Compare comments on above with baseline of observed behaviour (more or less repetitious?).

Potential types of risk encountered (not exclusive):

- Manual handling injury;
- Workplace transport – struck by vehicle (visibility issues), climbing on vehicle rather than into cab;
- Use of compaction system / packer / bin hoist system;
- Struck by falling object from vehicle;
- Moving / runaway bins;
- Slips and trips (during access / egress from cab, on road surface);
- Falls (from height, from vehicle – access / egress or maintenance);
- Cuts / lacerations (mainly from sacks);
- Fatigue (adequate breaks, job and finish decrease chance of stopping);
- Noise levels (e.g. during compaction); and
- Hazardous substances.

Other issues to capture:

- Identify how company formally state their employees will be carrying out activity; and
- If different people do different tasks, then need a description of what each person does.

B3 COLLECTION SYSTEM ACTIVITY DESCRIPTIONS

This section describes the activities carried out for the following collection subsystems:

- Residual waste collection in wheeled bins and disposable black sacks – Section B3.1;
- Green waste collection in reusable sacks – Section B3.2;
- Dry recyclables (in boxes) and food waste (in small food bins) collection by stillage vehicle – Section B3.3;
- Dry recyclables collection in boxes by Kerbsider vehicle – Section B3.4;
- High-rise flat door-to-door collection of dry recyclables using slave sacks – Section B3.5; and
- Residual waste collection in large wheeled bins, e.g. Palladins from bin stores – Section B3.6.

B3.1 RESIDUAL WASTE COLLECTION (WHEELED BINS AND DISPOSABLE BAGS)

Tables B1 to B5 summarise the activities carried out as part of a residual waste collection system collecting waste in either wheeled bins or disposable plastic sacks. This description is based on observations of the following key stages:

- Assembling of collection crew prior to collection round commencing – Table B1;
- Drive from lorry park to first point of collection on round – Table B2;
- Collection of residual household waste from wheeled bins – Table B3;
- Collection of residual household waste from disposable black sacks – Table B4; and
- Unloading RCV at the incinerator – Table B5.

Table B1 TASK 1: Assembling of collection crew prior to collection round commencing

Sub-task	***Description***
1. Operatives arrive at lorry park site	Operatives usually arrive at site between 05.15 and 05.45, by foot or own vehicle.
2. Operatives swipe employee pass card to gain access into lorry park site	This action essentially “clocks in” the employee.
3. Operatives meet with other crew members on round	Usually go out with the same crew each day. If any absences, crew will be assigned a different team member.
4. Crew confirm round and collection vehicle with on-site supervisor	Rounds normally allocated in advance; therefore, crews will know which area they will be collecting from.
5. Driver obtains keys to refuse collection vehicle (RCV) from on-site supervisor	Drivers use same vehicle for every shift, unless there are absences / breakdowns.

Sub-task	*Description*
6. Driver and loaders walk / run across yard to allocated RCV	
7. Crew climb into RCV cab	
8. RCV exits lorry park through secured gates	Driver may need to manoeuvre RCV from where parked to reach exit gate. Normally between 05.30 and 05.45.

Table B2 TASK 2: Drive from lorry park to first point of collection on round

Sub-task	*Description*
1. Driver drives RCV to first collection point on round	May stop to pick up other operatives along the route, who have not already arrived on-site by departure time. Generally crew members join the RCV at the depot.
2. RCV travels pre-determined route to first collection point	Distance from lorry park varies, although shortest route taken. Route may vary depending upon factors such as weather conditions, conditions of roads, roadworks and traffic-flow.

Table B3 TASK 3A: Collection of residual household waste from wheeled bins

Sub-task	*Description*
1. RCV arrives at collection point where bins are presented	
2. Park RCV with rear of vehicle as close to bins as possible to minimise handling required, and apply handbrake	If possible, this will be at the most convenient side of the road for accessing bins; on less busy roads this may be in the lane for oncoming traffic (rural routes rarely double back on themselves, hence bins must be emptied first pass). Parking may require significant reversing activity (using rear CCTV, banksmen where required, and reversing signals). Parking may require manoeuvring in areas of limited turning space to gain best access to where waste is presented.
3. Loader / driver exit cab	Loader exits cab from passenger side door. Driver [normally] exits cab from driver side door.
4. Loader / driver walks / jogs to where wheeled bins are located	This is normally at the kerbside. For rural properties, or where assisted doorstep collection is provided, bins may be located further inside property boundary at front or back door, or in bin store.

Sub-task	***Description***
5a. If collecting a single wheeled bin, pull / push bin from location to back of RCV (usually using both hands on the bin handles)	If bin overfilled, will use one hand to press down on lid to ensure any contents do not fall out. Task may require pushing / pulling over kerbs, up / down steps and across uneven ground. During observation, uneven surfaces did not appear to impede the operatives.
5b. If collecting two wheeled bins, pull / push bins simultaneously from location to back of vehicle (using one hand per bin gripping bin handle)	If two bins presented at the same point, will tend to collect both simultaneously.
6. Place front lip of wheeled bin(s) upper rim onto bin lift raising mechanism	Raising front end of bin by using foot to push on the bottom section of the back of the bin.
7a. On manually controlled raising vehicles: • Activate raising mechanism to raise and upturn bins into hopper, by pushing button on control panel at rear side of vehicle • Twist lever to activate mechanised “shake” of bins to remove any contents wedged into bin • Activate lowering mechanism to return emptied bin(s) to ground (by continuing to depress same button for raising)	Operatives stand to side of vehicle during raising of bins.
7b. On automatically controlled raising vehicles: • Bin(s) is automatically lifted and emptied into hopper, once bin lip is in contact with lift • Bin(s) are returned to ground level	There is a manual override control that can be used in instances where bins get stuck. Operatives stand to side or rear of vehicle whilst bins are raised.
8. Remove bin from vehicle bin lift	Operatives unhook bin from vehicle.
9. Pull / push emptied bin(s) back to kerbside, using handles	
10. Move onto next wheeled bin for collection	If the next bin is within relatively near distance, loader will walk / jog to it. If the next bin is too far away, loader will re-enter cab through passenger door; driver drives to next location.
11. Activate in-vehicle compaction	After emptying every 4/5 bins, or when the hopper appears full, the compaction is manually operated by pressing button on control pad on side of vehicle at rear or inside cab. In some vehicles, compaction occurs automatically.

Table B4 TASK 3B: Collection of residual household waste from black bags

Sub-task	*Description*
1. RCV arrives at collection point where bags are presented	
2. Park RCV with rear of vehicle as close to bags as possible to minimise handling required, and apply handbrake	See Table B3, sub-task 2.
3. Loader / driver exit cab	Loader exits cab from passenger side door. Driver [normally] exits cab from driver side door.
4. Loader / driver walks / jogs to where bags are located	Normally at kerbside, although on rural rounds may be kept inside old style metal containers to avoid wildlife ripping bags open.
5. Loader picks up bags from floor / inside container	May pick up to 4 bags simultaneously, up to 2 in each hand. Where fewer bags lifted, some may be carried on one shoulder.
6. Carry bags to back of RCV	
7. Throw or place bags directly into back of RCV	May do up to 2 /3 bags at a time, depending on weight of content.
8. Place empty bags (stored in cab) for householders in accessible location on property	This step occurs for rural collection rounds only.
9. Activate in-vehicle compaction	See Table B3, sub-task 11.

Table B5 TASK 4: Unloading at the incinerator

Sub-task	*Description*
1. Driver drives RCV to incinerator	This occurs once vehicle is full, or at the point where operatives decide it would be most time saving to return to the incinerator (or transfer station).
2. RCV enters incinerator site perimeter through gates	Operatives sign in to state that they are on-site.
3. RCV driven onto weighbridge to gain weight of gross tonnage	
4. RCV driven to area for tipping waste into incinerator pit	May have to wait in a queue for a free bay in which to tip into. Rules state that vehicles cannot tip into a bay adjacent to one occupied with another vehicle.

Sub-task	***Description***
5. RCV is reversed into tipping bay	Specific tipping bay for use indicated by green traffic light above bay. A red light signals that the bay cannot be used.
6. RCV reverses as far as edge of tipping bay	Driver halts vehicle when rear tyres come into contact with the edge of the bay, using rear CCTV for guidance.
7. Rear tail section of RCV opened automatically using controls situated in the cab	NOTE: this might be dependent on vehicle type.
8. Rear section of vehicle rises up through 90 degrees, and is emptied down into waste pit	Waste pit is 15m deep, and is fed into through a series of 5 parallel bays.
9. Remainder of vehicle contents emptied into pit through internal ram pushing horizontally outwards towards open back of vehicle	
10. Driver lowers vehicle tail section partially, using controls located in the cab	Close rear once the vehicle is emptied. A bulldozer may be used to push any remaining waste into the pit. Waste may be manually swept into pit by operatives, who clip themselves onto harnessing points to mitigate against the risk of falling over the bay edge.
11. Driver moves RCV forward about 5-10m from edge of bay	
12. Driver puts on safety helmet and exits vehicle from driver side door	
13. Driver manually operates control to lower and close tail section of vehicle	
14. Driver re-enters cab	
15. RCV driven back to weighbridge to gain weight of tonnage, in order to calculate amount of waste deposited	
16a. If further collection activities required, return to appropriate point on round	
16b. If round complete, return RCV to lorry park and hand over keys to supervisor	

B3.1.1 Observed task variations

- Some bulky items observed not were not placed in wheeled bins / bags (e.g. roll of carpet, small bedside table). These are manually lifted, carried to the RCV and thrown into the hopper.

- As a timesaving technique, loaders were observed to turn the wheeled bins around to ensure that the mouth of bin faced outwards towards the RCV prior to the vehicle arriving beside the bin to collect it.
- If there was spare capacity in a bin, loaders may transfer bags from nearby bins that are overflowing, or try and compress bags further into the bin or hold the bin lid down firmly with one hand while transporting bin to rear of vehicle.
- Drivers perform fewer collection duties than solely loading operatives. It was reported that they are more likely to assist in loading typically when several bins are placed together to empty or loaders have to obtain bins from up steps, round the side/back of houses.
- For houses with assisted deliveries (agreed by prior arrangement), operatives may have to pull/push full/empty bins up and down flights of stairs or slopes. In one instance, this required pulling an empty bin up ~25-30 steps.
- Operatives are not supposed to collect black sacks from any urban areas, although in reality, these are often collected – operatives state that if they do not pick them up now, they will only appear in the wheeled bin the following week.
- Black bags collected are not always tied at top, and operatives are required to hold them closed whilst manual handling.

B3.1.2 Unobserved task variations

- During icy weather, RCVs will only pick up from properties that are on roads that have been treated with grit. Non-treated roads will not be served. Apart from this, no differences were reported in how residual household waste is manually collected.
- When increased volume of waste is produced (e.g. from bank holidays, Christmas, or other periods of previous non-collection), the length of the round is extended to clear backlog of rubbish that has built up.
- For rural rounds this may involve 2 return trips to the incinerator.
- For urban rounds this may involve 3-4 return trips to the incinerator.
- Operatives may be required to work on a Saturday where a large volume of waste has built up. Operatives are paid overtime for this extra work.
- Wheeled bins can on occasion fall from the bin lift mechanism into the RCV hopper. Practice here is to not make any efforts to retrieve the bin, rather compact it, note the number of the property and arrange for a replacement.
- It was reported that when rounds collect from low-level flats (e.g. two-storey), sometimes the driver will take collected waste for incineration, leaving behind the loaders to collect the bins from upper levels and place them ready for emptying on the kerbside.

B3.1.3 General characteristics of collection teams

- Operatives normally work a 5-day week (Monday to Friday), with occasional Saturday work required to control any backlog of waste build up.
- Both urban and rural rounds normally start around 05.45. Rural rounds finish at around 11.00. Urban rounds finish around 13.00. Finish time is obviously dependent on participation, presentation rates, traffic flow etc.

- Some RCV filling strategies adopted help to avoid busy periods on the roads (e.g. may fill only half vehicle on first half of round, return to the incinerator as traffic flow increases, then return to finish with a full load).
- Job and finish system operated. Workers do not take formal breaks and work until the collection round is completed.
- All personnel wear full PPE: high visibility jacket, safety shoes and gloves.
- Wheeled bins observed mainly of 240 l capacity, with some examples of 120 l and 360 l.

B3.1.4 Characteristics of rural collection round

- Observed for ~2hrs – 5 mile drive to start point, 7 miles covered during 2 hours. Very rural setting observed – in some cases, large distances between individual houses on the collection round.
- Collection crew: 2 operatives – 1 loader and 1 driver/loader (pre 2001, only a single crew member present on round for both loading and driving).
- Always work in teams of 2 on this round; usually same personnel although these may change during holidays / sickness.
- Driver/loader tends to get out of the cab less frequently than the full time loading operative (e.g. where road single track and bins are on driver’s side, loader will exit cab from his side and walk round back of vehicle to access bins).
- RCV observed – 5 te capacity, manual activation rear-loader, narrow track (to allow access to difficult locations), fitted with emergency stop (in cab and at controls on back) and CCTV above hopper, radios in cab for communicating with base, no GPS system.
- Most commonly, complete one collection round per day (i.e. fill 5 te capacity during round, then drive to incinerator / transfer station for single drop-off).
- Normally service around 600-700 bins on a rural round.
- For larger houses/assisted deliveries, operatives may have to walk inside the property boundary, possibly to the back door, to access wheeled bin or black bag (can involve manual handling over a relatively large distance).
- Properties distant from each other may provide natural opportunities for rest breaks.

B3.1.5 Characteristics of urban collection round

- Observed for ~1.5hrs – medium level of urbanisation observed, collecting from low-rise flats, terraced houses, and semi-detached houses on 30 mph speed limit roads.
- Collection crew: 3 operatives – 2 loaders and 1 driver/loader.
- Always work in teams of 3 on this round, usually same personnel although these may change during holidays / sickness.
- RCV observed – 15 te capacity, Terberg automatic rear-loader with 2 separately operating bin lifts (with manual override), fitted with emergency stop (in cab and at controls on back) and CCTV above hopper, radios in cab for communicating with base, no GPS system.

- Most commonly, complete two collection rounds per day (i.e. fill 15 te capacity during round, drive to incinerator / transfer station for drop-off, then repeat, although may not require filling to full capacity on both).
- Normally service around 1500-1700 bins on urban round.

B3.1.6 Differences between urban and rural collection rounds

- Driver exits cab less frequently to assist on urban rounds in particular. This may reflect greater traffic flow and the need to move the RCV to allow other traffic to access the street, particularly when the entire street is blocked.
- Rural collections have greater uneven surfaces and surfaces peculiar to the area such as cattle grids.
- Loaders typically have further to walk to collect and return the bin in rural areas.
- There exists tremendous variation in distance travelled from one bin to another in the rural versus urban collections.
- Wheeled bins appear to contain more waste on the urban round than on the rural round. Bins were often overflowing and there were numerous additional black bags on the kerbside.

B3.1.7 Additional information on emptying RCV at an incinerator

- At the incinerator observed, vehicles turned in a relatively large turning area before reversing into a bay and leaving by passing through the same route. At other sites, a one-way system is operated.
- There were 5 bays side by side but vehicles are not permitted to tip either side of each other at the same time; they must always leave a spare bay next to them.
- Twenty to thirty vehicles an hour can tip.
- The incinerator burns approximately 750 tonnes of waste a day, 200 tonnes of ash are produced and approximately 30 tonnes of metal recovered.
- The incinerator operates 24 hours a day in the control room, monitoring the boilers and steam.
- The tipping area operates from 6am – 5.30pm.
- Cameras are used by the control room to monitor activity in the tipping area.

B3.2 REUSABLE SACKS COLLECTION (GREEN WASTE)

Tables B6 to B9 summarise the activities carried out as part of a green waste collection system collecting green waste in large reusable bags and emptying these into the back of an RCV (see Figure B1). This description is based on observations of the following key stages:

- Assembling of collection crew prior to collection round commencing – Table B6;
- Drive from lorry park to first point of collection on round – Table B7;
- Collection of green waste from kerbside – Table B8; and
- Unloading RCV at a compost (open windrow) site – Table B9.

Figure B1 Emptying of reusable bag of green waste into back of an RCV

Table B6 TASK 1: Assembling of collection crew prior to collection round commencing

Sub-task	*Description*
1. Operatives arrive at council depot	Depot opens at 07.00. Operatives usually arrive at site between about 07.30, by foot or own vehicle.
2. Operatives meet with other crew members on round in depot office	Usually go out with the same crew each day. If any absences, crew will be assigned a different team member.
3. Crew confirm round and collection vehicle with on-site supervisor	Rounds allocated in advance, the same crew conducts the same round on a 4-day weekly cycle, and therefore crews know which area they will be collecting from.
4. All crew members are checked in by supervisor in office and driver obtains keys for RCV from supervisor	Drivers use same vehicle for every shift, unless there are absences / breakdowns.
5. Work sheets allocated	Work sheets detail any additions (such as assisted collections) for that day's round.
6. Driver and loaders walk to lorry park to obtain allocated collection vehicle	
7. Driver conducts pre-start checks on vehicle	Driver checks vehicle lights, tyres, oil, water, tachograph and that the battery handling and first aid kits are on board the vehicle.

Sub-task	***Description***
8. Crew climb into vehicle cab	Each crew has 3 loaders and 1 driver.
9. Collection vehicle exits site through gates	Driver may need to manoeuvre vehicle from where parked to reach exit gate. They leave depot at 7.45.

Table B7 TASK 2: Drive from lorry park to first point of collection on round

Sub-task	***Description***
1. Driver drives collection vehicle to first collection point on round	All crew members joined the collection vehicle at the depot and will be present.
2. Collection vehicle travels route to first collection point	Distance from depot varies according to round and drivers preference for route taken, although shortest route usually taken. Route may also vary depending upon factors such as weather, conditions of roads, road works and traffic-flow.

Table B8 TASK 3: Collection of green waste from kerbside

Sub-task	***Description***
1. Collection vehicle arrives at first collection point	Household green waste (garden waste such as plants, grass cuttings and tree cuttings) is presented at kerbside in nylon sack.
2. Park collection vehicle with nearside of vehicle next to the nearside kerb, as close to sacks as possible to minimise handling required, and apply handbrake	On less busy roads and narrow urban roads, it may be possible to conduct only one pass on the street to empty sacks from both sides of the road. This is not possible on main roads/busy times of the day, and the vehicle must double back on itself with operatives collecting from only the kerbside. Parking may require significant reversing activity (using rear CCTV, banksmen where required, and reversing signals). Parking may require manoeuvring in areas of limited turning space to gain best access to where waste is presented.
3. Loaders exit cab	Loaders exits cab from passenger side door. Driver does not carrying out loading and remains in cab.
4. Loaders walk / jog to where sack is located	This is normally at the kerbside. For rural properties, or where assisted collection is provided, sacks may be located further inside property boundary at front or back door, or within grounds.

Sub-task	***Description***
5. Sack is grasped using one of the side handles	Each nylon sack has a handle on either side at the top of the sack.
6. Loader drags sack, using handle to the rear of the collection vehicle	Task may require pulling, over kerbs, uneven surfaces, steps, steep road verges. Twisting of upper torso is often required.
7. Sack is raised from ground level	Loaders lift/swing sack upwards from ground level to a sufficient height to rest sack on edge of vehicle hopper (upper arm height approximately). Loaders observed to lift the sacks either by one side handle (using two hands) or by grasping both side handles with either hand.
8. Sack contents are emptied into hopper	Loaders invert sack and grasp either the handle located on the underside of the sack or the corners of the sack. The sack contents fall or are shaken into the hopper. Any debris remaining is removed by using the underside handle to shake the sack up and down several times.
9. Carry empty sack back to kerbside	Sacks are returned to just within property boundary e.g. on wall, fence, gate or if assisted collection, returned to where they were obtained.
10. Move onto next sack for collection	If the next sack is within relatively near distance, loaders will walk/jog/run to it. If the next sack is too far away, loaders will re-enter cab through passenger door; driver drives to next location.
11. Activate in-vehicle compaction system	After emptying approximately 4/5 sacks, or when the hopper appears full, the compaction is manually operated by pressing button on control pad on side of vehicle rear or inside cab. Driver has a rear camera that allows him to monitor rear hopper and therefore push emergency stop button in the event of any loader becoming entangled in compaction machinery.

Some collection rounds also collect from ‘Bio-bins’, which are 240 l wheeled bins, which householders use to dispose of garden waste and food waste. These bins can be fitted onto a normal mechanical bin lift at the back of the RCV to empty. This practice was not observed during the visit.

Table B9 TASK 4: Unloading at the composting site

Sub-task	***Description***
1. Driver drives collection vehicle to composting site for unloading	This occurs always at end of round and additionally if operatives decide it is necessary to unload during round.
2. Collection vehicle enters through site gates	Loaders have to remain in cab when vehicle is tipping. Instead they often choose to exit vehicle and wait in area just within site gates prior to tipping.
3. Driver waits for signal to enter weighbridge	Compost site operatives signal manually (thumbs up) for vehicle to drive onto weighbridge.
4. Collection vehicle driven onto weighbridge	Gross tonnage of vehicle recorded.
5. Driver waits for signal to exit weighbridge	Site operative signals manually (thumbs up) for vehicle to drive off weighbridge.
6. Vehicle is driven into tipping area	Only one vehicle at a time is allowed to be in tipping yard. May have to wait in a queue if multiple collection vehicles arrive at once.
7. Compost site operative in mobile plant (shovel loader) signals to collection vehicle which area to tip green waste into	Compost staff are responsible for choosing area to tip into and for rotating area as necessary. Once waste has been tipped, shovel loader driver will move waste to pile for shredding prior to being placed in windrows for composting.
8. Collection vehicle stops in instructed area and driver applies handbrake	Driver halts vehicle and remains in vehicle.
9. Driver prepares vehicle to tip using controls situated in cab	This may depend on vehicle type.
10. Driver exits vehicle	
11. Using controls situated at side of vehicle driver operates tipping mechanisms	One button is pressed to open rear, and rear section of vehicle rises up through 90 degrees and is emptied partially.
12. Driver re-enters cab and drives forward approximately 5-10 metres	This is done to leave space for additional tipping.
13. Driver exits cab and empties remaining contents	Driver pushes a different control button to operate internal ram, horizontally pushing remaining contents out into tipping area.
14. Driver re-enters cab and lowers vehicle tail section partially	Using controls located in cab.
15. Driver moves vehicle forward about 10 metres	This is done to move away from tipped pile of green waste.

Sub-task	*Description*
16. Driver exits vehicle cab	
17. Driver manually operates control on side of vehicle to close rear of vehicle	Presses one control button to replace internal ram and using two hands, presses two other buttons simultaneously to lower and close tail section of vehicle.
18. Driver re-enters cab	
19. Vehicle driven back to weighbridge and driven on when compost site operatives manually signal it is okay to do so	This is done to gain weight of vehicle and calculate volume of waste tipped. Print out detailing the volume of waste tipped is handed to driver.
20. Driver drives off weighbridge and loaders re-enter cab.	
21. Vehicle is driven out of compost site through gates	Vehicle driven out the same way it was driven in.
22. If round complete, collection vehicle is driven back to lorry park, crew are checked out by supervisor and driver returns keys to supervisor, if not vehicle is driven back to complete round.	Supervisor is also given print out of tonnage tipped at compost site.

B3.2.1 Observed task variations

- On occasion, operatives reach into hopper to flatten down the green waste that has accumulated, to allow more materials to be placed inside.
- Due to the risk of injury when the hopper compaction machinery is in operation loaders are instructed to stand clear and not empty any bags into the hopper whilst the machinery is in motion. However, loaders were observed emptying the contents of black bags (which householders had used to dispose of additional garden waste) into the hopper during this time.
- Supervisor monitors each crew for approximately 15-30 minutes daily.
- Where materials not suitable for collection are placed in the waste sacks (e.g. food, paper, card, ashes, soil, and rubble or residual waste) or if sack is excessively heavy, loaders leave sack at the kerbside. A pre-printed council letter, kept in cab, is posted through household door to inform the householder why the sack has not been removed and to remind them about the types of materials that will not be collected.
- The householder may leave excess garden waste that will not fit into the sack provided in other alternative receptacles e.g. black bags. These are emptied at the discretion of each crew; some crews will leave them at kerbside. These are emptied into hopper directly and the empty bag returned to household, placed inside sack or stuffed in wall or fence etc.
- Typical distance to drive to compost site at end of round is 5-9 miles followed by a 12-mile journey back to depot.

B3.2.2 Unobserved task variations

- During icy weather, drivers use own discretion to decide whether or not they will drive on icy roads. However, green waste collection is considerably less in winter months; between November and March only 4 crews operate. Excess staff are generally laid off and re-recruited in spring.
- When increased volume of waste is produced (e.g. from bank holidays, or other periods of previous non-collection), the length of the round may be extended to clear backlog of green waste that has built up. This may include additional trips for unloading at the composting site.
- For houses with assisted deliveries (agreed by prior arrangement), operatives may have to walk inside the property boundary, possibly to the back door, to access the sack and drag it to the vehicle (this can involve manual handling over a relatively large distance, or up and down flights of stairs or slopes).
- Assisted deliveries are organised by householders phoning council department who contact supervisor. A help list is drawn up for each round and allocated to each crew at the start of the shift.
- If crew report a sack as being heavy to supervisor, he will come out and determine whether or not 2 loaders can lift the sack to empty it. If so, each loader will take a handle on either side of the sack and together empty it into the hopper. If the sack is deemed too heavy to lift a notice, described above, is posted and it is the householder’s responsibility to empty the sack.
- Only one sack is allocated to each household, but occasionally households have acquired 2 sacks and will leave them for collection. In this instance, a notice is posted, as above, and either only one sack will be emptied or both sacks will be emptied but the crew will take the additional sack back to the depot.
- Where sacks are found to be damaged or have been split, they are replaced with spares that are located within the vehicle.
- Four extra rounds are conducted during summer on Saturdays and Mondays. Overtime crew cover these.

B3.2.3 General characteristics of collection teams

- Operatives normally work a 4-day week over Monday-Friday, each day working 9.25 hrs. Operatives are paid an overtime rate of time and a half for any hours worked over 37 hours in a week. Overtime typically occurs after bank holidays/during summer months when extra rounds will be put on to clear any backlog.
- Eight collection crews operate on this council’s compostable waste collection schemes, 6 crews collecting green waste and 2 collecting bio-bins (wheeled bins which householders use to dispose of garden waste and food waste; this was not observed during visit).
- Green waste crews have 3 loaders and 1 driver; bio-bin crews have only 2 loaders and 1 driver. The roles are not interchangeable.
- Both urban and rural rounds start at 07.45, although the demarcation between degrees of urbanisation is not always clear, as both rounds incorporate a variety of housing types. Finish time for all crews was 17.45.

- Each round visits between 1200-1500 households daily. The drive to the start of the round varies between 5-10 miles. An average round is between 50-60 miles for both urban and rural collections.
- Drivers remain in the cab for the entire round and never conduct loading duties.
- After one hour of work loaders are allocated a 20 minute break every hour. The breaks are rotated where one loader will take a break and remain in the cab whilst the other two load, then the next one will take a break etc. The driver takes a break every 2.5 hours for 20 minutes. All crew stop for lunch at 1300-1345; they have to return to the depot and will either eat in the canteen or go home/out for lunch.
- Green waste collection crews were always in teams of 4 on the rounds observed; usually the same personnel are in each crew, although this may change during holidays or sickness. Agency staff are never utilised when there are absences; instead, council waste collecting staff from other schemes, e.g. residual waste, may be shifted temporarily to cover shortages.
- The driver gets out of the cab occasionally, i.e. when he takes a break. He may stay in the cab or may get out to walk about, have a cigarette etc.
- All personnel wear full PPE; high visibility jacket, safety shoes and gloves.
- New staff are given one day of training run by the council training team. This covers hazards, vehicle safety, PPE, emergency procedures, etc. They are then observed on the round by their supervisor for 1-2 hours and are thereafter periodically supervised for several weeks.
- Risk assessments have identified risk to employees such as manual handling, workplace transport, public vehicles, slips and trips and entanglement in hopper machinery.

B3.2.4 General characteristics of collection receptacle/vehicle

- The green waste sacks observed were made of white nylon, with one handle at each side and a handle strap on the base. They were stated to be about 25 kg in weight when full.
- Sack weight varies, although on average was stated to be approximately 15 kg.
- Collection vehicle observed – 8 te capacity, manual activation rear-loader, narrow track to allow access to difficult locations, fitted with emergency stop (in cab and at controls on back) and CCTV above hopper. Daily collection for each crew is normally between 6-11 tonnes.
- Each vehicle is contactable by mobile phone, kept in the cab.
- Drivers use CCTV in cab to observe loading activities at rear. In the event of an emergency (e.g. loader becoming entangled in hopper mechanics, the driver can press emergency stop button in cab).
- Usually complete 1 collection round per day (i.e. fill to capacity during round and drive to composting site for drop-off); occasionally 2 trips to compost site may be required, especially during busy summer months.

B3.2.5 Differences between urban and rural collection rounds

- Rural collections have greater uneven surfaces and surfaces peculiar to the area such as cattle grids.
- Loaders typically have to walk further to collect and drag sacks from rural areas.

- There is greater variation in distances travelled from one household to another in the rural versus urban areas.
- A problem with having to drag bags down longer verges was reported in rural areas.
- In the rounds observed, participation rate was stated to be good, in the range from 60-80%. It was reported that a greater volume of green waste is left for collection in rural areas.
- In urban cul-de-sacs the crew will exit vehicle to load as vehicle reverses down street. At the bottom of street loaders will enter cab and ride back up the street and onto the next street.
- For busy urban roads or wide roads, vehicle will typically go down one side of the street and back up the other in order to prevent loaders having to cross the street. In narrow streets, loaders may collect sacks from either side of the street, dragging sacks over the road.

B3.2.6 Additional information on emptying at a compost site

- Three full time staff were employed, all of whom have interchangeable roles (they can operate weighbridge and mobile plant etc).
- The site is open from 8am to 5pm Monday to Friday and 8am to 1pm Saturday.
- Approximately 12 vehicles a day tip at the site.
- Only one vehicle is allowed to tip at a time.
- Trucks typically begin arriving at the composting site about 4pm, although they will tip in the early afternoon if required.
- On the observed round each crew will visit the composting site at least once and sometimes twice a day.
- The site employed the open windrow method of composting.
- Tipped green waste was left in piles. Contractors come to site 2 or 3 times a week (as required) to shred this waste mechanically and place in open windrows for composting.
- The composting process takes approximately 9 weeks during which time the compost is regularly turned using mobile plant.
- Finished compost is sold for best price, loaded onto vehicles and taken away by external contractors.

B3.3 KERBSIDE SORT AND COLLECTION OF DRY RECYCLABLES (BOXES) AND FOOD WASTE (SMALL FOOD BINS) – STILLAGE VEHICLE

Tables B10 to B15 summarise the activities carried out as part of a kerbside sort and collection system for dry recyclables and food waste. In the system observed a stillage vehicle (as illustrated in Figure B2) was used for collection. Dry recyclables were collected in boxes and food waste was collected in small bins. This description is based on observations of the following key stages:

- Assembling of collection crew prior to collection round commencing – Table B10;
- Drive from lorry park to first point of collection on round – Table B11;

- Collection of recyclables from boxes with kerbside sort – Table B12;
- Collection of food waste from bins at kerbside – Table B13;
- Unloading dry recyclables at the transfer station (depot) – Table B14; and
- Unloading food waste at the transfer station (depot) – Table B15.

Figure B2 Stillage vehicle used in observed dry recyclable and food waste collection system

Table B10 TASK 1: Assembling of collection crew prior to collection round commencing

Sub-task	*Description*
1. Operatives arrive at depot and sign in	Depot opens at 06.00. Operatives usually arrive at site between 06.15 and 06.45, by foot or own vehicle.
2. Operatives meet with other crew members on round	Usually go out with the same crew each day. If any absences, crew will be assigned a different team member.
3. Crew confirm round and collection vehicle with on-site supervisor	Rounds normally allocated in advance, therefore crews will know which area they will be collecting from.
4. Driver signs in at office to obtain keys for collection vehicle	Drivers use same vehicle for every shift, unless there are absences / breakdowns.

Sub-task	*Description*
5. Work sheets allocated	Work sheets detail any additions (such as assisted collections) for round that day.
6. Driver and loaders walk short distance to lorry park to obtain allocated collection vehicle	
7. Driver conducts pre-start checks on vehicle	Driver checks vehicle lights, tyres, oil, water, tachograph and that the battery handling and first aid kits are on board the vehicle.
8. Crew climb into collection vehicle cab	
9. Lorry is weighed on weighbridge prior to leaving site	
10. Collection vehicle exits site through gates	Driver may need to manoeuvre collection vehicle from where parked to reach exit gate. Normally leaves depot between 6.45 and 7.00.

Table B11 TASK 2: Drive from lorry park to first point of collection on round

Sub-task	*Description*
1. Driver drives collection vehicle to first collection point on round	Crew members join the collection vehicle at the depot.
2. Collection vehicle travels route to first collection point	Distance from depot varies according to drivers preference, although shortest route usually taken. Route may vary depending on weather conditions, road condition, road works and traffic-flow.

Table B12 TASK 3A: Collection of recyclables from boxes with kerbside sort

Sub-task	*Description*
1. Collection vehicle arrives at collection point where boxes are presented at kerbside	
2. Park collection vehicle with nearside of vehicle next to the nearside kerb, as close to boxes as possible, to minimise handling required, and apply handbrake	On less busy roads, it may be possible to conduct only one pass on the street to empty boxes from both sides of the road. This is not possible on main roads/busy times of day, and the vehicle must double back on itself. Parking may require significant reversing activity (using rear CCTV, banksmen where required, and reversing signals). Parking may require manoeuvring in areas of limited turning space to gain best access to where waste is presented.

Sub-task	*Description*
3. Loader / driver exits cab	Loader exits cab from passenger side door. Driver [normally] exits cab from driver side door.
4. Stillage bars are removed by loaders / driver to allow access to section of stillage	Operatives remove stillage bars on each side of the vehicle (metal bars which securely close stillage flaps) by removing pin and allowing bars to swing down.
5. Lowest side flap on stillage is opened using key	Flap is unlocked and lowered on hinges to rest against side of vehicle and allow access to empty stillage.
6. Loader / driver walks to where boxes are located	This is normally at the kerbside. For rural properties, or where assisted doorstep collection is provided, boxes may be located further inside property boundary at front or back door.
7. Loader carries or pushes boxes to vehicle	Task may require lifting and carrying boxes over kerbs, up / down steps, across uneven ground. During observation, uneven surfaces did not appear to impede the operatives. Loaders are advised to kick boxes to ascertain weight if it is not apparent how heavy the box is prior to lifting (e.g. heavy items may be obscured by paper). If collecting a single box, operatives either: lift and carry the box to stillages on side of collection vehicle (usually using both hands on the handles); or push box along ground using foot to near vehicle, then lift up to side of vehicle. If boxes are light in contents, operatives may carry two boxes at once, one in each hand. When side waste (additional bags not presented in boxes) are present, operatives will collect and empty boxes first, then return to kerbside to deposit empty box and collect side waste. This technique reduces the number of times operatives have to walk back and forth between house and vehicle.
8. Attach lip of box over hooks on edge of stillage	This allows the box to rest on the side of vehicle, leaving the operative’s hands free to conduct the kerbside sorting operation.
9. Operatives sort one type of recyclable into designated stillage on collection vehicle	The type of recyclable emptied first can depend on i) where there is space to place box on side of vehicle, and ii) which recyclable type is most prevalent in the box. If recyclables are presented in plastic bags within the boxes, the bags are checked visually for contents and then emptied as appropriate. Empty bags are collected in plastic sacks on the vehicle.
10. Operatives sort second and third types of recyclables into appropriate stillage on vehicle, if also presented in box	May have to lift box and re-position nearer to a different stillage on the vehicle.

Sub-task	*Description*
11. Lift emptied box and carry back to kerbside, using handles	
12. Replace outside property on kerbside	
13. Move onto next box for collection	If the next box is within a relatively near distance, loaders will walk to it. If the next box is too far away, loaders will re-enter cab through passenger door; driver drives to next location.
14. When the lowest portion of the stillages are full, the lowest stillage flap is closed/locked and the higher stillage flap is opened/unlocked	Operatives decide whether stillages are sufficiently full to merit closing the lower flap and opening the higher one.
15. Middle portion of stillage is filled through the higher flap following exactly the same procedures detailed before.	When loaders are filling the stillages via the highest flap a significant amount of overarm lifting and stretching is required.
16. When the middle portion of the stillages are full the highest flap is closed/locked	Operatives decide whether stillages are sufficiently full to merit closing the highest flap.
17. Once the highest stillage flap is closed recyclables are placed in the stillages via accessing the vehicle	Loaders ascend 3 steps into body of the vehicle and deposit recyclables directly into the stillages. Loaders descend via 3 steps once the collection box has been emptied.

Table B13 TASK 3B: Collection of food waste from bins at kerbside

Sub-task	*Description*
1. Collection vehicle arrives at point where food waste bins are presented at the kerbside	
2. Park collection vehicle with nearside of vehicle next to the nearside kerb, as close to bins as possible to minimise handling required, and apply handbrake	On less busy roads, it may be possible to conduct only one pass on the street to empty bins from both sides of the road. This is not possible on main roads/busy times of day, and the vehicle must double back on itself. Parking may require significant reversing activity (using rear CCTV, banksmen where required, and reversing signals). Parking may require manoeuvring in areas of limited turning space to gain best access to where waste is presented.
3. Loader / driver exit cab	Loader exits cab from passenger side door. Driver [normally] exits cab from driver side door.
4. Loader / driver walks to where food waste bins are located	This is normally at the kerbside. For rural properties, or where assisted doorstep collection is provided, bins may be located further inside property boundary at front or back door.

Sub-task	***Description***
5. Operatives lift and carry bin, using handle, to stillages inside collection vehicle	Task may require lifting and carrying bins over kerbs, up / down steps, across uneven ground. During observation, uneven surfaces did not appear to impede the operatives. Operatives access stillages inside vehicle via 3 steps.
6. Food waste bin is emptied into stillage	Operatives hold rear of bin over stillage edge, bin lip facing away from operative, and invert bin in order to empty food waste. Holding the bin rear prevents contact with food waste. Bin may be tapped on the stillage edge several times to remove any residue waste.
7. Operatives descend from the vehicle via 3 steps	
8. Emptied food waste bin is carried back to kerbside, using handle	
9. Place outside property on kerbside	Empty waste bin is returned to kerbside and locked by pushing handle on bin down. If a recyclable box is also present, the empty food waste bin is placed on its side within the recyclable box. This indicates to the householder that it has been emptied and also keeps the kerbside tidy.
10. Move onto next bin for collection	If the next bin is within a relatively near distance, loaders will walk to it. If the next bin is too far away, loaders will re-enter cab through passenger door; driver drives to the next location.

Table B14 TASK 4A: Unloading at the transfer station (depot)

Sub-task	***Description***
1. Driver drives collection vehicle to transfer station (depot) for unloading	This occurs once a certain section of the vehicle is full (normally cans, as these have greatest volume or paper which fills quickly).
2. Collection vehicle enters transfer station (depot) through site gates	
3. Collection vehicle driven onto weighbridge	Gross tonnage of vehicle recorded.

Sub-task	*Description*
4. Batteries, yellow pages, textiles and plastic bags are removed from the vehicle: • Plastic sacks containing plastic bags are removed from the vehicle and placed within a skip located beside the weighbridge. • Operatives put on battery handling equipment, full length gloves, apron and goggles and take batteries to specialised battery container close to the weighbridge. • Textiles, which have been collected in bags, are removed from the vehicle and placed within a skip near the weighbridge. • Yellow pages are removed from the vehicle and placed within a skip near the weighbridge.	Once vehicle tonnage has been recorded and prior to exiting weighbridge, loaders exit vehicle cab and remove plastic bags and any batteries, yellow pages or textiles collected. Specialist contractors remove all these items once a sufficient volume has been collected.
5. Loaders exit vehicle and wait at office whilst driver drives collection vehicle off weighbridge into unloading area for recyclables, consisting of separate concrete bays	Only the driver is allowed to be in the tipping yard. He may have to wait in a queue for a free bay in which to tip into, if multiple collection vehicles arrive at once. Only one 12 tonne vehicle or two 7.5 tonnes vehicles are permitted in the observed unloading area at the same time.
6. Collection vehicle stops in centre of unloading yard and driver applies handbrake	Driver halts vehicle and remains in cab
7. Fork-lift trucks removes stillage containers from vehicle	Fork-lift inserts forks into apertures at the base of stillage container on collection vehicle and removes container from vehicle.
8. Fork-lift reverses away from collection vehicle with stillage container in situ	
9. Stillage containers which consist of two compartments (e.g. green and brown glass) are covered on one side	Fork-lift driver halts the vehicle beside a skip in the yard containing metal sliders. Fork-lift driver exits cab, manually picks up a slider and slides it over one half of the stillage container (so that only one compartment is emptied into a bay at a time, e.g. green glass, thus preventing contamination of recyclables).
10. Recyclables are emptied into the appropriate bay	Fork-lift is manoeuvred into a bay and, using controls located in the fork-lift cab, the stillage container is rotated and inverted over bay, thus emptying contents into the bay.
11. Slider is removed	Having emptied one half of container, fork-lift drives to yard skip containing metal sliders and inverts container, sliding off metal slider and depositing it back into skip. The remaining half of the container can now be emptied as previously detailed.

Sub-task	*Description*
12. Recyclables are pushed to the rear of bay	A shovel loader may be used to push any remaining waste into the bay. The loader may be driven over cans in order to crush them and the bucket of the shovel loader is pressed on top of the glass to break it, thus increasing bay capacity. Recyclables are also manually swept into bays by yard operatives.
13. Empty stillage containers returned to the collection vehicle	Fork-lift is driven back to the side of collection vehicle and replaces stillage container on collection vehicle. It then reverses from vehicle withdrawing prongs leaving the stillage container on the collection vehicle.
14. Once fully emptied, collection vehicle is driven back to the weighbridge	This is done to determine weight of tonnage, in order to calculate the amount of recyclables deposited.
15. Loaders replace stillage bars on side of collection vehicle	While vehicle is on the weighbridge the two loaders return to the vehicle and use the weighbridge platform to gain the necessary height to replace rear stillage bars. Stillage bars on the side of the vehicle are replaced by one loader and pins inserted in order to secure them.
16a. If further collection activities are required, return to appropriate point on round to continue	
16b. If round complete, return collection vehicle to lorry park and hand over keys to supervisor	At end of shift operatives sign off in depot office and drivers check vehicle for any damage incurred to vehicle during the shift.

Table B15 TASK 4B: Unloading food waste at transfer station

Sub-task	*Description*
1. Driver drives collection vehicle to food waste transfer station (depot) for unloading	This is done once food waste stillage is full or at the point where operatives decide it would be most time saving to return to the transfer station.
2. Collection vehicle enters transfer station (depot) through site gates	
3. Collection vehicle driven onto weighbridge	Gross tonnage of vehicle recorded.
4. Loaders sign in at weighbridge	Once vehicle tonnage has been recorded and prior to exiting weighbridge, loaders exit vehicle cab and sign in at weighbridge office.

Sub-task	*Description*
5. Collection vehicle driven into unloading area for food waste	It may have to wait in a queue to deposit food waste if multiple collection vehicles arrive at once.
6. Collection vehicle stops and driver applies handbrake	Driver halts vehicle and driver/loaders remain in the vehicle.
7. Fork-lift truck removes food waste containers from vehicle	Fork-lift inserts forks into apertures at the base of the food waste container on the collection vehicle and removes container from the vehicle.
8. Fork-lift reverses away from collection vehicle with food waste container in situ	
9. Food waste deposited in food waste skip	Fork-lift driver halts vehicle besides food waste, using controls located in fork-lift cab, container is rotated and inverted over the skip, thus emptying contents into the skip.
10. Empty containers returned to collection vehicle	Fork-lift is driven back to the side of the collection vehicle and replaces food waste container on the collection vehicle. It reverses from the vehicle, withdrawing prongs, leaving stillage container on the collection vehicle.
11. Food waste container on opposite side of collection vehicle is emptied	Food waste container from opposite side of the vehicle is emptied following the same procedure detailed above.
12. Driver/loader replaces stillage bars on side of collection vehicle	Driver/loader exits cab and replaces stillage bars on both sides of the vehicle and pins are inserted in order to secure them.
13. Once emptied, the collection vehicle is driven back to the weighbridge	This is done to determine weight of tonnage, in order to calculate the amount of food waste deposited.
14. Vehicle exits transfer station site	Driver signs out at weighbridge office, returns to vehicle and drives through gates, exiting site.
15a. If further collection activities are required, return to appropriate point on round to continue	
15b. If round complete, return collection vehicle to lorry park and return keys to supervisor	

B3.3.1 Observed task variations

- On occasion, operatives reach in through the side flaps to flatten down the recyclables that have accumulated, to allow more materials to be placed inside.
- If there was spare capacity in a box, loaders may transfer materials from nearby boxes that are overflowing, or try and compress material further into the box.

- Drivers perform fewer collection duties than solely loading operatives. It was reported that they are more likely to assist in loading typically when several boxes are placed together to empty, or where loaders have to obtain boxes from up steps or round the side/back of houses. On busy streets drivers typically do not leave their cab, and typically are less likely to load on rural rounds.
- Where materials not suitable for collection are placed in the recycling/food collection box/bin, operatives sort the suitable materials into the stillages as normal, and leave the other materials in the box at the kerbside. A brightly coloured sticker is then placed on the side of the box to inform the householder about the types of materials that will be collected. Gloves are usually removed when applying these stickers, as they are awkward to apply otherwise.
- The householder may leave excess recyclables that will not fit into the box provided in alternative receptacles. These are sorted and emptied in the same manner as described above.
- Where recyclables are presented in carrier bags within the box, the recyclables are emptied from the carrier/plastic bags into the appropriate stillages, and the empty carrier/plastic bags are collected in large plastic sacks hanging beside the stillages.

B3.3.2 Unobserved task variations

- During icy weather, collection vehicles will only pick up from properties that are on roads that have been treated with grit. Non-treated roads will not be served. Apart from this, no differences were reported in how recyclables are manually collected in these conditions.
- When an increased volume of waste is produced (e.g. following bank holidays, Christmas, or other periods of previous non-collection), the length of the round may be extended to clear the backlog of recyclables that has built up. This may include 3 trips for unloading at the transfer station as opposed to the normal 2. Occasionally, extra staff (agency) are employed to assist at busy times.
- For houses with assisted deliveries (agreed by prior arrangement), operatives may have to walk inside the property boundary, possibly to the back door, to access the box (this can involve manual handling over a relatively large distance, or up and down flights of stairs or slopes).
- Support crews consisting of one person are sent out on a daily basis to about 7-8 properties on average, depositing new boxes as requested.
- Where boxes are found to be damaged or have split, they are replaced with spares that are located on the driver's side of the vehicle.
- Yellow pages are collected via recycling boxes and when presented are deposited within a collection box within the vehicle.
- Large batteries (e.g. car) are collected from the kerbside by operatives who employ a battery handling kit, which consists of full-length gloves, apron and safety goggles. Batteries are placed within a compartment on the underside of the vehicle, which has a capacity of 4 batteries. If 4 batteries are collected during the round prior to returning to the depot, operatives will call a supervisor. The supervisor will meet the round, remove the batteries and take them back to the depot in specialised containers within a transit van.
- Occasionally householders will place one piece of plastic within the recycling box. Loaders sometimes remove this and place it in the large plastic sack for collecting

plastic bags; however, if there are numerous plastic items, or the householder is a frequent offender, the plastic will not be removed and the recyclable box will be tagged to indicate which items are acceptable.

B3.3.3 General characteristics of collection teams

- Operatives normally work a 5-day week. Operatives are paid an overtime rate for any hours worked over 40 hours in a week.
- Both urban and rural rounds normally start around 07.00, although the demarcation between degrees of urbanisation is not always clear, as both rounds incorporate a variety of housing types. A job and finish system is operated; finish time is obviously dependent on participation, presentation rates, traffic flow etc, but was reported to typically be about 1300 to 1400 hours.
- Workers are allocated 10 minute breaks every 2.5 hours and 30 minutes for a lunch break, which it was stated, they normally take.
- All collection personnel wear full PPE; high visibility jacket, safety shoes and gloves.
- New staff have a half an hour induction talk and are always placed with an experienced loader for a 13 week probationary period.
- An ‘Ensure Collection’ system is in operation for households who have missed collection on 3 occasions, either due to not placing boxes out on time, or because loaders have missed boxes. The supervisor informs crew of an ‘Ensure Collection’ and once collection has been conducted the crew must log the exact time of collection and the driver must sign the ‘Ensure Collection’ form to confirm.

B3.3.4 General characteristics of collection receptacle/vehicle

- The plastic recyclable boxes observed were of 55 litre capacity.
- Householders have 5 litre capacity food waste caddies kept inside their house, which are lined with paper prior to filling with food waste. Once full, the food is wrapped in the paper and these internal boxes are emptied into the larger external food waste bins.
- All collection teams involve 3 operatives: 2 loaders and 1 driver/loader.
- Observed two types of urban round, collecting from detached, semi-detached, bungalows (assisted deliveries) and terraced houses on 30 mph speed limit roads.
- Teams made up of 3 on the rounds observed; usually the same personnel are in each crew, although these may change during holidays / sickness. Agency staff are utilised where there are absences.
- Driver/loader tends to get out of the cab less frequently than the full time loading operative and less frequently in rural compared to urban rounds.
- Collection vehicle observed – 12 te capacity (7.5 te capacity vehicles also operate in this area but not observed). Stillages located on either side of the vehicle (for paper, coloured glass, clear glass and cans.
- Recyclables collection is performed weekly at the locality observed.
- Most commonly, crew complete two collection rounds per day (i.e. fill / nearly fill to capacity during the round, drive to the transfer station for drop-off, then repeat, although it may not require filling to full capacity on both rounds).

- Normally service around 600-800 boxes on an urban round, collecting about 12 tonnes of waste, and 450 houses, collecting about 7 tonnes of waste, on a rural round. Generally one 12 tonne load takes about 6 hours to collect. Box weight varies, although on average it was stated to be 8 kg.
- Due to noise issues, the company are contractually bound to not perform collections until 07.00 am.
- In the rounds observed, participation rate was stated to be variable, in the range from 20-80%. This reflects mainly socio-demographic factors.
- There is usually a spare collection crew available to help out during busy periods / rounds.

B3.3.5 Additional information on emptying stillage vehicle at a transfer station

- At the transfer station, collection vehicles drive in via the weighbridge into the yard and once empty, turn around and drive out via the weighbridge.
- Three staff were employed at the yard: one charge hand and two fork-lift drivers. At quiet times (morning) both fork-lifts will unload vehicles simultaneously. At busy times, in the afternoon, only one fork-lift operates at a time; drivers will rotate, each spending half an hour driving the fork-lift before taking a break and being replaced by the other driver.
- Prior to trucks arriving yard staff will generally clear up the yard and check bays for contamination of recyclables.
- Trucks typically begin arriving at the transfer station from about 10 am.
- If too many trucks arrive at once, they are parked in the lorry park, locked up and then yard staff will drive them round for emptying one at a time at the end of the day.
- There were five concrete bays side by side in the recycling section of the station (for paper, cans, brown glass, green glass and clear glass).
- When recyclable bays are three quarters full, the charge hand will call the contractors to come and collect in large articulated lorries. Typically by the time they arrive (about half an hour) the bay will be at full capacity.
- Yard operatives were observed wearing safety glasses (to reduce likelihood of shards of smashed glass from the bays flying into their eyes).
- Yellow pages are stored within a separate container at the transfer station and once full are collected by specialist contractors.
- Oil is removed from the collection vehicle and temporarily placed at an oil station near the weighbridge. At quiet times yard staff will decant oil into a large oil container. This container is emptied, via a pump, every 6 weeks by specialist contractors.
- Batteries are placed within sealed containers by loaders wearing battery-handling kit. Once full, specialist contractors empty the containers.
- Each crew will visit food waste transfer station at least once and often twice a day. If food waste fills up quickly, crews will typically empty only food waste and return to continue round.

B3.4 MIXED DRY RECYCLABLES COLLECTION (BOXES) – KERBSIDER VEHICLE

Tables B16 to B20 summarise the activities carried out as part of a kerbside sort and collection system for dry recyclables. In the system observed a Kerbsider vehicle (as illustrated in Figure B3) was used for collection. Dry recyclables were collected in boxes of 55 l capacity. This description is based on observations of the following key stages:

- Assembling of collection crew prior to collection round commencing – Table B16;
- Drive from lorry park to first point of collection on round – Table B17;
- Collection of recyclables from boxes with kerbside sort – Table B18;
- Vehicle reversing – Table B19; and
- Unloading at the transfer station (depot) – Table B20.

Figure B3 Kerbsider vehicle used in observed dry recyclable collection and sort system

Table B16 TASK 1: Assembling of collection crew prior to collection round commencing

Sub-task	*Description*
1. Operatives arrive at lorry park / transfer station site	Operatives usually arrive at site between 06.30 and 06.45, by foot or own vehicle.
2. Operatives meet with other crew members on round	Operatives usually go out with the same crew each day. If there are any absences, crew will be assigned a different team member.

Sub-task	*Description*
3. Crew confirm round and collection vehicle with on-site supervisor	Rounds are normally allocated in advance; therefore, crews will know which area they will be collecting from.
4. Driver puts code into key lockers to obtain keys for collection vehicle	Drivers use same vehicle for every shift, unless there are absences / breakdowns.
5. Driver and loaders walk / run across yard to allocated collection vehicle	
6. Crew climb into collection vehicle cab	
7. Lorry is weighed on weighbridge prior to leaving site	
8. Collection vehicle exits site through secured gates	Driver may need to manoeuvre collection vehicle from where parked to reach exit gate. They normally leave between 6.45 and 7.00.

Table B17 TASK 2: Drive from lorry park to first point of collection on round

Sub-task	*Description*
1. Driver drives collection vehicle to first collection point on round	Vehicle may stop to pick up other operatives along the route, who have not already arrived on-site by the departure time. Generally, crew members join the collection vehicle at the depot.
2. Collection vehicle travels pre-determined route to first collection point	Distance from lorry park varies, although shortest route is taken. Route may vary depending on weather conditions, road conditions, road works and traffic-flow.

Table B18 TASK 3: Collection of recyclables from boxes with kerbside sort

Sub-task	*Description*
1. Collection vehicle arrives at collection point where boxes are presented	
2. Park collection vehicle with hopper side (nearside) of vehicle next to the nearside kerb, as close to boxes as possible	On less busy roads, it may be possible to conduct only one pass on the street to empty boxes from both sides of the road. This is not possible on main roads, and the vehicle must double back on itself. Parking may require significant reversing activity (using *rear CCTV*, banksmen where required, and reversing signals). Parking may require manoeuvring in areas of limited turning space to gain best access to where waste is presented.
3. Loader / driver exits cab	Loader exits cab from passenger side door. Driver [normally] exits cab from driver side door.
4. Loader / driver walks / jogs to where boxes are located	This is normally at the kerbside. For rural properties, or where assisted doorstep collection is provided, boxes may be located further inside property boundary at the front or back door.
5. Loader carries or pushes box to vehicle	The task may require lifting and carrying boxes over kerbs, up / down steps or across uneven ground. During observation, uneven surfaces did not appear to impede the operatives. The carrying distance will vary, and may involve crossing the road. If collecting a single box, operatives either: lift and carry the box to hoppers on the side of the collection vehicle (usually using both hands on the handles); or push the box along the ground and up to the vehicle using either the feet or hands, then it lift up to the side of the vehicle. If boxes are light in contents, operatives may: carry 2 boxes at once with one in each hand, place one on top of the other, or empty the contents of one into another and carry a single box.
6. Attach lip of box over hooks on edge of hoppers	This allows the box to rest on the side of the vehicle, leaving the operative’s hands free to conduct the kerbside sorting operation. If no sorting is required, the contents of the box are tipped directly into the hopper.
7. Operatives sort one type of recyclable into a hopper on the collection vehicle	The type of recyclable emptied first can depend on where there is space to place the box on the side of the vehicle and which recyclable type is most prevalent in the box.

Sub-task	***Description***
8. Operatives sort second and third types of recyclables into an appropriate hopper on the vehicle	Operatives may have to lift the box and re-position it nearer a different hopper on the vehicle or may lift and carry the contents of the box to an appropriate hopper. When the remaining items within the box are the same material, the box may be lifted off the lugs and the contents tipped into the relevant hopper.
9. Lift emptied box from the vehicle and carry it back to the kerbside, using handles	Operatives may carry more than one empty box at a time.
10. Place box face down outside property to indicate that it has been emptied	Each box has a house number written on its side. Any plastic bags retrieved from boxes are placed into a nearby wheeled bin.
11. Move onto next box for collection	If the next box is within a relatively near distance, loaders will walk / jog to it. If the next box is too far away, loaders will re-enter cab through passenger door; driver then drives to the next location.
12. When hopper(s) are full, an operative will start the mechanism to raise the hoppers and empty them into the main body of the vehicle	Operatives visually check hoppers to decide whether hoppers are sufficiently full to merit emptying (observing whether build up of material has reached a certain point within the hopper). Where a hopper for a particular type of material is full, operatives may fill up the second hopper for that material before emptying them into main vehicle body. Operative stands facing the hoppers whilst using the controls. Hoppers are lifted mechanically to the top of the vehicle, a lid opens and the hoppers are tipped up. The operative ‘shakes’ the hoppers to empty out the contents. The hoppers are lowered.

Table B19 TASK 4: Vehicle Reversing

Sub-task	***Description***
1. Vehicle reversing is required in areas where it is not possible to turn the vehicle round	A loader acts as a banksman to guide the driver. To do so he was at times walking backwards. The banksman also had to assist in controlling traffic when reversing from a major to a minor road. The banksman stands so that the driver can see him in his wing mirrors. The driver is able to view within the cab a rear-view CCTV system.

Table B20 TASK 5: Unloading at the transfer station

Sub-task	***Description***
1. Driver drives collection vehicle to transfer station for unloading	This occurs once a certain section of the vehicle is full (normally cans, as these have greatest volume), or at the point where operatives decide it would be most time saving to return to the transfer station. The volume of cans collected can be observed through a grille at the top of the vehicle.
2. Collection vehicle enters transfer station through site gates	Operatives sign in to state that they are on-site.
3. Collection vehicle driven onto weighbridge	Gross tonnage of vehicle recorded.
4. Collection vehicle driven to area for tipping recyclables into separate concrete bays	Vehicle may have to wait in a queue for a free bay in which to tip into if multiple collection vehicles arrive at once.
5. Collection vehicle is reversed into first tipping bay (paper) as far as edge of pile of recyclables	Driver halts vehicle when rear tyres come into contact with the edge of pile, using rear CCTV and banksmen for guidance.
6. An operative/banksmen activates lifting the rear tail section of the collection vehicle	The controls are located on the driver's side of the vehicle, next to the rear section. The operator is therefore able to stand to one side whilst the rear tail section opens. He indicates to the driver when it has opened.
7. The rear tail section of the vehicle rises up to 45 degrees on a hydraulic lift, and empties contents of first section of vehicle [paper] into the bay	Lifting of the vehicle body is operated from within the cab. Whilst it is being lifted the banksman stands to one side of the truck.
8. Once section emptied, hydraulic lift lowers back section of vehicle to horizontal, using controls located in cab	
9. Driver manoeuvres the vehicle so he can reverse into adjacent tipping bay (cans)	Prior to tipping the second load, the driver uses controls located in the cab to release pins within the vehicle body. This will release the next material to be tipped. On one occasion the pins did not release so the banksman had to hit out the pin using a hammer. A large shovel loader may be used to push any remaining waste into the bay. Recyclables may be manually swept into bays by operatives. Steps 6-9 are repeated for other recyclables (i.e. clear glass, coloured glass).
10. When the unloading task is complete, the banksman checks that all the pins are back in place within the vehicle body	

Sub-task	***Description***
11. Once fully emptied, the collection vehicle is driven back to the weighbridge	This is done to determine weight of tonnage, in order to calculate the amount of waste deposited.
12a. If further collection activities are required, vehicle returns to appropriate point on the round to continue	
12b. If the round is complete, the vehicle is returned to the lorry park and keys handed over to the supervisor	At end of the shift, operatives fill in a form with time on duty for signing off by supervisors.

B3.4.1 Observed task variations

- As a timesaving technique, loaders were observed to move ahead of the vehicle and gather together a number of boxes. This allows pre-sort of materials at certain locations on the round, such as cul-de-sacs. Therefore, when the collection vehicle arrives, these boxes of a single recyclable stream can be emptied into the relevant hopper directly.
- On occasion, operatives reach into the side hoppers to flatten down the recyclables that have accumulated, to allow more materials to be placed inside.
- If there was spare capacity in a box, loaders may transfer materials from nearby boxes that are overflowing, or try and compress material further into the box.
- Drivers perform fewer collection duties than solely loading operatives. It was reported that they are more likely to assist in loading typically when several boxes are placed together to empty or loaders have to obtain boxes from up steps, round the side/back of houses.
- For houses with assisted deliveries (agreed by prior arrangement), operatives may have to walk inside the property boundary, possibly to the back door, to access the box (this can involve manual handling over a relatively large distance, or up and down flights of stairs or slopes).
- Where materials not suitable for collection are placed in the recycling box, operatives sort the suitable materials into the hoppers as normal, and leave the other materials in the box at the kerbside. A brightly coloured sticker is then placed on the side of the box to inform the householder about the types of materials that will be collected.
- The householder may leave excess recyclables that will not fit into the box provided in other alternative receptacles. These are sorted and emptied in the same steps as described above.
- Where recyclables are presented in carrier bags within the box, the recyclables are normally emptied from the carrier bags into the hoppers.

B3.4.2 Unobserved task variations

- During icy weather, collection vehicles will only pick up from properties that are on roads that have been treated with grit. Non-treated roads will not be served. Apart from this, no differences were reported in how recyclables are manually collected in these conditions.

- When increased volume of recyclables is produced (e.g. following bank holidays, Christmas, or other periods of previous non-collection), the length of the round may be extended to clear the backlog of recyclables that has built up. This may include 3 trips for unloading at the transfer station as opposed to the normal 2. Operatives receive overtime pay for this work should it extend past 17.30.
- A transit van is used to collect boxes from farm properties only. One crew member drives the van and collects the boxes. The box is lifted into the back of the van and the contents are decanted into boxes located within the van. There is a 2-week cycle. The van can cover up to 75 farms in a day, collecting up to a maximum of ¾ te of recyclables.
- Where boxes are damaged or have been split, they are replaced with spares that are located on the driver’s side of the vehicle.
- Some collection teams adopt filling strategies to help to avoid busy periods on the road (e.g. they may fill only half the vehicle on the first half of the round, return to the transfer station as traffic flow increases, then return to finish with a full load).
- Vehicles are refuelled on-site.

B3.4.3 General characteristics of collection teams

- Operatives’ length of working week is dependent upon which area they are collecting from. Most operatives normally work a 4-day week (Monday to Thursday), although in one area they work a 5-day week (Monday to Friday).
- Operatives are paid an overtime rate for any hours worked over 40 hours in a week.
- Both urban and rural rounds normally start around 07.00, although the demarcation between degrees of urbanisation is not always clear, as rounds incorporate a variety of housing types. Rounds are contracted to finish at 17.30, although in reality the round is usually completed before this time. Finish time is obviously dependent on participation, presentation rates and traffic flow etc.
- A contract job and finish system is operated, whereby when one collection crew has finished their round, they may be required to assist another crew who have yet to finish in their collection duties. This does not always occur, and there is often an agreement made to not perform this practice, particularly if the slowest crew is almost finished on their round.
- Workers are allocated 30 minutes for a lunch break, which it was stated they normally take.
- All personnel wear full PPE; high visibility jacket, safety shoes and gloves, and earplugs (which are now compulsory wear, as opposed to recommended use). One operative was observed wearing safety glasses, to reduce likelihood of shards of smashed glass from the hopper flying into his eyes.

B3.4.4 General characteristics of collection receptacle/vehicle

- The plastic boxes observed were of 55 l capacity with a continuous grab rim handle
- All collection teams involved 3 operatives: 2 loaders and 1 driver/loader.
- Observed two types of urban round (3 hrs in total), collecting from semi-detached, bungalows (assisted deliveries) and terraced houses on 30 mph speed limit roads.

- Operatives always work in teams of 3 on this round. Usually the same personnel are in each crew, although these may change during holidays / sickness. Agency staff will be utilised where there are absences.
- Driver/loader tends to get out of the cab less frequently than the full time loading operatives.
- Collection vehicle observed – 6 te capacity**,** 6 hoppers located on nearside of the vehicle (2 for paper, 1 for coloured glass, 1 for clear glass, 2 for cans) with manual activation side-loader into main vehicle body.
- Recyclables collection is performed fortnightly at locality observed.
- Most commonly, complete 2 collection rounds per day (i.e. fill / nearly fill 3.5t capacity during round, drive to transfer station for drop-off, then repeat, although may not require filling to full capacity on both).
- Normally service around 800-900 boxes on urban round (max 1200). Box weight varies, although on average was stated to be 8 kg.
- Wearing of earplugs [within 2 m of collection vehicle] is compulsory in this collection scheme, due to large volume of noise experienced during sorting of glass, and emptying of glass hopper into the main body of the vehicle (which can measure up to 96D(B)a.
- Due to volume, company are contractually bound to not start collections until 07.00 am.
- In the rounds observed, participation rate was stated to be generally between 60-70% (with the range from 20-80%). This reflects mainly socio-demographic factors. Weekly put out rates were stated as between 50-55%.
- There is usually a spare collection crew available to help out during busy periods / rounds.

B3.4.5 Additional information on emptying Kerbsider at the transfer station

- At the transfer station, vehicles turned in a relatively large turning area outside before reversing into a bay, and leaving by passing through the same route. At other sites, a one-way system may be operated.
- There were 4 bays side by side in the recycling section of the station (for paper, cans, coloured glass and clear glass). The paper bay is larger to reflect the greater volume of this collected in comparison with other types of recyclables.

B3.5 HIGH-RISE DOOR-TO-DOOR DRY RECYCLABLES COLLECTION

Tables B21 to B24 summarise the activities carried out as part of a door-to-door collection system of dry recyclables from flats. In the system observed the recyclables were collected from the door of each flat and emptied into a slave sack (as illustrated in Figure B4). This slave sack was then emptied into the collection vehicle. This description is based on observations of the following key stages:

- Assembling of collection crew prior to collection round commencing – Table B21;
- Drive from van yard to first point of collection on round – Table B22;
- Collection of recyclables from various receptacles – Table B23;
- Drive from last point of collection on round to yard / MRF – Table B24; and
- Unloading at an MRF.

Figure B4 Slave sacks used in observed high-rise door-to-door dry recyclable collection system

Table B21 TASK 1: Assembling of collection crew prior to collection round commencing

Sub-task	*Description*
1. Operatives arrive at van yard site	Operatives usually arrive at site between 07.30 (cannot start round before 08.00 due to complaints about noise from residents).
2. Operatives swipe employee pass card to gain access into site	
3. Operatives meet with other crew members on round	Usually go out with the same crew each day. If there are any absences, crew will be assigned a different team member.
4. Crew confirm round and collection vehicle with on-site supervisor	Rounds normally allocated in advance, therefore crews will know which area they will be collecting from.
5. Driver obtains keys to collection transit van from on-site supervisor	Drivers use same vehicle for every shift, unless there are absences / breakdowns.
6. Driver and loaders walk to allocated transit van	
7. Crew climb into vehicle cab	
8. Van exits site through secured gates	Driver may need to manoeuvre from where parked to reach exit gate.

Table B22 TASK 2: Drive from van yard to first point of collection on round

Sub-task	***Description***
1. Driver drives transit van to first collection point on round	Generally crew members join the vehicle at the depot.
2. Vehicle travels pre-determined route to first collection point	Shortest route taken. Route may vary depending upon factors such as weather conditions, conditions of roads, roadworks and traffic-flow.
3. Van crew meet with RCV crew	RCV operated by a different company, and driven to first collection point from their depot.

Table B23 TASK 3A: Collection of recyclables from various receptacles

Sub-task	***Description***
1. RCV and Transit van arrive at collection point	
2. Park RCV and Transit van as close to kerbside as possible to minimise handling required, and apply handbrake	Parking may require reversing / manoeuvring in areas of limited turning space to gain best access to where waste is presented.
3. Operatives exit vehicle cabs	
4. Operatives collect number of large empty ‘slave’ sacks from body of transit vehicle	Empty sacks are stored within the transit van body
5. Operatives walk to flats where recyclables are presented	Operatives carry a number of large empty sacks with them (usually sacks all stuffed inside a single sack). They tend to start collection from the upper level of flats and work down to the ground floor. This may involve climbing a number of sets of steps, or using the lift if available / functioning.
6. Operatives conduct brief visual check of material presented to ensure that it is recyclable.	Non-recyclable material is left at the doorstep.

Sub-task	***Description***
7. Operatives empty all recyclable material presented outside the flat into a slave sack	Material may be presented in green box, white or pink reusable sack, or single use sack. Operatives conduct a brief visual check to ensure that non-wanted materials are not collected. Any such material is left at the doorstep. If excess material is presented that overflows from the receptacle, or is not in a receptacle, they may place this excess first into the slave sack, before emptying the remaining contents. If un-flattened cardboard is presented, operatives will flatten this and place in sack if room – or may just carry in hand. Containers are emptied by inverting the receptacle over the empty sack to remove material, using either one or both hands depending on the weight of the receptacle.
8. Once all material has been collected, operative returns receptacles to doorstep.	
9. Operative walks to the next flat, carrying the large slave sack	Dependent on weight of material collected, operative may carry the slave sack over the shoulder with one hand, or may use dragging motion.
10. Steps 7-9 are repeated until the slave sack is full, at which point it is taken to a ‘consolidation point’, commonly near the lift / steps	Operatives usually carry 2 full slave sacks at the same time (either one over each shoulder, or 2 over the same shoulder) – 3 sacks carried on occasion. If lift is used, operatives should place warning notices on the lift to explain to the public that the lift is in use for recycling.
11. Operatives will take another empty slave sack and continue with collection, repeating steps 6-8 until that floor of the flats is completely serviced	
12. The ground floor of the flat is serviced using a large ‘slave’ wheeled bin instead of sacks. Material is placed in bins as described in steps 6-9	Slave bins are stored on the back of the RCV when not being utilised.
13. Pile of consolidated bags carried down stairs / transported in lift to second consolidation point at ground floor	Commonly the collection vehicle cannot access near to the flats.
14. Bags from consolidation pile either manually carried to the RCV or contents emptied into a 360 l capacity ‘slave’ wheeled bin, which is pushed to the back of the RCV	Once a block of flats has been completely serviced, and bags consolidated on ground floor. Operatives are supposed to empty slave bags into slave bins, but this practice does not always occur. Note, operatives may sometimes use the Transit van to place bags into instead of the RCV. This van will later rendezvous with the RCV and transfer bags into the back of the RCV prior to transfer to the MRF.

Sub-task	*Description*
15. Lip of slave bin attached to rear of RCV lifting mechanism	
16. Lifting mechanism activated and contents of slave bin emptied into RCV	Lifting mechanism activated by operatives, using controls located at the rear side of RCV.
17. Activate in-vehicle compaction on RCV	After emptying every 4/5 slave bins, or when the hopper appears full, the compaction is manually operated by pressing a button on the control pad on side of vehicle at rear or inside cab.
18. Collection round moves to next block of flats to repeat the process	RCV/transit van drives to next consolidation point. Operatives will either walk or travel in vehicle cab, depending upon distance to travel.

Table B24 TASK 4: Drive from last point of collection on round to yard / MRF

Sub-task	*Description*
1. Driver drives Transit van/RCV from last collection point on round	
2. Vehicle travels pre-determined route to van yard/MRF	Shortest route taken. Route may vary depending on weather conditions, conditions of roads, roadworks and traffic-flow.
3. Van/RCV crew exit vehicle outside depot gates and go home	
4a. Van driver enters yard via security gates	Swipe employee pass card to gain access to yard.
4b. RCV drives to MRF or depot	
5. Van enters yard and is parked	Driver may need to manoeuvre from where parked to reach exit gate.
6. Driver signs out and hands back van keys at site office.	

Unloading at the MRF was not observed for this particular collection round; however, it is assumed that the procedure would be similar to that observed at the MRF described in Section B4.1.

B3.5.1 Observed task variations

- Some bulky items were observed that were not placed in wheeled bins / bags (e.g. cardboard packaging). These are manually lifted, carried to the RCV and thrown into the hopper.

- Loaders are supposed to empty contents of slave sacks into slave bins prior to emptying into vehicle; however, they were observed emptying slave sacks directly into hopper on occasion.
- Slave sacks collected must be pulled closed at top by operatives whilst manual handling, using the integral ties.
- Consolidation sites for slave sacks are chosen to avoid blocking access and circulation space. Maximum amount of time for which bags can be left is 4 hours.

B3.5.2 Unobserved task variations

- During icy weather, operatives will only pick up from properties that are on roads that have been treated with grit/salt. Non-treated roads will not be served. Also, where blocks are sometimes being refurbished, crew will telephone supervisor and ask them to assess the situation. Occasionally, refurbishment work will preclude collection.
- Sometimes a Transit van will operate collection on its own. Full slave sacks are stored in the van, which subsequently meets the RCV at a convenient rendezvous point. Sacks will then be taken from van and emptied into the slave bins, then RCV hopper.
- When an increased volume of recyclables is produced (e.g. following bank holidays, Christmas, or other periods of previous non-collection), the length of the round is extended to clear the backlog of rubbish that has built up.
- Operatives may be required to work on a Saturday when a large volume of material has built up. Operatives are paid overtime for this extra work.
- In a number of high-rise flats, lifts do not function (roughly 40%). Therefore, practice is for operatives to collect only from the first 5 floors up from the ground level. This avoids the need to climb up large numbers of stairs to collect recyclables.
- Collections are also made from communal bin stores; contamination of recyclables in such bins was reported to be high for communal bins. Communal bins have a 1280 litre capacity. Two operatives are required to manoeuvre the bin to the vehicle. The bins are attached to the rear of the hopper and emptied in the same manner as the smaller slave bins.
- When slave sacks wear out, they are removed from stock and replaced with a newer version.

B3.5.3 General characteristics of collection teams

- Operatives normally work a 5-day week (Monday to Friday), with occasional Saturday work required to control any backlog of waste build up.
- Rounds normally start around 08.00 and finish around 16.00. Finish time is obviously dependent on participation and presentation rates.
- Job and finish system operated. Workers do not tend to take formal breaks and work until the collection round is completed.
- All personnel wear full PPE; high visibility jacket, safety shoes and gloves.
- New staff attend a 1-day induction where health and safety aspects such as risk assessment and manual handling procedures are covered.
- 3 supervisors monitor the teams, observing them and dealing with any issues/problems that arise. Supervisors occasionally cover absences as required.

- When extra staff are required to cover sickness/holiday absence they are recruited from a pool of temporary staff. These are typically people who have applied for jobs but are yet to be recruited permanently. This also gives the company an opportunity to assess individuals prior to employing them.
- 7 people are employed as ‘Outreach workers’ to educate householders about recycling and how the scheme operates.

B3.5.4 Characteristics of collection round

- Observed for ~2.5hrs – high level of urbanisation observed, collecting from predominantly low-rise flats, but also from communal bin stores; all properties located on 30 mph speed limit roads.
- 53,000 homes are part of the doorstep collection scheme. 13,000 homes use communal bin stores.
- On average 10-12 miles are travelled each day.
- 42 collection operatives in total.
- Scheme initially started by providing green plastic boxes (capacity 40 l) for residents. The boxes were replaced by white reusable sacks (40 l capacity). Boxes were considered to present an health and safety hazard in the narrow walkways outside flats impeding movement of, for example, mothers with pushchairs.
- Have now introduced single use sacks – householders were given a 6-month supply to use one a week (but in some instance people used 2/3 each collection due to lack of publicity about presentation).
- Householders also sometimes present material in normal black bin bags.
- “Slave” sacks are approximately 150 litre capacity.
- “Slave” wheeled bins are normally 360 litre capacity
- Approximately 400 tonnes of material is collected per month. Generally collect mostly paper / card, but in terms of volume taken up, plastics and un-flattened cardboard take up most volume.
- There are 6 collection crews, using either an RCV or Transit van, each consisting of 3 operatives: 2 loaders and 1 driver/loader.
- Always work in 2 teams (RCV and van) on each round, usually using same personnel, although these may change during holidays / sickness.
- Drivers generally would not change vehicles.
- Complete one collection round per day (i.e. fill, or nearly fill, 7 te capacity during round and drive to MRF for drop-off). Sometimes vehicle will only visit the MRF every 2 days (if participation rate has been poor).
- Formerly, the recyclables were separated at source. This practice took too much time and has been abandoned.

B3.6 LARGE WHEELED BIN COLLECTION

Tables B25 to B28 summarise the activities carried out as part of a residual waste collection system collecting waste from large wheeled bins (as illustrated in Figure B5). This description is based on observations of the following key stages:

- Assembling of collection crew prior to collection round commencing – Table B25;
- Drive from lorry park to first point of collection on round – Table B26;
- Collection of residual household waste from large bins located in bin stores – Table B27; and
- Unloading at the incinerator – Table B28.

Figure B5 Collection of residual waste from large wheeled bins

Table B25 TASK 1: Assembling of collection crew prior to collection round commencing

Sub-task	***Description***
1. Operatives arrive at lorry park site	Operatives usually arrive at site between 05.15 and 05.45, by foot or own vehicle.
2. Operatives swipe employee pass card to gain access into lorry park site	This action essentially "clocks in" the employee.
3. Operatives meet with other crew members on round	Operatives usually go out with the same crew each day. If there are any absences, crew will be assigned a different team member.
4. Crew confirm round and collection vehicle with on-site supervisor	Rounds are normally allocated in advance; therefore, crews will know which area they will be collecting from.
5. Driver obtains keys to refuse collection vehicle (RCV) from on-site supervisor	Drivers use the same vehicle for every shift, unless there are absences / breakdowns.

Sub-task	*Description*
6. Driver and loaders walk / run across yard to allocated RCV	
7. Crew climb into RCV cab	
8. RCV exits lorry park through secured gates	Driver may need to manoeuvre RCV from where parked to reach exit gate. They normally leave between 5.30 and 5.45.

Table B26 TASK 2: Drive from lorry park to first point of collection on round

Sub-task	*Description*
1. Driver drives RCV to first collection point on round	May stop to pick up other operatives along the route, who have not already arrived on-site by departure time. Generally crew members join the RCV at the depot.
2. RCV travels pre-determined route to first collection point	Distance from lorry park varies, although shortest route taken. Route may vary depending upon weather conditions, road conditions, road works and traffic-flow.

Table B27 TASK 3: Collection of residual household waste from large bins located in bin stores

Sub-task	*Description*
1. RCV arrives at collection point and is parked as near as possible to first bins. Handbrake applied	Parking may require significant reversing activity (using rear CCTV, banksmen where required, and reversing signals) and manoeuvring in areas of limited turning space to gain best access to bin stores.
2. Loader / driver exit cab	Loader exits cab from the passenger side door. Driver [normally] exits cab from the driver side door.
3. Loader / driver walks / jogs to where large bins are located	This may either be in a concrete open-air bay, or within an enclosed bin store. It may also depend on the type of bin provided.
4. If located inside bin store, operative uses key to unlock and open door	
5a. If collecting a Palladin bin, pull / push bin from location to back of RCV (using either one or both hands on bin handles)	This task may require pushing / pulling bins over kerbs, up / down slopes, across uneven ground, such as drains, grates and potholes. During the observation, these surfaces clearly impeded easy

Sub-task	*Description*
5b. If collecting a Euro bin, pull / push bins using handles from location to back of vehicle	observation, these surfaces clearly impeded easy movement of the bins, particularly old Palladin bins. Depending on ease of access, Tasks 5a/5b may be 2-man jobs, with operatives pushing/pulling taking a handle each.
6a. Place Palladin bin against rear of vehicle and activate 2 side holding bars	The pressure of the bin weight against closing mechanism on rear of the hopper clamps the bin tight between the bars.
6b. Place front lip of Euro bin upper rim onto bin lift raising mechanism	
7. Activate raising mechanism to raise and upturn bin into hopper, by pushing button on control panel at rear side of vehicle	Operatives stand to the side of the vehicle during raising of bins.
8. Activate lowering mechanism to return emptied bin to ground by pressing another button	This is done once bin is emptied.
9. Remove bin from vehicle bin lift	Operatives unhook Euro bins from vehicle; Palladin bins are released automatically.
10. Pull / push emptied bin back to bin stores, using handles	
11. Move onto next bin for collection	If the next bin is within relatively near distance, loader will walk / jog to it. If the next bin is too far away, loader will re-enter the cab through the passenger door; driver then drives to the next location.
12. In-vehicle compaction activated	Compaction occurs automatically.

Table B28 TASK 4: Unloading at the incinerator

Sub-task	*Description*
1. Driver drives RCV to incinerator	This is done once vehicle is full.
2. RCV enters incinerator site perimeter through gates	Operatives sign in to state that they are on-site
3. RCV driven onto weighbridge to gain weight of gross tonnage	
4. RCV driven to area for tipping waste into incinerator pit	Vehicle may have to wait in a queue for a free bay in which to tip into. Rules state that vehicles cannot tip into a bay adjacent with another vehicle.

Sub-task	*Description*
5. RCV is reversed into tipping bay	Specific tipping bay for use indicated by green traffic light above bay. A red light signals that the bay cannot be used.
6. RCV reverses as far as edge of tipping bay	Driver halts vehicle when rear tyres come into contact with the edge of the bay, using rear CCTV for guidance.
7. Rear tail section of RCV opened automatically using controls situated in the cab	Note, this may be dependent on the vehicle type.
8. Rear section of vehicle rises up through 90 degrees, and is emptied down into waste pit	Waste pit is 15m deep and is fed from 5 parallel bays.
9. Remainder of vehicle contents emptied into pit through internal ram pushing horizontally outwards towards open back of vehicle	
10. Driver lowers vehicle tail section partially, using controls located in the cab	Rear of vehicle closed once it has been emptied. A bulldozer may be used to push any remaining waste into the pit. Waste may be manually swept into pit by operatives, who clip themselves onto harnessing points to mitigate against the risk of falling over the bay edge.
11. Driver moves RCV forward about 5-10m from edge of bay	
12. Driver puts on safety helmet and exits vehicle from driver side door	
13. Driver manually operates control to lower and close tail section of vehicle	
14. Driver re-enters cab	
15. RCV driven back to weighbridge to gain weight of tonnage, in order to calculate amount of waste deposited	
16a. If further collection activities required, return to appropriate point on round	
16b. If round complete, return RCV to lorry park and hand over keys to supervisor	

B3.6.1 Observed task variations

- Moving heavy bins is clearly strenuous activity, particularly when undertaken as a one-man job. This is compounded in hilly locations, where maintaining control of the bin becomes very difficult.

- Some bulky items were observed that were not placed in large bins (e.g. roll of carpet). These are not carried to the RCV, but are left at their location of deposit.
- In many flats, householders feed their waste into a chute, which subsequently feeds into Palladin bins below. In some instances, bins are filled to overflowing, to the point that the waste can back up into the chute above. In such instances, operatives may rotate the bin around in order to free up the waste, which is distributed more evenly into the bin below. Some waste often falls to the floor during such operations.
- Operatives can refuse to collect from repeatedly overflowing bins (although this is reportedly uncommon). They may take a note of where this occurs, and get their supervisor to contact the Housing Agency regarding the problem.
- If there was spare capacity in a bin, loaders may transfer bags nearby bins that are overflowing, or try and compress bags further into the bin.
- Drivers perform fewer collection duties than solely loading operatives. It was reported that they are more likely to assist in loading typically when several bin stores may be accessed from the same parking point.
- Various types of large bins are collected. Primarily Palladin bins – ~900 l capacity, 4 wheels on castors, cylindrical, 2 handles located at waist height, very unstable. Also, Euro bins (large, rectangular wheeled bulk bins, 660, 1100, 1280 l capacity), normal wheeled bins (120, 240, 360 l capacity), and Chamberlains (large square bulk bins (720, 940 l capacity) are collected.
- Where poor ground conditions exist (for example broken tarmac, potholes, broken drains/grates near bin stores), operatives can make a note of this, and report it to their supervisor. The supervisor can then contact the local council to ask them to attempt to rectify the problem.
- Operatives will often make use of any handrails to assist in moving heavy bins. For example, on upward slopes one hand will be used to pull the bin by its handles, whilst the other will be used on the handrail to help maintain momentum.
- Householders / trades people can often park their vehicles in such a way that access for the RCV is difficult to gain. This may require significant manoeuvring of the RCV. On occasions, access may be impossible and the RCV may have to return at a later date to perform the collection.

B3.6.2 Unobserved task variations

- During icy weather, RCVs will only pick up from properties that are on roads that have been treated with grit. Non-treated roads will not be served.
- When an increased volume of waste is produced (e.g. following bank holidays, Christmas, or other periods of previous non-collection), the length of the round is extended to clear the backlog of rubbish that has built up.
- Operatives may be required to work on a Saturday when large volumes of waste have built up. Operatives are paid overtime for this extra work.
- The task is basically the same for high-rise flats, except the concentration of bins to empty is greater (i.e. the bin store is larger).
- Within bin stores, the numbers of bins may vary. Where there are multiple bins, it is the responsibility of the janitor to move the bin underneath the waste chute when it is full and replace it with an empty bin. This does not always happen meaning waste can overflow from a single bin whilst others remain empty in the same store.

B3.6.3 General characteristics of collection teams

- There were 3 collection crews of 2 operatives that solely service large bins from flats. 2 crews primarily empty Palladins and Euro bins, whilst the other crew empty large blue recycling wheeled bins.
- Operatives normally work a 5-day week (Monday to Friday).
- All rounds normally start around 05.45 and finish around 12.30 pm. The finish time is dependent on presentation and traffic flow etc.
- A job and finish system is operated. Workers do not take formal breaks and work until the collection round is completed.
- All personnel wear full PPE; high visibility jacket, safety shoes and gloves.
- Round was observed for ~1hr. Medium level of urbanisation observed, collecting from low-rise flats on 30 mph speed limit roads.
- Collection crew consisted of 2 operatives: 1 loader and 1 driver/loader.
- Crew always work in teams of 2 on these rounds, usually with the same personnel although these may change during holidays / sickness.
- RCV observed – 15 te capacity, Terberg manual loader with choice of bin lift mechanisms, fitted with emergency stop (in cab and at controls on back) and CCTV above hopper, radios in cab for communicating with base and no GPS system.
- Most commonly, complete 1 collection round per day (i.e. fill to capacity during round, then drive to incinerator / transfer station for single drop-off).
- Normally service around 150-200 large bins on each round, primarily Palladins. This can vary from round to round, as does the distance between collection points.
- Properties distant from each other may provide natural opportunities for rest breaks.

B3.6.4 Additional information on emptying RCV at an incinerator

- At the incinerator observed, vehicles turned in a relatively large turning area before reversing into a bay, and leaving by passing through the same route. At other sites, a one-way system is operated.
- There were 5 bays side by side but vehicles are not permitted to tip either side of each other at the same time; they must always leave a spare bay next to them.
- Twenty to thirty vehicles can tip each hour.
- The incinerator burns approximately 750 tonnes of waste a day, 200 tonnes of ash are produced and approximately 30 tonnes of metal recovered.
- The incinerator operates 24 hours a day in the control room, monitoring the boilers and steam.
- The tipping area operates from 6 am to 5.30 pm.
- Cameras are used by the control room to monitor activity in the tipping area.

B4 POST-COLLECTION SYSTEM ACTIVITY DESCRIPTIONS

This section describes the activities carried out for the following post-collection subsystems:

- Materials Recycling Facility – Section B4.1;
- Mechanical Biological Treatment plant – Section B4.2;
- Composting (open windrow and in-vessel) – Section B4.3;
- Incineration – Section B4.4; and
- Landfill – Section B4.5.

Although within scope, no separate observation of a transfer station was made as many of the collection systems, as described in Section B3, incorporated a transfer station.

B4.1 MATERIALS RECYCLING FACILITY (MRF)

Tables B29 to B37 summarise the activities carried out at an MRF. Two MRFs were observed and the activities at each are described. This description is based on observations of the following key stages:

- Arrival of collected material (mixed dry recyclables) at MRF – Table B29;
- Drive from weighbridge to reception hall – Table B30;
- Depositing of recyclable material in reception hall – Table B31;
- Loading of recyclable material onto conveyor belts – Table B32;
- Shift start for MRF Employees – Table B33;
- Sorting of material – Table B34;
- Transfer of pre-sorted material for additional sorting – Table B35;
- Baling of recyclable material – Table B36; and
- Transfer of sorted paper materials – Table B37.

Table B29 TASK 1: Arrival of collected material (mixed dry recyclables) at MRF

MRF 1

Sub-task	***Description***
1. Articulated lorry (~30 ton capacity) enters MRF via security gates	MRF opens at 06.00. Between the hours of 0600-1800 hrs approximately one 30 tonne truck arrives every 15 minutes.
2. Administration employee in gate house checks vehicle in	Vehicle logged in electronically via registration number, which is recorded on computerised system. System will indicate if the vehicle has previously visited the MRF. If not, the driver is presented with MRF user induction rules (detailing PPE, acceptable driving etc).

MRF 1

Sub-task	***Description***
3. Vehicle drives onto weighbridge	Gross tonnage of vehicle recorded.

MRF 2

Sub-task	***Description***
1. Collection vehicles enter MRF site	MRF opens at 07.00. No collection vehicles can enter site prior to 8 am as RCVs are leaving. RCVs (8 owned by council) collect and drop off paper and cardboard one week and plastic and cans on the 2nd week. 2 skip vehicles are used to collect glass from skips placed in supermarket car parks. 2 private contractors also operate from the site for the purposes of collecting waste.
2. Administration employee in gate house checks vehicle in	Vehicle logged in at the gatehouse. Driver is presented with site rules if not familiar with the site (detailing PPE, acceptable driving etc).
3. Vehicle drives onto weighbridge	Gross tonnage of vehicle recorded. Driver has to get paperwork signed before proceeding to tip-off point.

Table B30 TASK 2: Drive from weighbridge to reception hall

MRF 1

Sub-task	***Description***
1. Driver exits weighbridge and drives to reception hall	Driver follows one way system that operates around the entire MRF site.
2. Vehicle arrives at reception hall bay and driver manoeuvres vehicle in order to reverse into unloading bay	4 unloading bays located either side, only 2 central bays utilised to minimise congestion and size of waste pile. Shovel loader driver employed in reception hall decides when a vehicle can enter reception hall and beckons to driver when it is clear to enter.

MRF 2

Sub-task	***Description***
1. Driver exits weighbridge and drives to sorting facility	No one-way system is in operation.
2. Vehicle arrives at sorting facility and driver	Paper / cardboard and plastics / cans dropped off

MRF 2

Sub-task	*Description*
manoeuvres vehicle in order to reverse vehicle to off-load point	on different sides of the facility, directly outside the location where it is shovelled into the facility to be sorted. As such there is no designated bay. The glass is off-loaded into designated bays. No tipping takes place whilst loading is performed. When drivers arrive at the facility they have to obtain permission before they can tip.

Table B31 TASK 3: Depositing of recyclable material in reception hall

MRF 1 AND MRF 2

Sub-task	*Description*
1. Once signalled to do so driver reverses vehicle into reception hall via bay	Employs reversing CCTV.
2. Vehicle halts toward rear of reception hall (loading area), driver applies handbrake	Driver halts vehicle and remains in vehicle.
3. Rear doors of vehicle opened	Rear doors are opened automatically by driver from within the cab in newer vehicles. On older vehicles driver has to exit vehicle and use 2-button control on vehicle rear to manually open doors.
4. Material tipped into loading area	MRF 1: Lorry has walking floor activated using controls in vehicle cab in order to deposit material onto loading area floor. MRF 2: RCVs unloaded through opening rear section and emptying through pushing horizontal ram out.
5. Vehicle moves forward and rear doors are closed and sealed	In newer vehicles rear doors may be closed automatically by the driver from within the cab; however, drivers still have to exit vehicle and manually check door rims and seals are free of material. For older vehicles, driver must exit vehicle and manually close and seal the rear doors using 2-button controls. MRF has a policy of only the lorry driver exiting the cab within the reception hall.
6. Vehicle exits reception hall through loading bay	Vehicle exits reception hall and drives to weighbridge office (round one-way system at MRF 1, retracing entrance route at MRF 2).
7a. MRF 1 only: If being loaded with sorted material, vehicle drives to loading part of site – see Table B37 (MRF 1).	At MRF 2 vehicles that are used to drop off material to be sorted do not remove sorted material.

MRF 1 AND MRF 2

Sub-task	*Description*
7b. MRF 1 only: If not being loaded with sorted material, vehicle exits MRF site	Driver signs out and at MRF 1 are logged out on MRF computerised system. Vehicle exits MRF site through secure gates.

Table B32 TASK 4: Loading of recyclable material onto conveyor belts

MRF 1 AND MRF 2

Sub-task	*Description*
1. Recyclable material deposited in reception hall is collected in shovel of shovel loader vehicle	Driver operates vehicle to collect recyclable material in shovel. A significant amount of manoeuvring and reversing is required.
2. Recyclable material is loaded onto conveyor belts	Shovel lowered to empty recyclables onto loading conveyor. Conveyors provide a controlled, constant flow of material to MRF. MRF 2 only: a worker uses a brush to push plastics and cans onto conveyor belt.
3. Material is transferred from loading conveyor to elevating conveyors	Material deposited on loading conveyor in reception hall feeds directly onto 2 identical side-by-side elevating conveyors at MRF 1. Note: only one conveyor at MRF 2.
4. Elevating conveyors transports material upwards from ground floor reception hall area to upper level pre-sort area	Elevating conveyors operate at a faster speed than the loading conveyor in order to thin out the material depth prior to delivery to pre-sort area.

Table B33 TASK 5: Shift start for MRF employees

MRF 1 AND MRF 2

Sub-task	*Description*
1. Employees arrive at MRF via secure gates	Employees arrive at MRF either via foot or car.
2. Enter administration building (containing locker-rooms, rest room and office suite)	Employees enter building and clock in. Employees arrive approximately 15 minutes before shift starts.
3. Employees put on PPE	Employees put on PPE appropriate for their designated job (e.g. work suits, gloves).
4. Employees enter MRF	Exit office block and walk across site using pedestrian crossing. Enter MRF via designated doorway.

MRF 1 AND MRF 2

Sub-task	***Description***
5. Employees walk to designated work stations	MRF 1 only: use designated walkways and stairways to arrive at workstation. Locked gates seal off isolation areas preventing pedestrians entering.
6. MRF conveyor line and mechanical sorting starts up	MRF 1 only: warning siren signals to employees the start of automated conveyor lines and the mechanical sorting.

Table B34 TASK 6: Sorting of material

MRF 1

Sub-task	***Description***
1. Waste material delivered to a pre-sort cabin	Waste material arrives in pre-sort area on 2 conveyor belts.
2. Unwanted materials are manually removed by picking staff	Picking operatives stand at workstations on either side of conveyor belt. Plastic bags, plastic bottles, metal, large items and non-recyclables are removed manually. A very small amount of upper body twisting was observed. The contents of bags are emptied onto the conveyor and the bags discarded down chutes. Textiles are placed to one side in the cabin and collected later.
3. Unwanted materials are deposited down waste chutes into appropriate storage bays	Operatives place materials down waste chutes located to the side of them. No over-reaching was observed.
4. Unwanted materials deposited back in reception hall	Unwanted material lands in a pile at the side of the ground floor reception hall.
5. See Steps 1-4 Task 4, Table B32	
6. Steps 2-5 may be repeated several times until waste stream cannot be filtered any further	Operatives in reception hall decide when stream cannot be filtered further. Non-recyclable materials are removed by shovel loader and stored in a bay prior to transfer to incinerator/landfill.

MRF 2

Sub-task	***Description***
1. Waste material delivered to a pre-sort cabin	Cardboard and paper are sorted mechanically prior to manual sort through the PCS (Paper Cardboard Sorter). Large pieces of cardboard are separated from the recyclable stream and despatched to the baler via conveyor. Unsorted paper and card is transferred to the manual sorting area. Plastic and cans go directly to manual sort via conveyor.
2a. Unwanted materials are manually removed from paper / cardboard line by picking staff	Paper and card sorting on the upper conveyor involves 4 sorters standing at workstations either side of the conveyor belt. Small pieces of cardboard are manually separated from the paper and deposited into chutes located to the side of the worker. This drops the cardboard onto the conveyor below to be transported to the baler.
2b. Unwanted materials are manually removed from plastics / cans line by picking staff	1 manual sorter is located on the belt below to pre-sort any plastics or cans that are present. The main plastics and cans recyclable material sorting involves 3 sorters standing on one side only. Certain types of plastics are picked out from the plastic and cans material stream and are thrown down a chute located in front of the operator.
3a. Pre-sorted paper is transferred by conveyor into a large storage area	A Manitou (rough terrain fork-lift truck) is used to shovel paper up within the storage area to control the build of paper in one location prior to collection.
3b. The plastics and cans are further sorted into separate recyclable streams – see Task 7, Table B35	

Table B35 TASK 7: Transfer of pre-sorted material for additional sorting

MRF 1

Sub-task	***Description***
1. Mixed recyclable material exits pre-sort area	Two streams on separate conveyor belts.
2. Material enters trommel screens (rotating drum with slits of different sizes) from conveyor belt	Trommel screens separate materials into: fine materials, newspapers and magazines and card. These items fall through slots in trommel and onto separate conveyor belts (e.g. to paper cabin).
3. Material exits trommel screens on conveyor belts and passes to disc screens	Disc screens agitate material up and down to further process, removing paper which falls onto conveyor belt feeding paper picking cabin

MRF 1

Sub-task	*Description*
	conveyor belt feeding paper picking cabin.
4. Material exits disc screens on conveyor belts and passes through air knife separation	Jets of air separate small pieces of paper and card which fall through slots into residual storage bunker.
5. Material passes from air knife separation to picking cabins	Following the automated process of separation, the material lines are monitored manually. Any non-recyclable material is picked off and put down chutes into a residual storage bay.
6. Steel cans and aluminium cans are removed	A magnetic separator removes steel cans automatically and transfers them to a storage bunker via conveyor belt. Conveyors from electromagnets feed the mixed picking cabin and any remaining material other than cans are deposited down chutes into the residual storage bay. Aluminium cans are extracted using an eddy current-separator unit and are stored in another storage bunker. Cans are fed on can line to storage bunker to await baling.
7a. Mechanically sorted material from trommel, disc screens and air knifes enters paper picking cabins on 3 conveyor belts	Operatives in paper the cabin stand between 2 chutes and remove any pieces of card or other non-recyclables that have not been separated mechanically. Paper is allowed to flow through; card is placed down one chute into a card storage bunker, and non-recyclables down the other chute into the residual waste pile.
7b. Mechanically sorted material enters mixed picking cabin on 3 conveyor belts	Operatives in mixed picking cabin remove materials such as plastic bottles and cans, which are placed down separate chutes into storage bunkers to await baling.
8. Residual material passed on conveyor to storage area	Unusable material is stored in storage bays until being transferred by lorry to landfill/incinerator.

MRF 2

Sub-task	*Description*
1. Plastics and cans not manually sorted remain on the conveyor and are transferred to the next sorting phase	

MRF 2

Sub-task	*Description*
2. Steel and aluminium cans removed	A magnetic separator removes steel cans automatically and transfers them to a storage bunker via a conveyor belt. Aluminium cans are extracted using a current-separator unit and are stored in another storage bunker. When enough cans have built up they are baled.
3. Residual material passed on conveyor to storage area	Unusable material is stored in Euro bins until it is transferred to a lorry bound for landfill/incinerator.

Table B36 TASK 8: Baling of recyclable material

MRF 1

Sub-task	*Description*
1. Sorted recyclable material (metals, aluminium cans and ferrous cans, plastics and cardboard) stored in separate metal bunkers are transferred to baling machine	Material has been mechanically sorted into metals, plastics and cardboard and is stored in bunkers. Bunker flap is opened and material pushed mechanically onto conveyor belt.
2. Loading of recyclable material (metals, plastics, cardboard) into baling machine	Only one recyclable material is fed on conveyor, and into baler at a time. This can depend upon current demand/volume waiting baling. E.g. machine can make 3 bales of cans and then be switched over to make 1 bale of plastic.
3. Baling machine operator inserts key into control panel on baling machine to start baling process	Baling machine will only operate when key is in situ on control panel and guarding system on machine cannot be removed unless the key is removed from control panel.
4. Recyclable materials are baled	Materials are compressed by ram machine and secured with thin wire rope.
5. Baled material exits machine on conveyor	
6. Baled material transferred to residual storage area using fork-lift truck	When several bales have accumulated baling machine operator transfers bales to storage area.
7a. Baling machine operator removes key from control panel	Removing key from control panel shuts down baling machine.
7b. Machine operator walks to fork-lift truck parked towards rear of baling area	
8. Driver collects bales on fork-lift	Operator picks up bales on forks of truck.

MRF 1

Sub-task	*Description*
9. Bales are transported to storage area	Fork-lift exits baling hall and transports bales on fork-lift round one-way system to adjacent transfer hall.
10. Transfer of bales for reprocessing	When sufficient bales have been collected 3rd party contractors transfer them on flatbed lorry to reprocessing centres. Bales are placed on lorry using fork-lift.

MRF 2

Sub-task	*Description*
1. Sorted cardboard, plastics, steel and aluminium cans are baled. The paper is not baled but collected loose	Material that has been mechanically sorted into metals, plastics and cardboard enters the baling machine.
2. Loading of recyclable material (metals, plastics, cardboard) into baling machine	Only one recyclable material is fed on conveyor, and into baler at a time. This can depend upon current demand/volume waiting baling.
3. Recyclable materials are baled	Materials are compressed by ram machine and secured with thin wire rope.
4. Baled material exits machine on conveyor	When the next bale is produced the first bale is automatically pushed out of the baler. At one of the plastic balers a worker was using a knife to puncture the plastic bottles. This is because the baler did not have an automatic puncturing mechanism. The bottles need to be punctured to ensure they do not explode.
5. Baled material transferred to residual storage area using fork-lift truck	When several bales have accumulated the bales are transferred to a storage area.
6. Transfer of bales for reprocessing	When sufficient bales have been collected 3rd party contractors transfer them on flatbed lorry to reprocessing centres. Bales are placed on lorry using fork-lift.

Table B37 TASK 9: Transfer of sorted paper materials

MRF 1 AND MRF 2

Sub-task	***Description***
1. Articulated lorry enters MRF site, logs in and drives to paper storage bay	Lorry logs in and is weighed as per Task 1, Table B29.
2. Once signalled by MRF operative to do so articulated lorry drives into loading bay and halts	Lorry drives in forward into bay, halts and applies handbrake.
3. Loading bay doors are closed	MRF 1 only: once lorry has halted in loading bay, the bay doors are closed behind in order to prevent paper being blown about whilst loading.
4. Sorted paper material (newspapers, magazines and pamphlets) stored in 3 residual storage bunkers in hall are collected using either a shovel loader or a mechanical grab vehicle	A significant amount of manoeuvring and reversing may be required of loading vehicles. Articulated vehicle driver remains in cab whilst loading is conducted.
5. Paper loaded into articulated lorry	
6. Once fully loaded, driver’s fall arrest system is applied	Once articulated lorry has been fully loaded vehicle driver exits cab and secures his harness to fall arrest system located in loading hall.
7. Tarpaulin is secured over top of vehicle to ensure contents do not escape	Driver climbs up onto vehicle using access ladders and pulls over/secures top tarpaulin.
8. Loading bay doors opened	MRF operative uses automatic controls to open loading bay doors behind articulated vehicle.
9. Vehicle exits paper loading hall through loading bay	Vehicle reverses from loading hall, using cab CCTV and returns to weighbridge office. Driver signs out and at MRF 1 is logged out on MRF computerised system.
10. Vehicle exits MRF site	Vehicle exits MRF site through secure gates.

B4.1.1 Observed task variations

MRF 1

- During hot weather, the generation of dust/fine paper particles is reported to be a problem within the reception hall. Fans emit water droplets into the hall to try and minimise this problem.

MRF 2

- Fans/air cooling facilities supplied in area where manual sorting takes place.

B4.1.2 Unobserved task variations

MRF 1

- Increased volumes of recyclables are produced after bank holidays, Christmas, and summer months and overtime is sometimes required to process this material.
- On occasion more waste is tipped in reception hall than the conveyors can deal with. When this happens supervisors will phone contractors and prevent them from entering the MRF site until backlog has been cleared.
- In the event of line pickers identifying needles within the material stream, the line is halted and litter pickers are used to pick up the needle and deposit it into a sharps box, located in the picking stations.
- The MRF computerised system offers the opportunity to run the conveyor belts feeding the machines and cabins in a number of different combinations depending upon demand and availability of material type.

MRF 2

- Increased volumes of recyclables are produced after bank holidays, Christmas, and summer months and overtime is sometimes required to process this material. A worker may also be used to direct traffic due to the resulting increase in traffic flow. Material may be stock piled to work through at a later date when the volumes have reduced.
- Attempts are made to book a day for hauliers to remove the material; however, it is difficult to book a specific time such as am or pm.
- A lock off procedure and safe system of work is used for maintenance operations.
- Daily entrance into the balers is required to clean off dust built up on the sensors. A key system is in operation whereby a baler cannot be entered without first removing a key, which shuts down the baler. Two people are required to do the maintenance.
- Conveyor belt jams infrequently. When it does, it has to be stopped and the blockage removed manually.
- Quarterly maintenance is undertaken on the machinery and gantry.
- Daily checks are undertaken on the gantry, ladders, and emergency buttons.

B4.1.3 General characteristics of picking teams

MRF 1

- Operatives normally work a 5-day week. Operatives are paid an overtime rate for any hours worked over 40 hours in a week.
- 18-20 employees work per shift.
- 2 shift system worked: 0630-1430 hrs and 1430-2230 hrs.
- There are 2 mandatory breaks per shift. A half hour break in the morning after 2.5 hours work and a half hour lunch break.
- There are 3 distinct groups of employees whose jobs are not interchangeable. This includes picking line operatives, supervisory staff (who also engage in low level maintenance tasks) and engineering staff (1 Chief Engineer who controls all third party engineers).

- Three different picking stations operate: pre-sort, to remove large items and plastic bags (this was reported as being the most hazardous, and the area most likely to encounter needles and sharps), paper, to remove paper from the conveyor, and mixed which dealt with varying materials depending upon current demand (e.g. plastics).
- All picking staff wear PPE: safety shoes and gloves (full length gloves in pre-sort area), aprons and work suit. Some staff choose to wear masks and goggles; staff employed in areas with mobile plant and visiting drivers must wear high visibility jackets, hard hats, gloves and safety boots.
- The picking tasks require only small amounts of upper body movement; pickers are instructed to cover no more than half of the belt width, and practically no lower body movements are required. Employees are reminded to move their lower body frequently to prevent cramp, etc.
- A high proportion of picking staff have English as a second language; this was reported to be a considerable issue. Multilingual induction packs are available.
- New staff are given an induction talk and induction packs, containing a hazard awareness test. Initially, new staff on picking lines are ‘buddied’ until they are considered competent by supervisors.
- 60% of the workforce were reported to be temporary labour.
- Needles stick injury and Weil’s disease were reported to be the major risks to picking staff.
- The picking lines are established for employees of average height and it was reported that problems could arise when employees are above or below average height.

MRF 2

- Operatives normally work a 5-day week. Operatives are paid an overtime rate for any extra hours worked.
- Approximately 15 employees work per shift.
- 1 shift worked: 7.30 am – 4 pm.
- 1 hour lunch break.
- 1 MRF manager, 1 operations manager, pickers and fork-lift truck drivers.
- Staff wore hi-visibility jackets, gloves, safety boots and ear defenders.
- They have a low staff turnover. Agency staff are used to cover holiday periods.
- 1000 tonnes of paper a month, and 200 tonnes of plastics and cans a month are collected.

B4.1.4 Additional information on MRF

MRF 1

- The MRF observed received approximately 85,000 tonnes of recyclable material annually. Material is collected from all the LAs in the county, stockpiled and bulked at transfer stations throughout the region prior to transportation to the MRF.
- The MRF observed dealt with dry recyclables, but not glass. Waste had been previously bulked at transfer stations and predominately consisted of paper, card and plastic.

- Certain areas where mobile plant are operated and in the reception hall (tipping area) were designated Isolation Areas. Secure gates were in situ preventing pedestrians and unauthorised personnel from entering these areas.
- The MRF observed utilised 2 pieces of mobile plant in the reception hall (2 mechanical shovel loader vehicles). One loaded materials onto the conveyor belts and the other was used to transport residue (non-recyclable material passed through process several times and returned to reception hall until it cannot be processed further) to storage area prior to transfer to incinerator.
- The picking line speed (typically 0.85 metres/second) can be adjusted if employees report it is moving too fast or too slow.
- Emergency stop pull cords are fitted above all conveyor belts in picking cabins. Pulling the cord will stop the entire plant. Lines are halted if unknown or hazardous material is observed or in the event of an emergency (e.g. fire).
- Emergency lines hung down over the elevator conveyor, these lines were in situ in order that anyone who accidentally fell onto the conveyor in the reception hall could grab them, halting the line.
- The MRF has an intuitive computerised system that will start back up the plant following a shut down once the problem has been dealt with.
- A control room situated on the upper level of the MRF houses Entrapment Keys on a computerised control panel. These keys are required to unlock mechanical sorting machinery (e.g. trommel) when access is required to clear blockages etc. Removing the keys from the control panel automatically shuts down the machinery and line operations.
- Conveyor belts are flush to the belt bed in order to eliminate pinch points.
- Belt width is 1.2 m, to allow persons adjacent to each other to cover half the width of the belt each.
- The pre-sort cabin can receive the largest items as material is fed onto this line from the reception hall; items were reported as being typically 1-5kg.
- Picking cabins are fed with forced filtered air and are temperature controlled.
- Mobile plant cabins are fed with filtered air and are temperature controlled.
- Dust levels are monitored in picking cabins annually. Dust was not reported to be a problem within cabins which are force fed with air filtered from outside, but was in other areas of the MRF. Supervisors were the group of employees most at risk from dust exposure due to the mobile nature of their duties (they spend around 2 hours a day outside the cabins exposed to dust around the MRF).
- A daily clean is performed by staff at the end of their shift and staff conduct general housekeeping in the course of their duties.
- The MRF is subject to a deep clean every Saturday involving sweeping and vacuuming in order to remove dust/dirt residue and debris. During this clean the plant does not operate. Material collected is taken to the reception hall to be passed through the system again.
- Baling machinery only operates when a key is placed in the control panel on the baler. Baler operatives remove the key, shutting down the machinery when they leave the

machine unattended. Machine guards on the baler are only removable when the key is removed from the machine.

- In the event of a blockage in the trommel screen, human intervention may be required. Access to the screen is obtained via a secure metal hatch with a retainer chain, to prevent it swinging open, on the side of the trommel. Blockages can typically be cleared from outside the machinery in 20 minutes or less; in the event that an individual is required to climb into the trommel, specialist teams are utilised for this job.
- The MRF observed operates a CASH (Common Approach to Safety and Health) system. Any misdemeanours by 3rd party operatives (e.g. drivers) on-site are immediately reported back to their supervisors.

B4.2 MECHANICAL BIOLOGICAL TREATMENT (MBT) PLANT

Tables B38 to B44 summarise the activities carried out at an MBT. It is noted that this should not be taken to be representative of all MBTs as the activities vary widely across MBT plant. This description is based on observations of the following key stages:

- Arrival of composting site employees on-site – Table B38;
- Unloading of sub-50mm particles from transfer station (from black bins screened waste) – Table B39;
- Processing sub-50mm waste – Table B40;
- Unloading partially composted waste from the first stage vessels to the second stage vessels – Table B41;
- Unloading from second set of vessels – Table B42;
- Windrow turning – Table B43;
- Loading screener / milling machine – Table B44; and
- Housekeeping and maintenance.

Table B38 TASK 1: Arrival of composting site employees on-site

Sub-task	***Description***
1. Operatives arrive at MBT site	Operatives work a shift system usually arriving on-site at 07.00, 08.00, 09.00 and 10.00.
2. Operatives log in at site	Operatives note their presence on-site by signing the sheet in the administration area.
3. Vehicle drivers obtains keys for vehicles if required	The keys are kept in the administration office.
4. Operatives are issued with a daily task rota	Site Manager issues task rota on a daily basis. Each operative will sign against the task when it has been completed.
5. Work day begins	

Table B39 TASK 2A: Unloading of sub-50mm particles from transfer station (from black bins screened waste)

Note: the waste arriving at this MBT is pre-treated at a transfer station to remove metals and waste over 50mm. The waste content is predominantly garden and food waste with some plastic and glass.

Sub-task	***Description***
1. An articulated lorry is used to transfer the waste material from the transfer station to the MBT plant. It is driven onto the weighbridge to obtain the weight of gross tonnage	This is logged at weighbridge gatehouse.
2. The articulated lorry is driven to the reception area for tipping waste	This is a reception building with an adjacent concrete pad.
3. The lorry is reversed into the reception building as far as tipping bay	This is done under the supervision of a banksman.
4. Rear section of vehicle is raised to empty the contents into the reception area via a hydraulic arm	
5. Driver moves forward about 5-10 m from edge of bay	This is done to empty the remainder of the contents.
6. Once fully empty, driver lowers vehicle body section back to horizontal position, using controls located in the cab	
7. The lorry is driven through the wheel-wash to eliminate chance of contamination	Due to Animal By-products Regulations.
8. The lorry is driven onto the weighbridge to obtain weight of net tonnage	This is logged at weighbridge gatehouse.

Table B40 TASK 2B: Processing sub-50mm waste

Sub-task	***Description***
1. Site operative climbs into cab of shovel loader	
2. Operative loads waste into a hopper using shovel attachment on loader	The shovel attachment is extended upwards on a hydraulic arm to allow tipping of shovel contents into the hopper.
3. Operative parks shovel loader and exits vehicle	Vehicle parked to allow access for incoming vehicles to deposit their loads.
4. Waste is then transferred by conveyor belt into the leachate tank.	The leachate is mixed with the sub 50 mm particles to required moisture level.

Sub-task	*Description*
5. Material passes through mixing drum on a conveyor to an automatic loading machine	
6. The operative programmes the loading machine to fill the relevant composting vessel with material	Use control panel located within the reception hall. Loading machine is situated on tracks. The loading machine is programmed to go to a specific tunnel for transferring the material. There are a total of 10 vessels.
7. Operator opens the top half of loading doors of the composting vessel	Vessel doors can be opened in two halves (split horizontally). The top half may be opened manually (by opening catch bolt and swinging open the doors) whilst the bottom half can only be opened using an attachment on the shovel loader.
8. Vessel is filled with material	Using loading machine.
9. Operator closes the top half of compost vessel door when full	The doors are closed manually by swinging them shut and bolting in place.
10. Site Manager / Deputy Site Manager climbs onto the roof of the loaded vessel	Climb steps to access roof.
11. 8 temperature probes are inserted into the vessel through the roof	Probes are approximately 3 m in length and made from a light alloy material. A crossbar type grip is present near the top of the probe to aid insertion. The probe is pointed. On the roof there are a number of pipes that are there to blow air into the tunnels and to clean the air to remove odour.
12. The composting monitoring operation is switched on from the main office	The operation is computer controlled via the administration building.

Table B41 TASK 3A: Unloading partially composted waste from the first stage vessels to the second stage vessels

Sub-task	*Description*
1. Shovel loader operative opens rear top half of doors of first set of vessels and front top half of second set of vessels	After the compost has reached 60°C for 48 hours, the compost is moved from the first vessel and transferred to the second vessel. First and second stage vessels face each other.
2. Operative removes bottom half of door of the vessels using attachment on the mechanical shovel	Only top half of door can be opened manually.
3. Operative uses telescopic grab to remove the compost from the first vessel and place it into second vessel	This task requires multiple vehicle manoeuvres.

Sub-task	*Description*
4. Operative manually unblocks the holes in the piping which blows air through the compost (located in the vessel)	The air holes are located in the floor. They become blocked with the compost material when the shovel loader drives over them. As the shovel loader fills the vessel they have to periodically exit the vehicle and clear the holes using a screwdriver, spade and brush. There are approximately 100 holes in each vessel.
5. Operative replaces bottom half of doors to the vessels using attachment on shovel loader	
6. Operative exits cab and manually closes top half of vessel doors	
7. Probes are inserted into the second vessel as described in Steps 10-12 of Task 2B (Table B40)	

Table B42 TASK 3B: Unloading from second set of vessels

Sub-task	*Description*
1. Operative climbs into cab of shovel loader and removes the rear doors from the vessels	The second vessels are emptied after the compost has reached 60°C for 48 hours.
2. Shovel loader vehicle drives forward to scoop compost into shovel	
3. Shovel loader is manoeuvred and compost is placed on windrow maturation pad	This task requires multiple manoeuvres.
4. Material is placed into long windrow	Ten windrows are formed on the maturation pad, one for each set of vessels (each row is located directly in front of the vessel where the material has been removed from).
5. Driver exits vehicle cab	

Table B43 TASK 4: Windrow turning

Sub-task	*Description*
1. Site operative climbs into cab of windrow turning machine	Windrows are turned every 3 days. This mixes and introduces air into the compost.
2. Turning machine is driven slowly along the windrows mixing the compost	Each row is turned fully up and down in each turning session.
3. Driver exits cab	

Table B44 TASK 5: Loading screener / milling machine

Sub-task	*Description*
1. Site operative climbs into cab of shovel loader vehicle	
2. Loading shovel is manoeuvred to pick up compost from the windrow	This task requires multiple manoeuvres.
3. Compost from windrow shovelled into hopper of machine	The matured compost is fed through a final screener and miller.
4. Compost is screened	Compost then passes into another part of the machine.
5. Compost is milled	The miller breaks material such as glass into fine particles.
6. Once the compost is milled it enters a compactor which pushes it into an enclosed skip	At present the skip is removed using a Hookloader and transferred to the landfill for storage.

TASK 6: Housekeeping and maintenance

Cleaning and maintenance of the equipment forms a large part of the task operations undertaken by the site operatives. General housekeeping involves litter picking and sweeping of all the areas around the plant. Also, drain-off channels for the collection of leachate from the composting vessels have to be swept to direct the leachate into the collection sumps. Jet washing of the floors is also done on a weekly basis. Daily maintenance checks on equipment such as leachate pumps are also performed. This includes cleaning the pump filters. The wheel wash is also checked and filters cleaned on a daily basis.

B4.2.1 General characteristics of site operatives

- Four operatives plus the manager and a team leader are on-site during normal working hours. Each member of staff signs in and out on a daily basis.
- Operatives normally work a 5-day week (Monday to Friday). Operatives work a staggered shift system 07.00-15.00, 08.00-16.00, 09.00-17.00 and 10.00-18.00. Occasionally Saturdays are worked during busy periods.
- Workers take formal breaks for lunch. Lunch is 45 minutes and there is a 15 minute break in the afternoon.
- All personnel wear certain items of PPE; high visibility jacket, safety shoes, gloves and a hard hat (except when driving a vehicle). Ear defenders are required in certain locations, such as the reception building. Respirators and safety glasses are provided, but wearing is not compulsory.

B4.2.2 Additional information

- If the loading machine in the reception hall is not working, the waste is transferred into the tunnel using a shovel loader

- When the material is removed from the second tunnel, a sample is taken to test for salmonella and other bacteria. Only when the material is given the all clear will it be turned using the windrow turning machine.
- The operatives are trained in a range of tasks including the operation and breakdown of the machinery, fire-fighting, and the composting process.
- This MBT plant has only been operational for about 6 months and so there have been daily blockages occurring in the loading and screening / milling machinery. Off-site maintenance employees are called upon to remove blockages.
- A Castel lockout procedure is in place whereby a key is removed to lockout a piece of machinery. The machinery will only operate again when that key is replaced.
- A full face mask is used when the windrow turner and miller are in operation as they create a lot of dust.

B4.3 COMPOSTING

Tables B45 to B51 summarise the activities carried out at two types of composting sites that were observed: open windrow and in-vessel. This description is based on observations of the following key stages:

- Arrival of composting site employees on-site – Table B45;
- Unloading mixed food and garden waste – Table B46;
- Processing mixed food and garden waste – Table B47;
- Unloading garden waste only – Table B48;
- Processing garden waste only – Table B49;
- Composting in-vessel and afterwards – Table B50; and
- End-of-day housekeeping – Table B51.

Table B45 TASK 1: Arrival of composting site employees on-site

Sub-task	***Description***
1. Operative arrive at composting site	Operatives usually arrive at site at 07.00 in own vehicle.
2. Operatives log in at site	Operatives acknowledge their presence on-site by marking tick box in administration area (this can be taken outside in emergencies to check who is on-site).
3. Vehicle drivers obtain keys	The drivers keep keys in their personal lockers. Each driver has a key for all the machinery.
4. Work day begins	

Table B46 TASK 2A: Unloading mixed food and garden waste

Sub-task	*Description*
1. Driver drives RCV to composting site	
2. RCV enters site perimeter through gates	Operative signs in at the gatehouse to state that they are on-site.
3. RCV driven onto weighbridge to gain weight of gross tonnage	This is logged at weighbridge gatehouse.
4. RCV driven to reception area for tipping mixed waste	This is a reception building with an adjacent concrete pad. Vehicle may have to wait in a queue for the bay to tip into to become free (only 1 bay).
5. RCV is reversed into reception building as far as tipping bay	On-site operative takes note of vehicle at this point.
6. RCV reverses as far as edge of tipping bay	Banksman used to signify stopping point.
7. Rear tail section of RCV opened automatically using controls situated in the cab	
8. Rear section of vehicle rises up through 90 degrees, and is emptied down into the bay	Note: this may be dependent on vehicle type.
9. Remainder of vehicle contents emptied into pit through raising body of vehicle to 75 degrees using vertical hydraulic ram	
10. Driver moves RCV forward about 5-10 m from edge of bay	This is done to empty remainder of contents.
11. Once fully empty, driver lowers vehicle body section back to horizontal position, using controls located in the cab	
12. RCV driven through disinfectant wheel-wash to eliminate chance of contamination	Due to Animal By-products Regulations.
13. RCV driven onto weighbridge to gain weight of net tonnage	This is logged at weighbridge gatehouse.
14. RCV leaves site through perimeter gates	

Table B47 TASK 2B: Processing mixed food and garden waste

Sub-task	***Description***
1. Site operative climbs into cab of shovel loader	
2. Vehicle is manoeuvred from where parked so can access pile of compostables	This may require multiple reversing movements.
3. Shovel loader vehicle drives forward to scoop mixed food and garden waste into shovel	
4. Shovel attachment extended upwards on hydraulic arm to allow tipping of shovel contents into open top section of shredding machine	Note, Steps 3 and 4 are repeated until all compostables have been deposited into the shredder.
5. Another operative may sweep up any material that does not drop into shredding machine	This is done to maintain a clean and tidy worksite.
6. Operative parks shovel loader and exits vehicle	Vehicle is parked to allow access for incoming RCVs to deposit their loads.
7. Material passes through shredder	
8. Shredded material passes along a conveyor belt into screening machine	This separates out unwanted fractions allowing required material to pass through system and fall onto floor below machine.
9. Operative climbs into cab of shovel loader and manoeuvres vehicle so it can access pile of screened material	Once a suitable pile of screened material has formed it is stored on-site. This is then recycled during the less busy winter period. Plastic is removed for recycling. The larger pieces of paper are wetted down, re-shredded and fed back into the system.
10. Loader drives forward to scoop up material with shovel attachment	
11. Another operative climbs into cab of tractor, attached to large, close-sided container	Vehicle is stored adjacent to reception building.
12. Tractor and container truck reverse to reception building as far as the 'exit' door	
13. Use shovel loader hydraulic arm to load material into the top of the container	
14. Once full of screened material, top of container is sealed manually using plastic sheeting	Materials to be transported in open must be stored in an enclosed container due to Animal By-products Regulations.
15. Tractor with container is driven from reception building to in-vessel area (or 'clamps' as they are also known)	

Sub-task	*Description*
16. Roof of in-vessel retracted using motors at either side of vessel	Controls are operated manually, and located at side of in-vessel entrance.
17. Metal front door of in-vessel removed using shovel loader, raised vertically upwards till out of base supports	This is done using a special hook attachment on the shovel loader. The door is placed on the floor out of the way during the unloading operation.
18. Tractor reverses into in-vessel until it reaches edge of pile of waste	
19. Contents of container deposited into in-vessel by raising container through ~75 degrees	Container is raised on a hydraulic arm, using controls located within tractor cab.
20. Tractor drives forward 5 m to allow remaining container contents to empty out	
21. Container returned to horizontal position	This is done using controls located within cab.
22. Tractor drives back to reception building	
23. In-vessel roof re-sealed and front door placed back on	Note, prior to re-sealing in-vessel, oversize fragments of green waste (from other process) may be added to provide more structure to piles.

Table B48 TASK 3A: Unloading garden waste only

Sub-task	*Description*
1. Driver drives large bulk container vehicle (roll-on roll-off) to composting site	
2. Vehicle enters site perimeter through gates	
3. Vehicle driven onto weighbridge to gain weight of gross tonnage	
4. Vehicle driven to concrete pad for tipping garden waste only	
5. Vehicle is reversed into appropriate outdoor tipping area	Green waste is delivered directly onto concrete pad adjacent to the building.
6. Driver exits cab and operates controls near cab to automatically remove sheeting over top of container	Sheeting arm moves forward to remove sheeting.
7. Driver walks to rear of container and opens rear door of container	
8. Door fixed open onto side of vehicle using clamp	

Sub-task	*Description*
9. Driver returns to cab and operates controls on side of vehicle to hydraulically raise rear section up through 75 degrees	
10. Container contents emptied down onto concrete pad	
11. Vehicle drives forward 5-10 m to empty remainder of contents	
12. Once fully empty, driver lowers vehicle body section back to horizontal position, using controls located in the cab	Garden waste may be stockpiled for one week or more prior to shredding.
13. Vehicle driven back onto weighbridge to gain weight of net tonnage	
14. Vehicle leaves site through perimeter gates	

Table B49 TASK 3B: Processing garden waste only

Note, the shredding and screening tasks were not observed during the visit as the machine was not functioning properly.

Sub-task	*Description*
1. Site operative climbs into cab of shovel loader and manoeuvres vehicle so it can access pile of garden waste	Pile waits to compost for one week before shredding. Vehicle parked to allow access for incoming RCVs to deposit their loads.
2. Shovel loader vehicle drives forward to scoop garden waste into shovel	Note, as an alternative a grab loader may be used instead for this task.
3. Shovel extended upwards on hydraulic arm to allow tipping of shovel contents into mobile shredding machine	Shredding machine positioned nearby to minimise distance of transportation.
4. Material passes through shredder	
5. Operative uses shovel loader to scoop up shredded material	
6. Shredded material emptied into a mobile screening machine	This separates out unwanted fractions allowing required material to pass through system and fall onto floor below machine.
7. Screened material is loaded into trucks using shovel and taken to farmland for stockpiling	This is done once a suitable pile of screened material has formed.

Sub-task	*Description*
8. Larger oversize materials that are ‘screened out’ loaded into trucks using hydraulic shovel and taken for use in adding structure to piles in-vessel	

Table B50 TASK 4: Composting in-vessel and afterwards

Sub-task	*Description*
1. Material composts in first clamp for 7-11 days usually (‘first barrier’)	After temperature has reached 60-70 degrees at all 5 temperature probes within the pile, the temperature is kept steady for 48 hours (this completes the first barrier stage).
2. Roof of in-vessel opened	
3. Door of in-vessel opened and removed	This is done using special attachment on telescopic handler.
4. Shovel attachment fitted to shovel loader	
5. Shovel loader vehicle drives forward to scoop compostables into shovel	
6. Material transported to second in-vessel and deposited inside (‘second barrier’)	Roof of in-vessel opened, and door of in-vessel opened and removed beforehand.
7. Material composts in second in-vessel	After the temperature has reached 60-70 degrees at all 5 temperature probes within the pile, the temperature is kept steady for 48 hours (this completes the second barrier stage). This 2 stage barrier complies with UK regulations.
8. Steps 2-5 repeated to open in-vessel and transport material	The material is then checked for salmonella as indicative bacteria to indicate if pathogens have become non-viable. If they are still present then the second barrier stage is repeated.
9. Material transported to open air part of the site and deposited at end of a row based on a large concrete pad	

Sub-task	*Description*
10. APB row turned every single week using turning machine (large tractor unit with beater with blades). Thus, windrow of material gradually shifts in one direction towards end of row	This aerates row and stops it collapsing on itself, encourages composting as material is not as compacted. As well as aeration, turning reinstates the structure of the internal and external areas of the windrow and helps the gases diffuse around the compost. It also drives off some of the excess moisture. The end result is a more homogeneous windrow. It takes 10-12 weeks to turn material from one end of the row to the other (so 4-5 turns).
11. After secondary maturation, material is fed into top of mobile screening machine, using shovel loader	Screening machine incorporates 'windsifter' to remove plastic shreds from the material. Note, screening in Step 11 may be repeated to gain the required quality of the product.
12. Material is screened into two different streams	
13. Finished product (fully composted, screened material) loaded into articulated vehicles and taken for sale / use	Used in construction, agriculture, landscape gardening, etc. Vehicle is weighed on leaving site.
14. Oversize waste material may be loaded into articulated vehicles (using loader / grab) and taken as day cover material at nearby landfill or used at an energy from waste site	This is material that is non-usable as a compost.

Table B51 TASK 5: End-of-day housekeeping

Sub-task	*Description*
1. Add sweeping attachment to front of shovel loader	
2. Clean up excess material from around the clamps	Picks out hot spots for machine cleaning.
3. Operative in reception building cleans up with brush and barrow	Also goes around on a daily basis picking up litter from the process.
4. Drains are checked for contamination	

B4.3.1 Unobserved task variations

- Plastic bags may be manually picked out of mixed food and garden waste prior to shredding if there is a slack period, with sufficient time to allow for this practice.
- No differences were reported in how compostables are treated with respect to differing weather conditions.

- When increased volume of compostable material is produced (e.g. during summer months), the length of the shift may be extended to clear any backlog that has built up.
- If there is an excessive production of green waste that cannot be dealt with, for example due to plant failure, then this material is taken in collection vehicles directly to the adjacent landfill site for depositing.

B4.3.2 General characteristics of site operatives

- 6 operatives are on-site during normal working hours: 2 operatives at the in-vessel and 4 sorting out incoming compostables. However, all operatives are trained and are able to perform all tasks on all pieces of workplace transport, and so work interchangeably.
- Operatives normally work a 5-day week (Monday to Friday), from 07.30-16.30 with extended working required over the weekend to deal with deliveries of green waste in bulk containers, which occur every day of the week.
- Workers take formal breaks for lunch.
- All personnel wear certain items of PPE; high visibility jacket, safety shoes, gloves and a hard hat (except when driving a vehicle). Ear defenders are required in certain locations, such as the reception building. Respirators and safety glasses are provided but wearing them is not compulsory.
- Usually the same personnel work on-site, although during holidays / sickness, hire in other staff from same contractor.
- RCVs observed delivering household compost collections – up to 10 te capacity.
- Large lorries also observed – up to 20 te capacity.

B4.3.3 Additional information on composting site

- Site observed is designed to compost waste derived from: kerbside collections of biodegradable household and kitchen waste; and general green and garden waste from council Household Waste Recycling Centre (HWRC) sites.
- Reception building only has one bay for arriving RCVs to tip into (therefore, it does not allow for a considerable build up of compostables, and has to be emptied into shredder as soon as possible).
- There are ten in-vessels, or clamps, on-site, each with a maximum capacity of 165 te.
- At the site observed, vehicles delivering turned in a relatively large turning area before reversing into the reception building / drop-off point, and leaving by passing through the same route.
- A range of workplace transport vehicles are used on-site. In the in-vessel part of the site, all workers are commonly inside workplace transport vehicles, so there are no pedestrians.
- Volume of compostables brought onto site each day varies from 600 to 1000 te.
- Collection is performed on a fortnightly basis, with one week ‘busier’ than the other, with an increased volume of material.
- Exposures to airborne hazards: the cabs of the vehicles used on-site are fitted with air filters to remove particulate dust. These are changed on a regular basis. The operators did not know the type of filter used. However, from past experience, they tend to be P3

filters. Personal samplers on the drivers of these vehicles indicate that the filters are adequate (from previous study). The exception is the loader with only half a cab door.

B4.4 INCINERATION

Tables B52 to B54 summarise the observed activities carried out at an incineration plant that was visited. This description is based on observations of the following key stages:

- Unloading at the incinerator – Table B52;
- Loading of tipped waste into incinerator furnace – Table B53; and
- Loading of ash onto contractor's lorry – Table B54.

Table B52 TASK 1: Unloading at the incinerator

Sub-task	*Description*
1. RCV enters incinerator site perimeter through gates and drives to weighbridge	
2. RCV driven onto weighbridge to gain weight of gross tonnage	Driver signs in at weighbridge office to state that they are on-site.
3. RCV driven to tipping hall area	On arrival at tipping hall entrance the vehicle may have to wait in a queue prior to being allowed access to the tipping hall.
4. RCV is driven into tipping hall through hall door and then reversed into tipping bay	Specific tipping bay for use is indicated by a green traffic light above the bay. A red light signals that the bay cannot be used. Rules state that vehicles cannot tip into a bay adjacent to another vehicle.
5. RCV reverses as far as edge of tipping bay	Driver halts vehicle when rear tyres come into contact with the edge of the bay, using rear CCTV for guidance.
6. Rear tail section of RCV opened automatically using controls situated in the cab	This may be dependent on vehicle type.
7. Rear section of vehicle rises up through 90 degrees, and waste is emptied down into waste bunker	Waste bunker is 15m deep, and is fed into through 5 parallel bays.
8. Remainder of vehicle contents are emptied into the pit through internal ram pushing horizontally outwards towards open back of vehicle	

Sub-task	***Description***
9. Driver lowers vehicle tail section partially, using controls located in the cab	Driver closes rear once the vehicle is emptied. A bulldozer may be used to push any remaining waste into the bunker. Waste may also be manually swept into the bunker by operatives, who clip themselves onto harnessing points to mitigate against the risk of falling over the bay edge.
10. Driver moves RCV forward about 5-10 m from edge of bay	
11. Driver puts on safety helmet and exits vehicle from driver side door	
12. Driver manually operates control to lower and close tail section of vehicle	
13. Driver re-enters cab	
14. RCV driven back to weighbridge to gain weight of tonnage, in order to calculate amount of waste deposited	Vehicle exits tipping hall through entrance door.
15. Driver signs out at weighbridge and exits incinerator site via gates.	

Table B53 TASK 2: Loading of tipped waste into incinerator furnace

Sub-task	***Description***
1. Tipped waste in waste bunker is picked up by grab crane	Waste is collected in claws of grab crane that is operated automatically via computerised system in control room. 2 grab cranes operate either individually, or at busy times at the same time. The cranes are linked to the bay traffic lights, sensing which bay has just been tipped into and hence where the larger pile of waste to collect from is.
2. Waste is mixed	Grab crane deposits waste pile back into waste bunker from a height of about 2 metres and picks it back up again. This ensures that waste is mixed prior to being fed into the incinerator – a good mix ensures an efficient burn.
3. Waste is transferred by crab crane to chute feeding the hopper	Grab crane claws drops waste into feed chute situated to the rear left hand side of bunker that feeds into a hopper. The waste chute is separated into 3 zones, each of which has a microwave sensor above it telling the crane which zone to drop the waste into.

Sub-task	*Description*
4. Waste is transferred from the hopper onto the conveyor belt	Conveyor belt at bottom of the hopper transports waste to incinerator furnace.
5. Waste is conveyed onto a flat bed grate	Once on flat bed grate, rams push waste onto a series of 5 moving grates (zones), one after the other.
6. Waste is fed through incinerator on moving grates	Air injected via slits below grates facilitates burning. Over fire air is introduced into flames to fully burn off flames, which are a by-product. Urea is injected at furnace site via pipes; this converts to ammonia in the heat and eliminates nitrous oxide.
7. Ash is removed	Ash produced during incineration falls through slots at bottom of zone 5 (by which time it is inert) onto conveyor belt below.
8. By-products of incineration are removed/treated	The heat generated by incineration is used to heat water in the boilers to 400°C to generate superheated steam (gas); the boilers are under a pressure of 45 bar. This steam is passed to turbines, as steam blows onto turbine blades it generates energy (19.5 megawatts) which is used to heat water. APC residue – particles of dust in hot gases and flue gas – are sent via pipes to fabric filters (bag house). Prior to transfer to bag house lime and activated carbon is injected to treat dioxins. These filters have air pulsed through them, which captures dust in the filter and drops it into storage hoppers and then via pipes to storage silos. The residue is removed by contractors and taken to landfill or salt mines for disposal.
9. Ferrous metals are removed	After incineration, the ash is passed through a magnet separator on a conveyor belt. Ferrous metals are extracted onto a separate conveyor belt and fall off into a separate storage pile in the ash bay.
10. Remaining ash is deposited in ash bay	Ash is transported on conveyor belt to ash bay, where it falls off end of conveyor into ash pile on floor of the bay.

Table B54 TASK 3: Loading of ash onto contractor's lorry

Sub-task	***Description***
1. Contractors vehicle enters incinerator site perimeter through gates and drives to weighbridge	Vehicle may vary but is typically an 8 wheeled vehicle, with large capacity.
2.Vehicle driven onto weighbridge to gain weight of gross tonnage	Driver signs in at weighbridge office to indicate that they are on-site.
3. Vehicle driven to ash bay area	
4. Vehicle is driven into ash bay through hall door	This may be in forward or reverse, depending upon driver's preference.
5. Mobile plant (shovel loader) collects a pile of ash and deposits it into top of container on vehicle	Day team member, called to ash bay by control room staff, may operate the shovel loader. On occasion contractor driver will exit cab and operate bucket loader himself.
6. Vehicle is loaded to capacity with ash	
7. Once full, vehicle is sheeted across open top of container to cover contents	May be done automatically or manually depending on vehicle.
8. Vehicle driven back to weighbridge to gain weight of tonnage, in order to calculate the amount of ash collected	Vehicle manoeuvres out of ash bay either in reverse (using cab CCTV, banksmen) or in forward depending upon entrance method.
9. Driver signs out at weighbridge and exits incinerator site via gates.	Ash is taken for use as day cover at landfill sites.

B4.4.1 Unobserved task variations

- Occasionally bulky items such as fridge freezers can get stuck in the feed chute into the incinerator, blocking it. In such instances, a smaller manually operated gantry mounted hook crane is used to remove the item and unblock the chute.
- The incinerator observed is a newly built state of the art facility. Older facilities remain although it was reported that there is very little variation in process within such older facilities compared to the new one. Slightly more manual intervention may be required and the combustion is less well controlled, emissions are also typically less well controlled, e.g. the ash produced is not necessarily of such a high quality (inert) and can only be used for landfill.
- At some sites the RCVs drive into tipping hall via one route and out via another using a one-way system; however, it was reported that at the majority of incinerators RCVs drive in and out via same entrance.
- During late Friday afternoon the 2 bays to the right hand side of the tipping hall will be closed and waste will be stockpiled against one corner of the bunker by the cranes. This is to manage the waste pile over the weekend and ensure there is space for tipping on Monday morning (into the area behind 2 right hand bays).

- When the incinerator hopper is full, the crane system will automatically shut down and no further waste will be collected until the backlog has cleared.
- Only 3 RCVs are permitted in the tipping hall at any one time.
- There are 8 safety showers located around the site to be utilised in the event of any chemical spills/accidents. These are linked by a building management system to control room computers. In the event of a shower being utilised an alarm will sound in the control room and a member of staff will be allocated to go to the indicated shower in case the person may be in need of emergency assistance.

B4.4.2 General characteristics of incinerator

- The incinerator aims to function for 90 -95% of each day and operates 24 hours a day, 7 days a week.
- Approximately every 4000 hours (6 months) the plant is shut down for a short period of time (outage) to service, clean, repair etc.
- There is normally one small outage (5 days) in April when the plant is cleaned and inspected to ascertain what work is required and one larger outage (10) days in November when this work is completed and again the plant is cleaned.
- The incinerator provides heat and hot water via 45 km of pipeline.
- 19.5 MW of energy are produced every half an hour.
- There are 5 bays side by side but vehicles are not permitted to tip either side of each other at the same time; they must always leave a spare bay next to them. Only 3 vehicles can tip at one time.
- Waste pushed from the tipping hall is stockpiled in a concrete bunker that takes approximately 5000 cubic metres of waste every 3 days.
- The grab cranes are generally fully automatic but during busy times this can be overridden and they can be operated manually (either one or both at same time).
- The crane driver’s seats are located behind a large window in the control room, above the waste bunker, that has full visibility of the bunker.
- Each crane can grab 3- 3.5 tonnes of waste per load.
- 60 -70 RCVs tip every day. 28 tonnes of waste is burnt every hour and 7 tonnes of inert ash generated every hour.
- The incinerator grates are separated into 5 zones and the amount of air blown into each zone can be adjusted according to burn quality; this requirement is sensed by computers and done automatically.
- Ash is sent to landfill for landfill cover or depositing in landfill; it may also be used to manufacture breezeblocks for the construction industry.
- Ferrous metals extracted after burning by a magnet separator are sold to metal recycling contractors.
- APC residue is highly alkaline and is disposed of at landfill or in a salt mine.
- Lime, urea and activated carbon are delivered to site via tankers that blow compounds into storage silos via pipes. This is transferred into the incineration process via pipes controlled automatically, so no manual intervention is required.

- Gases produced have to be maintained at 850°C for at least 2 seconds (residence time) to burn off dioxins.
- A permit to work system is in operation; operatives and contractors cannot do any job/maintenance on the plant without a permit to work. The exception is for tasks that do not require electrical isolation (e.g. sweeping tipping hall). For such tasks there are detailed procedures to follow that contain risk assessments and method statements. These must be read and signed as understood prior to undertaking the tasks.
- External contractors provide their own risk assessments and method statements. The incinerator maintenance manager will check these conform to site policies and sanction them prior to permitting work.
- For recurring tasks, risk assessments and method statements only have to be completed once.
- The majority of plant maintenance is preventative or predictive maintenance and is conducted by service providers and external contractors. Hence, a large variety of external contractors visit the incinerator site on a regular basis.
- The grab cranes are maintained on a weekly basis and for 2 days every month, 1 crane cannot be used whilst being maintained.

B4.4.3 General characteristics of incinerator employees

- There are two distinct types of employees – control room staff and day team staff.
- Day team consists of 8 employees who work in the tipping hall, operate shovel loaders and other mobile plant around the site, and perform plant cleaning and residual duties. They normally work a 5-day week rota. There are 12 control room staff operating 6 shifts of 2 staff.
- A 12-hour shift system is worked, 6 am-6 pm and 6 pm-6 am, in the control room to provide 24 hour a day cover. The shifts rotate backwards.
- The rota always includes 2 spare staff available for covering sickness and holiday etc.
- Control room staff typically work 3 days followed by 3 days off.
- All staff/contractors in areas of mobile plant or when within the incinerator wear PPE; safety shoes, high visibility jackets and hard hats (ear defenders are also required in the turbine rooms).
- New staff are given an induction specifically to the site in addition to general company induction.

B4.5 LANDFILL

Tables B55 to B59 summarise the observed activities carried out at a landfill site that was visited. This description is based on observations of the following key stages:

- Arrival of landfill site employees on-site – Table B55;
- Tipping of waste into landfill site – Table B56;
- Distribution and compaction of waste on the landfill – Table B57;
- Litter picking – Table B58; and
- Checking gas and leachate concentrations – Table B59.

Table B55 TASK 1: Arrival of landfill site employees on-site

Sub-task	***Description***
1. Operatives arrive at landfill site office	Operatives arrive on-site at 07.30 (no signing in procedure is in operation) and finish at 17.00.
2. Vehicle drivers obtains keys for vehicles if required	The keys are kept in the administration office.
3. Drivers make their way to the vehicle storage areas and pick up mechanical shovel and compactor vehicle	Mechanical shovel is garaged in a workshop attached to the offices. Compactor is stored in a lock-up shed. Typically operatives are on the tipping face from 08.00 - 16.30.
4. Vehicles are driven to tipping face of the landfill	Face of tipping area moves with the progression of the infill. The operatives use a checklist on a daily basis to assess the condition of the vehicles (e.g. check for cracks in the shovel bucket).
5. Work day begins	08.00

Table B56 TASK 2: Tipping of waste into landfill site

Sub-task	***Description***
1. Driver drives waste collection vehicle to landfill site	
2. Collection vehicle driven onto weighbridge to gain weight of gross tonnage	This is logged at weighbridge gatehouse. Directions will be given at the weighbridge to the drivers so they know which route to take to the tipping face, and the location for off-loading.
3. Collection vehicle driven to tipping face area for tipping waste.	The drivers will be given precise directions by one of machine operatives working on the tip face to inform them where to tip.
4. Collection vehicle is reversed on to the tipping face	Tip face operatives continue to work whilst waste collection vehicles are on the tip face.
5. Collection vehicle reverses as far as edge of tipping face	
6. Driver or other member of the crew gets out of the cab.	Typically a member of the crew will get out of the cab to operate vehicle lift controls.
7. Rear tail section of RCV is opened by a crew member / RCV driver using the automatic controls located just behind the vehicle cab.	
8. Rear section of vehicle rises up through 90 degrees, and is emptied onto tipping face	This may be dependent on vehicle type.

Sub-task	*Description*
9. Remainder of vehicle contents emptied in the area through raising body of vehicle to 75 degrees using vertical hydraulic ram	This may be dependent on vehicle type.
10. Driver moves RCV forward about 5-10 m	This is done to empty remainder of contents. When a crew member has operated the controls they will walk alongside the vehicle until it stops.
11. Once fully empty, driver lowers vehicle body section back to horizontal position, using controls located in the cab	
12. Collection vehicle driven through wheel-wash to eliminate chance of contamination	The wheel wash is used to ensure the site and highway is kept free of mud. The wheel wash is about 2 ft deep and is re-filled with fresh water every 13 weeks. The vehicles drive over gridding positioned above the wheel wash. To clean the wheel wash, a vehicle is hired to pull out the gridding. The dirty water is then removed and replaced with clean water.
13. RCV driven onto weighbridge to gain weight of net tonnage	This is logged at the weighbridge gatehouse.
14. RCV leaves site through perimeter gates	

NB: At some landfill sites, collection vehicles empty waste into a large enclosed building, rather than driving directly onto the landfill itself. The waste is then loaded into heavy-duty lorries using a shovel loader. These lorries are then driven onto the landfill for tipping.

Table B57 TASK 3: Distribution and compaction of waste on the landfill

Sub-task	*Description*
1. Site operative climbs into cab of mechanical shovel	The mechanical shovel, or Traxi, is used to tip the waste over the edge, into the landfill, or for evenly distributing the waste across the landfill site.
2. Soil placed on top of landfill as day cover is scraped off the top of the surface prior to the first load arriving.	
3. Waste arrives and is deposited by collection vehicles	
4. Compactor driver drives over the waste several times to compact down the waste	Task repeated numerous times throughout the day as waste arrives.
5. At the end of the day the waste on the landfill is covered by soil.	This task will generally be undertaken using the mechanical shovel.

Sub-task	*Description*
6. At the end of the shift the drivers return machinery to storage area	

Table B58 TASK 4: Litter picking

Sub-task	*Description*
1. Operative walks the site picking up litter	Operative uses litter picking stick (grabber) and black plastic sacks.
2. Full sacks of litter are taken to a pick up area and consolidated there	This is a designated area for pick up by machinery.

Table B59 TASK 5: Checking gas and leachate concentrations

Sub-task	*Description*
1. Landsite operatives and environment team dip the wells on a weekly basis	The operatives dip the wells using a reading tape that is pushed down into the well. It will beep when it reaches the bottom. This operation is preformed to check the leachate level is compliant. The environment team also take gas readings to ensure compliance. A risk assessment is performed on the day dips are taken. A permit to work is required.
2. If the leachate levels are too high some has to be removed into a tank	The leachate is pumped into a holding tank. Contractors are then called to remove the leachate from the holding tank.

B4.5.1 General characteristics of site operatives

- Four operatives plus the manager, site supervisor and weighbridge operative are on-site during normal working hours. One of the operatives is part time and is on standby to cover holidays and sick leave.
- Operatives normally work a 5-day week (Monday to Friday), from 07.30-7.30.
- Workers take formal breaks for lunch.
- All personnel wear certain items of PPE; high visibility jacket, safety shoes, gloves and a hard hat.
- The litter picker can also work as a third landfill operative because they are trained to use the vehicles. Generally they do so to cover absence.
- The landfill operatives rotate the vehicle they drive on a weekly basis.

B4.5.2 Additional information

- Pumps located in the leachate wells can break down so they have to be removed using a block and chain. A permit to work is required. If site employees cannot fix the pump a contractor is called in.
- The landfill vehicles are equipped with reversing cameras.
- The number of vehicles tipping at the site varies from one week to the next.
- In the winter the waste collection vehicles can get stuck on the landfill site and have to be towed out.
- All collection vehicle drivers are issued with a site rules booklet that contains information on what to do if they get stuck.

B5 SELECTION OF COMPONENTS

B5.1 INTRODUCTION

In order to fulfil the third objective of this work package, it was necessary to determine a representative set of generic components that represent the key activities across the twelve waste and recyclables management systems considered in scope. These components will then form the building blocks of the Risk Comparator Tool.

B5.2 APPROACH TAKEN FOR SELECTION OF COMPONENTS AND FACTORS TAKEN INTO CONSIDERATION

The selection of components was based mainly on analysis of the task analysis presented in this appendix. Components were selected such as to:

- Capture the key activities;
- Enable more complex systems to be constructed based on parts of different defined systems; and
- Have a similar level of detail between components.

An initial set of components was created and these were circulated to the Project Advisory Committee for consideration and were also discussed at four risk assessment workshops (refer to Annex D2, Appendix D, for detail of these workshops) with representatives from all aspects of the waste and recycling industry. The discussions were focused on the following questions:

- Are there any key activities that have been missed for each system?
- Are there any activities whose inclusion appears strange?
- Is the level of detail, in terms of activities included or neglected, consistent across each of the systems?
- Have we cut off in a sensible place, i.e. ignored those tasks that are trivial?

Following the discussions a number of small changes were made to the initial activities; although, most of these changes generally related to clarification. A small number of additional components were included, however.

B5.3 RECOMMENDED COMPONENTS

The components selected to form a basis for the Risk Comparator Tool, and a justification for the selection, are discussed below, and are also summarised in Tables B60 to B67 in Annex B1. It is emphasised that the components do not cover everything that occurs on a specific collection or at a specific site, but they try to capture the key activities. For example, activities at the periphery of waste processing, such as energy production, are outside of scope as are engineering works, such as further development of a landfill site. Additionally, careful attention must be paid to the scope of the given systems as generally larger more automated processes have been captured, which may not be representative of smaller manual systems.

B5.3.1 Collection subsystem

For collection the generic components/activities chosen were as follows. Table B60 in Annex B1 describes each of these components.

- ***1.*** ***Assembly of collection crew at start of shift and pre-round activities*** – this is assumed to be a generic activity for each collection system in that the level of risk is essentially the same for all collection systems using the full range of collection vehicles. It includes all the main activities that are carried out prior to vehicles leaving the depot to go on their collection round, including for example vehicle checks.
- ***2.*** ***Driving from location to location*** – this is a generic activity capturing all driving of the collection vehicle. It is assumed to be independent of vehicle type and waste stream. On-street reversing is captured under this generic driving activity.
- ***3.*** ***Getting in and out of cab*** – this is a generic activity capturing the climbs in and out of a cab. Again it is assumed to be independent of vehicle type and waste stream. However, it is recognised that the specific vehicle design may have a huge impact on the level of risk, for example whether there is low-level entry or not. A typical collection vehicle has therefore been taken to be representative of vehicles commonly used in collection.
- ***4***. ***High-rise bags collect*** – this is assumed to be representative of door-to-door collection of dry recyclables from flats using large slave sacks. It is assumed that the operative empties the households recyclables into the slave sack outside their door. It also assumes that operatives generally move from one floor to the next by use of stairs and not lifts, and start at the top of the flats and work downwards.
- ***5***. ***Disposable bags collect*** – this is assumed to be representative of the collection of a typical black sack. Assessment has been based on sacks containing residual waste. The method of carrying the sacks has been assumed to be by the side and not over the shoulders. An additional activity, pulling out of black sacks, was considered, although not included as it was considered to be implicitly captured as part of this activity.
- ***6***. ***Reusable bags collect and bag return*** – this is the activity involving collection of material in reusable sacks. The assessment has been based on the collection of green waste in large sacks. Modification to the assessments would be required for alternative waste and recyclable streams or different sizes of bag. Returning the empty bag to the property boundary is also captured.
- ***7***. ***Big wheeled bins collect and bin return*** – this is assumed to be representative of the collection of all large wheeled bins, including both Palladins and Euro bins. It is understood that Palladins are being phased out and that use of the different bins may present a different level of risk. But, given that they are still in use, they are included here, and some collection of Palladins is implicitly considered in this component. Returning the emptied bin to the bin store is also captured.
- ***8***. ***Food waste collect and receptacle return*** – this is the generic activity of collecting food waste in small food bins from, generally, the kerbside and taking them to the collection vehicle. Also captured is returning the food bin after emptying.
- ***9***. ***Kerbside box collect and box return*** – this is the generic activity of collecting dry recyclables in boxes from, generally, the kerbside and taking them to the collection vehicle. Also captured is returning the box after emptying.
- ***10***. ***Slave wheeled bin collect*** – this is assumed to represent emptying the household receptacle into a wheeled bin, the slave bin, and moving the slave bin towards the next property and to the collection vehicle when full. Assessment has been based on collection of dry recyclables.
- ***11*** ***Slave bag or box collect*** – this is similar to the slave wheeled bin collect. The only difference being that a box or bag is used as the slave container rather than a

wheeled bin. Again, it has been assumed that this is utilised predominantly with mixed dry recyclables.

- *12*. ***Wheeled bin collect and bin return*** – this is assumed to be representative of the collection and return once emptied of standard wheeled bins in the capacity range 120 to 360 l, but predominantly 240 l. Contents of the bins have been assumed to be either residual waste, dry recyclables or compostables.
- *13*. ***Disposable bags empty*** – it has been assumed that emptying black sacks is into the rear of an RCV by swinging the bag into the back manually.
- *14*. ***Reusable bags empty*** – this activity is based on emptying large sacks of green waste into the back of an RCV. Again it is assumed that these are lifted and emptied manually.
- *15*. ***Big wheeled bins empty*** – this is based on bins being emptied by using the bin lifts on the back of an RCV. A mixture of automatic and manually operated lifts have been assumed. A mix of Palladin and Euro bins have also been assumed, as discussed above for big wheeled bin collect.
- *16*. ***Food waste empty*** – it has been assumed that food waste is emptied into a stillage on a stillage vehicle by climbing up steps to get onto the vehicle body.
- *17*. ***High-rise slave sacks empty*** – the sacks have been assumed to be thrown into the back of an RCV.
- *18*. ***Wheeled bins empty*** – as with the big bins, it has been assumed that the bins are emptied by using the bin lifts on the back of an RCV. A mixture of automatic and manually operated lifts have been assumed.
- *19*. ***Kerbsider vehicle box sort and empty*** – this activity assumes that boxes of dry recyclables are sorted into separate hoppers on the Kerbsider vehicle. This operation is carried out at kerbside by the same operative that collected the box.
- *20*. ***Stillage vehicle box sort and empty (same operative collects and sorts)*** – this activity assumes that boxes of dry recyclables are sorted into separate stillages on Stillage vehicles. As there are a large range of different vehicle designs, it has been assumed that some activities are carried out from the kerbside whilst others are carried out by climbing up steps onto the vehicle body before sorting. It has been assumed that the same person that collected the box sorts its contents.
- *21*. ***Stillage vehicle box sort and empty (separate operative collects and sorts)*** – this is similar to the above except there is a dedicated sorter. That is a separate person collects the box to the person who sorts it. In this case it has been assumed that sorting occurs from on the vehicle and not the ground.
- *22*. ***Slave wheeled bin empty*** – this is exactly the same as the wheeled bin empty except dry recyclables, predominantly glass and tin, have been assumed.
- *23*. ***Walking to and from collection point*** – this is a generic activity to capture the walking between each receptacle collection point. This is assumed to be applicable across all collection systems.
- *24*. ***Operating vehicle machinery – RCV compaction*** – this activity is specific to RCVs and operation of the compactor plate.
- *25*. ***Operating vehicle machinery – Kerbsider hopper empty*** – this activity is specific to Kerbsider vehicles where hoppers are mechanically lifted and tipped into the top of the vehicle to empty them.

- *26.* ***Emptying collection vehicle*** – this is a generic category, assumed to represent emptying an RCV and is included here for completeness. However, it is recognised that the emptying activity is going to depend strongly on the waste stream and the type of vehicle. To account for this more specific emptying activities are included in the post-collection activities.

Implicit in all relevant collection activities is that assisted collections occur in a small percentage of cases. Discussion at the industry workshops suggested that this occurred in about 5% of collections, although this will obviously vary between Local Authorities.

B5.3.2 Transfer/bulking station

For transfer/bulking stations[16] the generic components/activities chosen were as follows. Table B61 in Annex B1 describes each of these components.

- ***1. Inward vehicle movements*** – this is a generic activity capturing all inward vehicle movements including reversing of the collection vehicle. It is recognised that the reversing activity is going to depend strongly on the type of vehicle and the use of banksmen/rear CCTV for guidance. An average approach has therefore been taken; this takes account of the fact that sometimes banksmen/CCTV will be utilised, whilst at other times such control measures will not be in situ.
- ***2. Unloading vehicle*** – this is a generic category, assumed to represent emptying a collection vehicle. However, it is recognised that the emptying activity is going to depend strongly on the waste stream and the type of vehicle/tipping mechanisms and controls. Where this makes a significant difference to a hazard this will be captured in the hazard rating. Three main vehicle types have been considered[17]: RCVs, Kerbsiders and Stillage vehicles.
- ***3. Handling heavy/hazardous waste*** – this is assumed to be representative of the handling of all large, heavy unusual items and hazardous waste including batteries, oil and chemicals. It is assumed that heavy items will be handled using mobile plant or several operatives, and that operatives will be issued with, and wearing, the appropriate PPE when handling hazardous material.
- ***4. Loading lorries*** – this is a generic category, assumed to represent the loading of an articulated lorry[18] by a shovel loader. However, it is recognised that the loading activity is going to depend strongly on the waste stream and the type of vehicle. Where this makes a significant difference to a hazard this will be captured in the hazard rating.
- ***5. Onward vehicle movements*** – this is a generic activity, capturing the movement of vehicles to take material from the transfer/bulking station for further processing or disposal.
- ***6. General housekeeping*** – this is a generic activity, assumed to represent all housekeeping duties such as sweeping the loading yard/hall and cleaning machinery.
- ***7. Maintenance –*** this is a generic activity assumed to represent all maintenance activities by plant staff and contractors; both routine and due to breakdown. It is acknowledged that there will be variation in frequency depending upon the size of the site. The workshop attendees commented that frequently contractors are on-site to conduct maintenance/repair e.g. vehicle repair and this may affect the risk of harm.

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[16] *A transfer station and bulking station are taken to be similar. Where additional activities are undertaken at a bulking station, these can be included by selecting components from other systems.*

[17] *These were considered to represent the main categories of vehicle used in collection.*

[18] *An articulated lorry is taken to be a large lorry with a sheeted container trailer.*

However, an average approach is taken and it is assumed that all operatives (including contractors) will be briefed and issued with, and wearing, the appropriate PPE.

B5.3.3 MRF

For MRFs the generic components/activities chosen were as follows. Table B62 in Annex B1 describes each of these components.

- ***1. Inward vehicle movements*** – this is a generic activity capturing all inward vehicle movements including reversing of the vehicles. It is recognised that the reversing activity is going to depend strongly on the type of vehicle and the use of banksmen/rear CCTV for guidance. An average approach has therefore been taken; this takes account of the fact that sometimes banksmen/CCTV will be utilised, whilst at other times such control measures will not be in situ.
- ***2. Unloading vehicle*** – this is a generic category, assumed to represent emptying an RCV/articulated lorry[19]. However, it is recognised that the emptying activity is going to depend strongly on the waste stream and the type of vehicle/tipping mechanisms and controls. Where this makes a significant difference to a hazard this will be captured in the hazard rating.
- ***3. Pre-sorting materials*** – this is assumed to be representative of the initial disposal of major contaminants in the recyclate. It is acknowledged that contaminants may be removed manually or mechanically. It is assumed that all operatives will be issued with, and wearing, the appropriate PPE.
- ***4. Loading material onto conveyors and mechanical sorting*** – this is a generic category, assumed to represent the use of mobile plant (e.g. bucket loader) to pick up of material from bays and deposit it onto conveyor belts. However, it is recognised that the loading activity is going to depend on the type of mobile plant and MRF design. The material then passes through a series of mechanical screens and trammels. The exact details of the mechanical sorting will again depend on the waste stream and MRF design. However, in terms of risk to operatives, it is likely to be the loading activity that presents most risk in normal operation, so the exact details of the mechanical sorting is not important.
- ***5. Manual sorting*** – this is a generic category assumed to be representative of the manual removal of designated materials (e.g. paper, plastics) from the recyclate from conveyor belts. It is assumed that operatives will be issued with and wearing the appropriate PPE. It is recognised that this activity is going to depend on the MRF design.
- ***6. Baling materials*** – this is assumed to be representative of materials delivered into baling machines via conveyor belts, compressed, secured with thin wire rope and the baled material exiting the machine on a conveyor. It is recognised that this activity is going to depend on baling machine design. It is assumed that appropriate control measures e.g. lock out procedures and guarding will be in place. Loading of the conveyor belt is assumed to be by shovel loader as before.
- ***7. Storage of recovered fractions*** – this is a generic category, assumed to represent the storage of recovered fractions in bays. Movement of bales is assumed to be by fork-lift truck and loose material by shovel loader.
- ***8. Loading lorries*** – this is a generic category, assumed to represent the loading of an articulated lorry with recovered material. However, it is recognised that the loading

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[19] *An articulated lorry has been included to capture transfer of material from a transfer/bulking station.*

activity is going to depend strongly on the recyclable material and the type of vehicle/ mobile plant utilised. Where this makes a significant difference to a hazard this will be captured in the hazard rating. Loading by both shovel loader for loose material and fork-lift trucks for baled material is considered.

- ***9. Onward vehicle movements*** – this is a generic activity, capturing the movement of vehicles and associated activities, to take sorted or waste material from the MRF.
- ***10. General housekeeping*** – this is a generic activity, assumed to represent all housekeeping duties such as sweeping/dusting the MRF plant and cleaning machinery.
- ***11. Maintenance –*** this is a generic activity assumed to represent all maintenance activities by plant staff and contractors, both routine and due to breakdown/blockage. It is assumed that operatives will be issued with and wearing the appropriate PPE. It is acknowledged that there will be variation in frequency depending upon the size of plant.

B5.3.4 MBT

For MBT the generic components/activities chosen were as follows. Table B63 in Annex B1 describes each of these components. It should be noted that the order of the components is not necessarily representative of the order in which they occur in the overall process. The focus is on the significant task components.

Phase 1: Mechanical sorting

- ***1. Inward vehicle movements*** – the vehicle is reversed into a tipping bay/hall where a banksman may be used to signal a stopping point. It is assumed that mostly RCVs will enter the site, although large lorries are also considered.
- ***2. Unloading vehicle*** – this assumes that someone will exit the cab to operate the vehicle controls to unload the material in the reception hall. Once the vehicle is unloaded it is assumed that the worker climbs back into the cab. It is recognised that some vehicles would not require you to step out of the vehicle to operate the controls to empty it.
- ***3. Visual inspection of waste*** – it is assumed that an operative may manually remove incompatible material from the waste pile.
- ***4. Loading material into sorting drum and mechanical sorting*** – it is assumed that regardless of the specifics of the MBT plant the material will be loaded into some kind of sorting mechanism by way of a shovel loader.

Phase 2: Biological treatment

- ***5. Loading material into a vehicle*** – after sorting it is assumed that some of the material may be reloaded into a vehicle, typically an articulated lorry, via shovel loader to be taken either to a landfill site or the composting tunnel. This component would only be selected if there were a need to transfer the material from the sorting location to the compost tunnel or landfill site.
- ***6. Unloading transfer vehicle at compost tunnel*** – if the compostable material has to be transported from the sorting location this component refers to unloading the material at the site of the composting tunnel. It assumes that someone will exit the cab to operate vehicle controls to unload the material. Once the vehicle is unloaded it is assumed that the worker climbs back into the cab.

- ***7. Loading material into hopper*** – this component is included for when the loading of the composting tunnels is by conveyor belt. It is assumed the material is loaded via a shovel loader into the hoppers.
- ***8. Opening and closing doors of in-vessel*** – a shovel loader or similar is used to remove the doors to the composting tunnel.
- ***9. Transferring material between vessels and to maturation pad*** – this component is applicable for when the material is transferred from one tunnel to another as part of the overall process or taken to the maturation pad (windrow). It is assumed the material is typically transferred using a shovel loader.
- ***10. Inserting temperature probes*** – this assumes that temperature probes are manually inserted into the top of an enclosed composting tunnel.

Phase 3: Maturation and bio-drying

- ***11. Turning windrows*** – it is assumed the material on the windrows will be turned using some mechanical means such as a straddle turner. At the waste workshop reference was made to a range of vehicles available and that there are different hazards associated with the different vehicles. The hazard ratings have taken an average across this range.

Phase 4: Mechanical treatment – screening and milling

- ***12. Loading material into screener/miller*** – it is assumed that the material will be loaded into a hopper by a shovel loader to be fed into the screening/milling machine. This component may not be relevant to all MBT plants.
- ***13. Loading lorries*** – it is assumed that the final product will be removed from site by lorry and that the lorry will be loaded using a shovel loader.
- ***14. Onward vehicle movements*** – this is a generic activity, capturing the movement of vehicles and associated activities, to take sorted or waste material from the MBT plant.
- ***15. General housekeeping*** – this includes cleaning activities such as sweeping up excess leachate.
- ***16. Maintenance*** – it is assumed that some form of maintenance, planned or unplanned, will be required to keep the automated sections of the plant functional. This includes activities such as lubricating parts, unblocking the machinery and so on.

B5.3.5 In-vessel composting

For in-vessel composting the generic components/activities chosen were as follows. Table B64 in Annex B1 describes each of these components.

- ***1. Inward vehicle movements*** – the vehicle is reversed into a tipping bay/hall where a banksman may be used to signal a stopping point. It is assumed that mostly RCVs will enter the site. However, Stillage vehicles and articulated lorries are also considered.
- ***2. Unloading vehicle*** – this assumes that someone will exit the cab to operate the vehicle controls to unload the material in the reception hall. Once the vehicle is unloaded it is assumed that the worker climbs back into the cab. It is recognised that

some vehicles would not require you to step out of the vehicle to operate the controls to empty it.

- ***3. Manual pre-sorting*** – the material is visually inspected for any unwanted material. If unwanted material is identified it is assumed to be removed by hand.
- ***4. Loading material into shredder (mobile or stationery)*** – it is assumed that regardless of the specifics of the composting site the material will be loaded into some kind of shredding and/or screening sorting mechanism by way of a shovel loader type vehicle. It was highlighted at the workshop that the shredders could be mobile. It is assumed that for those located outside the weather will have the largest potential effect on the hazards associated with shredding.
- ***5. Loading material into bulk container*** – this component would only be selected if there were a need to transfer the material from the shredding location to the compost tunnel. After shredding/screening the material is loaded into a bulk container to be transferred to the composting tunnel.
- ***6. Opening and closing doors of in-vessel*** – a shovel loader or similar is used to remove the doors to the composting tunnel.
- ***7. Loading first vessel*** – material is tipped directly into the tunnel from the bulk container. It is assumed that the tipping mechanism in this case can be operated from within the cab.
- ***8. Transferring material between vessels and to maturation pad*** – this component should be selected if the material is transferred by shovel loader from one tunnel to another or taken to the maturation pad (windrow).
- ***9. Inserting temperature probes*** – the method of inserting the temperature probes is dependent on the type of in-vessel used, i.e. concrete enclosure or open-top.
- ***10. Turning windrows*** – it is assumed the material on the windrows will be turned using some mechanical means such as a straddle turner. At the waste workshop reference was made to a range of vehicles available and that there are different hazards associated with the different vehicles. The hazard ratings have taken an average across the main vehicle types.
- ***11. Finished product taken to stockpiles*** – this component is relevant when material is taken to a stockpile. It is assumed this is done using a shovel loader.
- ***12. Screening material and bagging finished product*** – in some instances the finished product is bagged on-site. This is assumed to involve manually holding the bags and transferring them to stock.
- ***13. Loading lorries*** – it is assumed that material is shovel loaded onto a vehicle to be removed from site.
- ***14. Onward vehicle movements*** – this is a generic activity, capturing the movement of vehicles and associated activities, to take sorted or waste material from the compost site.
- ***15. General housekeeping*** – this includes activities such as sweeping and litter picking.
- ***16. Maintenance*** – it is assumed that some form of maintenance, planned or unplanned, will be required to keep the automated sections of the plant functional. This includes the lubrication of parts, unblocking and so on.

B5.3.6 Open windrow composting

For open windrow composting the generic components/activities chosen were as follows. It should be noted that these components are currently only valid for larger, more automated sites. Table B65 in Annex B1 describes each of these components.

- ***1. Inward vehicle movements*** – the vehicle is reversed into a tipping bay/hall where a banksman may be used to signal a stopping point. It is assumed that mostly RCVs will enter the site. However, articulated lorries are also considered.
- ***2. Unloading vehicle*** – this assumes that someone will exit the cab to operate the vehicle controls to unload the material in the reception hall. Once the vehicle is unloaded it is assumed that the worker climbs back into the cab. It is recognised that some vehicles would not require you to step out of the vehicle to operate the controls to empty it.
- ***3. Manual pre-sorting*** – the material is visually inspected for any unwanted material. If unwanted material is identified it is assumed it is removed by hand.
- ***4. Loading material into shredder*** – it is assumed that regardless of the specifics of the composting site the material will be loaded into some kind of shredding and/or screening sorting mechanism by way of a shovel loader type vehicle. It was highlighted at the workshop that the shredders could be mobile. It is assumed that for those located outside the weather will have the largest potential effect on the hazards associated with shredding.
- ***5. Loading material into truck to be taken to windrows*** – this component would only be selected if there were a need to transfer the material from the shredding location to the windrow. After shredding/screening the material is loaded into a bulk container to be transferred to the windrow.
- ***6. Loading material onto windrow*** – material is tipped directly onto the windrow from the bulk container. It is assumed that the tipping mechanism in this case can be operated from within the cab.
- ***7. Monitoring compost process (temperature/visual observations)*** – it is assumed that to monitor the compost process a worker will walk around the site to make visual inspections and to insert temperature probes into the composting material.
- ***8. Turning windrows*** – it is assumed the material on the windrows will be turned using some mechanical means such as a straddle turner. At the waste workshop reference was made to a range of vehicles available and that there are different hazards associated with the different vehicles. An average across the vehicle types has been considered in the hazard ratings.
- ***9. Finished product taken to stockpiles*** – this component is relevant when material is taken to a stockpile. It is assumed this is done using a shovel loader.
- ***10. Screening material and bagging finished product*** – in some instances the finished product is bagged on-site. This is assumed to involve manually holding the bags and transferring them to stock.
- ***11. Loading lorries*** – it is assumed that usable and non-usable material is shovel loaded onto a vehicle to be removed from site.
- ***12. Onward vehicle movements*** – this is a generic activity, capturing the movement of vehicles and associated activities, to take sorted or waste material from the compost site.

- ***13. General housekeeping*** – this includes activities such as sweeping and litter picking.
- ***14. Maintenance*** – it is assumed that some form of maintenance, planned or unplanned, will be required to keep the automated sections of the plant functional. This includes the lubrication of parts, unblocking and so on.

B5.3.7 Incineration

For incineration the generic components/activities chosen were as follows. Table B66 in Annex B1 describes each of these components.

- ***1. Inward vehicle movements*** – this is a generic activity capturing all vehicle movements including reversing of the vehicles. It is recognised that the reversing activity is going to depend strongly on the type of vehicle and the use of banksmen/rear CCTV for guidance. An average approach has therefore been taken; this takes account of the fact that sometimes banksmen/CCTV will be utilised, whilst at other times such control measures will not be in situ.
- ***2. Unloading vehicle*** – this is a generic category, assumed to represent emptying an RCV/articulated lorry. However, it is recognised that the emptying activity is going to depend strongly on the waste stream and the type of vehicle/tipping mechanisms and controls. Where this makes a significant difference to a hazard this will be captured in the hazard rating.
- ***3. Removal of large items of waste from feed chute*** – this is assumed to be representative of the removal of all large items of waste which have blocked the feed chute, using small manually operated grab cranes. It is assumed that there is no manual intervention.
- ***4. Delivery of hazardous substances in bulk*** – this is assumed to be representative of the delivery of lime, urea and activated carbon to site via tankers. It is assumed that compounds are transferred into the incineration process via pipes controlled automatically; no manual intervention is normally required.
- ***5. Removal of by-products –*** this is a generic category, assumed to represent the removal of ash and APC residue from the incinerator site. However, it is recognised that the removal activity is going to depend strongly on the by-product and the type of vehicle/ mobile plant utilised. Based on observations from the sites visited, APC removal appeared to be entirely an automated task – no manual involvement, whereas ash removal was by mobile plant loading articulated lorries. For the intended purpose of this tool, there is not the scope to capture all variants; hence, a generic approach was taken to capture all by-product removal activities.
- ***6. Onward vehicle movements*** – this is a generic activity, capturing the movement of vehicles and associated activities, to take waste material from the incinerator.
- ***7. General housekeeping*** – this is a generic activity, assumed to represent all housekeeping duties such as sweeping the tipping hall, around silos, pipe work, chimney base floor area, collecting halls etc. It is assumed that operatives will be issued with, and wearing, the appropriate PPE. It is acknowledged that there will be variation in frequency depending upon size of the incineration plant.
- ***8. Maintenance –*** this is a generic activity assumed to represent all maintenance activities by plant staff and contractors, both routine and due to breakdown/blockage. It is assumed that operatives will be issued with and wearing the appropriate PPE. It is

acknowledged that there will be a variation in frequency depending upon size of the incineration plant.

B5.3.8 Landfill

For landfill sites the generic components/activities chosen were as follows. Table B67 in Annex B1 describes each of these components.

- ***1. Driving on access road*** – this is a generic activity capturing all driving of the collection vehicle on landfill access roads prior to, and post tipping. It is assumed to be independent of vehicle type.
- ***2. Reversing*** – this is a generic activity capturing all reversing of the collection vehicle. However, it is recognised that the reversing activity is going to depend strongly on the type of vehicle and the use of banksmen/rear CCTV for guidance. An average approach has therefore been taken; this takes account of the fact that sometimes banksmen/CCTV will be utilised, whilst at other times such control measures will not be in situ.
- ***3. Tipping collection vehicle*** – this is a generic category, assumed to represent tipping an RCV into the landfill. However, it is recognised that the tipping activity is going to depend strongly on the type of vehicle/tipping mechanisms and controls.
- ***4. Driving compaction vehicles*** – this is a generic activity capturing all driving of large landfill site vehicles, around site, for shovelling of waste and soil or compacting. It is recognised that there will be variation depending upon vehicle type.
- ***5. General housekeeping*** – this is a generic activity, assumed to represent all housekeeping duties such as litter picking. It is assumed that operatives will be issued with, and wearing the appropriate PPE. It is acknowledged that there will be variation in frequency depending upon the size of the landfill site.
- ***6. Maintenance*** – this is a generic activity assumed to represent all maintenance activities by plant staff and contractors, both routine and due to breakdown/blockage. It is assumed that operatives will be issued with and wearing the appropriate PPE. It is acknowledged that there will be variation in frequency depending upon the size of the landfill site. Suggestions were made at the industry workshops that the activities of checking leachate/gas levels and pump maintenance should be split. Pump maintenance was considered to be greater risk because it requires more manual involvement than checking levels. However, whilst accepting the variations, for the intended purpose of this tool, there is not the scope to capture all variants; a generic approach was therefore taken to capture all maintenance activities.

B5.4 GENERIC ASSUMPTIONS

- Inward vehicle movements, unloading vehicles and onward vehicle movements all assume that at least one person leaves and enters the cab as part of the activity.
- All movement of loose material over short distances is assumed to be by shovel loader.
- Movement of baled material is assumed to be by fork-lift truck.

B6 SUMMARY

The components described in this appendix have been selected to describe the key generic activities in relation to a generic operation or site. It should be noted that the order of the components is not necessarily representative of the order in which they occur in the overall process. The focus is on the significant task components. Only the main activities that relate to the collection or processing of household waste and recyclables have been included. Subsidiary activities have been excluded as these are considered outside scope.

For some of the systems described there will be much more variation than others; for example, there is probably no such thing as a typical MBT or MRF plant, or compost site. Therefore, the aim has been to try and include components such that individual components from across the systems can be selected to define a system that captured the key activities of the system being assessed. However, where key activities are still not adequately covered, it is possible to create further activities and incorporate these into the Risk Comparator Tool.

In particular, it is stressed that the components as described are based on-sites/activities that were observed and that they may not be fully representative of all sites/activities post-collection. It is noted that many of the components, particularly relating to composting, are based on large automated processes. These may not be representative of small sites involving much more manual operations. Care must be taken when interpreting the output from the tool.

B7 ANNEX B1 – RISK COMPARATOR TOOL COMPONENTS

This annex provides further description of the components within the Risk Comparator Tool. These descriptions are based on observation of the activities and as such it is stressed may not necessarily represent good practice.

Table B60 Collection components

Component	*Description*
1. Assembly of collection crew at start of shift and pre-round activities	Operatives arrive at the lorry park/depot and meet with other crew members. Crew confirm round and collection vehicle with on-site supervisor. Driver and loaders walk across yard to allocated collection vehicle and access vehicle. Collection vehicle exits site through gates. Any pre-round vehicle checks are carried out.
2. Driving from location to location	Driver drives collection vehicle to the first collection point on the round. They may stop to pick up other operatives along the route, who have not already arrived on the site by the departure time. The collection vehicle travels a pre-determined route to the first collection point and then to the second collection point and so on. The route may vary depending on weather conditions, road conditions, road works and traffic-flow.
3. Getting in and out of cab	Loaders exit vehicle cab from the passenger side door. Driver, normally, exits the cab from driver side door when required to perform collection activities. The method of access/egress depends upon the vehicle type.
4. High-rise bags collect	Operatives collect a number of large empty ‘slave’ sacks from the collection vehicle. They carry a number of large empty sacks with them (usually sacks all stuffed inside a single sack). They tend to start collection from the upper level of a block of flats and work down to the ground floor. This may involve climbing a number of sets of steps, or using the lift if available / functioning. Recyclables are emptied into slave sacks and carried from flat to flat until the slave sack is full. Bags may be placed together and are taken to the collection vehicle when all collections from a given floor have been made.
5. Disposable bags collect	Collection of waste/recyclables by operatives in bags that are disposed of (black sacks). Operatives walk to bag’s location. Bag is grasped and lifted using one or two hands. Operative walks to rear of RCV carrying bag(s).

Component	***Description***
6. Reusable bags collect and bag return	Collection of recyclables/waste in bags that are returned to the householder. Operatives walk to where the bag is located. Bag is grasped and lifted using one or two hands, depending on its design (e.g. side handles). Bag is carried to rear of RCV. After emptying (see later) the bag is returned to the household.
7. Big wheeled bins collect and bin return	If collecting a Palladin bin, pull / push bin from location to back of RCV (using either one or both hands on bin handles). If collecting a Euro bin, pull / push bins using handles from location to back of vehicle. Task may require pushing / pulling over kerbs, up / down slopes, across uneven ground, such as drains, grates and potholes. Pull / push emptied bin back to bin store using handles.
8. Food waste collect and receptacle return	Operative walks to food waste container presentation point, and lifts and carries container to collection vehicle (usually using one hand on the handle). Containers are typically light (in terms of weight), and operatives may carry two at once with one in each hand. Container returned to property kerbside after emptying (see later).
9. Kerbside box collect and box return	Operative walks to box presentation point. They lift and carry box to collection vehicle (usually using both hands on the handles). If boxes are light (in terms of weight) operatives may carry two boxes at once with one in each hand, place one on top of the other or empty the contents of one into another and carry a single box. Box returned to property kerbside after emptying (see later).
10. Slave wheeled bin collect	Operative walks to bin’s location. Slave wheeled bin may either be pushed/pulled from location to location whilst being filled, or may be left in one place with bags being taken to it and emptied into it. Once full it is pushed/pulled to back of RCV. This activity captures both movement of the slave bin and emptying household receptacles into the slave bin.
11. Slave bag or box collect	As above but utilising a bag or box as the slave container.
12. Wheeled bin collect and bin return	Operative walks to bin’s location. If collecting a single wheeled bin, pull / push bin from its location to back of RCV (usually using both hands on the bin handle). If collecting two wheeled bins, pull / push bins simultaneously using one hand per bin gripping bin handle. Bin returned to property kerbside after emptying (see later).
13. Disposable bags empty	Bag(s) is/are lifted/thrown directly into the collection vehicle and not returned to the householder.
14. Reusable bags empty	Contents of bags may be emptied into collection vehicle directly, or via a slave sack (larger sack which will hold the contents of several bags). Empty bags are returned to household.

Component	***Description***
15. Big wheeled bins empty	Place Palladin bin against rear of vehicle and activate the two side holding bars. Place front lip of Euro bin upper rim onto bin lift raising mechanism. Activate raising mechanism to raise and upturn bin into hopper, by pushing button on control panel on rear side of vehicle. Activate lowering mechanism to return emptied bin to ground by pressing another button. Remove bin from vehicle bin lift.
16. Food waste empty	Operatives access stillages inside vehicle via steps. Hold rear of food bin over stillage edge, bin lip facing away from operative, and invert bin in order to empty food waste. Bin may be tapped on stillage edge several times to remove any residue waste.
17. High-rise slave sacks empty	Operatives are supposed to empty slave sacks into slave bins (e.g. wheeled bins), by inverting sack over bin and emptying contents. This is then emptied into vehicle as per wheeled bin. However, sometimes sacks are emptied directly into hopper of RCV by lifting/swinging sacks up and inverting them over hopper until contents empty out.
18. Wheeled bins empty	Front lip of wheeled bin(s) upper rim is/are placed onto bin lift raising mechanism. Bin(s) is/are either automatically lifted to empty into hopper, or operatives manually operate lifting mechanism using controls at rear side of RCV. This may also involve twisting a lever to activate mechanised “shake” of bins to remove any contents wedged into bin. Once emptied bin is lowered either automatically or manually and operatives remove bin from vehicle bin lift.
19. Kerbsider vehicle box sort and empty	Attach lip of box over hooks on edge of hoppers. Operatives sort recyclables into separate hoppers on collection vehicle. May have to lift box and re-position nearer different hopper on vehicle, or may lift and carry the contents of the box to appropriate hopper. When the remaining items in box are the same material the box may be lifted off the lugs and the contents tipped into the relevant hopper. If no sorting is required, the contents of the box are tipped directly into the hopper.
20. Stillage vehicle box sort and empty (same operative collects and sorts)	Stillage bars are removed by loaders / driver to allow access to section of stillage. Lowest side flap on stillage is opened using key. Attach lip of box over hooks on edge of stillage. Operative sorts one type of recyclable into designated stillage on collection vehicle. Operatives sort second and third types of recyclables into appropriate stillage on vehicle. May have to lift box and re-position nearer to a different stillage on vehicle. When the lowest portions of the stillages are full, the lowest stillage flap is closed/locked and the higher stillage flap is opened/unlocked. Once highest stillage portion is full the flap is closed and recyclables are placed in the stillages by accessing the vehicle body. In this case operatives climb onto the back of the vehicle with the boxes prior to sorting and emptying.

Component	***Description***
21. Stillage vehicle box sort and empty (separate operative collects and sorts)	As above but one operative will carry box to vehicle and deposit it for another operative to sort and empty. In this case it is likely that the sorting operative will remain on the vehicle and the collection operative will remain on the ground.
22. Slave wheeled bin empty	As ‘wheeled bins empty’. This is included as a separate activity as the level of risk may be different – particularly noise if collecting tins and glass.
23. Walking to and from collection point	Loader walks to collection points. This is normally at the kerbside. For rural properties, or where assisted doorstep collection is provided, bins/bags may be located further inside property boundary at front or back door, or in bin store. This may involve walking over uneven ground/kerbs etc.
24. Operating vehicle machinery – RCV compaction	After emptying every 4/5 bins, or when the hopper appears full, the compaction is manually operated by pressing button on control pad on side of vehicle, at rear or inside cab. In some vehicles, compaction occurs automatically.
25. Operating vehicle machinery – Kerbsider hopper empty	Operative stands at side of vehicle (rear of cab) and activates raising mechanism. The stillages at side of vehicle rise up (above vehicle) and contents are tipped into relevant compartments on vehicle. The stillages are then lowered back down. (Note, variation depending upon vehicle type).
26. Emptying collection vehicle	Once vehicle is full, or at the point where operatives decide it would be most time saving to deposit contents at e.g. transfer station, incinerator, compost site or landfill etc, vehicle is taken to relevant site and contents are emptied into a tipping bay. Emptying method is dependent upon vehicle type, e.g. RCV rear raised up to tip, or fork-lift trucks used to offload stillages from vehicle, invert and tip into bays.

Table B61 Transfer/bulking station

Component	*Description*
1. Inward vehicle movements	Collection vehicle driven to tipping hall/yard area and then reversed into tipping bay. Vehicle reverses to edge of tipping bay using banksmen/rear CCTV for guidance. Assume crew member leaves vehicle to act as a banksman. Vehicles considered include RCVs, Kerbsiders and Stillage vehicles as these are in most use at the collection stage.
2. Unloading vehicle	Vehicle tipping mechanics operated manually/automatically and recyclables/waste tipped into bay. Variation depending upon vehicle type, i.e. vehicle may be a Stillage vehicle with a fork-lift truck used to unload stillages. RCVs, Stillage vehicles and Kerbsiders all considered.
3. Handling heavy/hazardous waste	Operatives put on battery handling equipment, full length gloves, apron and goggles and take batteries to specialised battery container close to weighbridge. Oil is removed from the collection vehicle and temporarily placed at an oil station. Yard staff will decant oil into a large oil container. This container is emptied via a pump periodically by specialist contractors. Heavy items are removed by mobile plant or manually by several operatives, depending upon size and nature of the item.
4. Loading lorries	Mobile plant (shovel loader) deposits material into top of container on vehicle. Once loaded, vehicle is sheeted across open top.
5. Onward vehicle movements	Articulated lorry enters site and drives via weighbridge to loading area and leaves via same route once loaded. It is assumed that the driver leaves and re-enters the vehicle cab as part of this activity.
6. General housekeeping	General housekeeping duties such as sweeping loading yard/hall.
7. Maintenance	Maintenance and inspection of plant equipment as required.

Table B62 MRF

Component	*Description*
1. Inward vehicle movements	Vehicle driven to tipping hall area and then reversed into tipping bay. Vehicle reverses to edge of tipping bay using banksmen/rear CCTV for guidance. RCVs and large lorries are considered.
2. Unloading vehicle	Vehicle tipping mechanics operated manually/automatically and recyclables tipped into bay. Variation depending upon vehicle type. RCVs and large lorries are considered.
3. Pre-sorting materials	Initial removal of major contaminants from recyclate. Items are identified and may be removed either manually by operatives or mechanically using mobile plant (e.g. shovel loader) depending upon size.
4. Loading material onto conveyors and mechanical sorting	Mobile plant (e.g. shovel loader) used to pick up of material from bays and deposit it onto conveyor belt situated at the side of the tipping hall. Conveyor belts transfer material to mechanical sorting and then onto picking cabins. Material is passed through a series of mechanical screens and trommels and unwanted items are removed.
5. Manual sorting	Material arrives in picking cabins on conveyor belts from tipping hall and mechanical sorting. Operatives stand either side of conveyor belt and remove designated items (e.g. paper, plastics) from belt, discarding them down chutes into piles on yard floor below. Piles are typically re-entered into the MRF process several times for sorting until waste stream cannot be filtered any further.
6. Baling materials	Materials delivered into baling machines via conveyor belts, which is loaded by shovel loader. Only one recyclable material is fed on conveyor, and into baler at a time. Baling machine operator inserts key into control panel on baling machine to start baling process. Materials are compressed by ram machine and secured with thin wire rope. Baled material exits machine on conveyor.
7. Storage of recovered fractions	The storage of recovered fractions is in bays until sufficient amounts have accumulated to warrant collection. A fork-lift truck is used to move baled material to storage and a shovel loader is used to move loose material.
8. Loading lorries	Mobile plant (shovel loader) deposits material e.g. paper into top of container on vehicle. Fork-lift trucks are used to load bales. Once loaded, vehicle is sheeted (if necessary) across open top.
9. Onward vehicle movements	Articulated lorry enters site and drives via weighbridge to loading area and leaves via same route once loaded. It is assumed that the driver leaves and re-enters the vehicle cab as part of this activity.

Component	***Description***
10. General housekeeping	General housekeeping duties such as sweeping loading yard/hall.
11. Maintenance	MRF plant is cleaned and inspected to ascertain what work is required. Work is completed as necessary. Variation in frequency depending upon size of plant.

Table B63 MBT

Component	*Comments*
Phase 1: Mechanical sorting	
1. Inward vehicle movements	After the delivery vehicle (typically RCV) has been checked in at the weighbridge, it is driven to the reception building where the waste material is tipped. The vehicle is reversed into a tipping bay where a banksman may be used to signal the stopping point. RCVs and articulated lorries are considered.
2. Unloading vehicle	A collection worker operates the vehicle tipping mechanism to empty the contents of the vehicle. The driver may have to drive forwards a short distance to fully empty the contents of the vehicle.
3. Visual inspection of waste	An operative will visually screen the waste for any unacceptable waste such as abattoir waste.
4. Loading material into sorting drum and mechanical sorting	A shovel loader is used to transfer the waste into the sorting drum. The waste is automatically screened and particles greater than 50 mm are removed. The oversized particles are passed over a large magnet to remove any ferrous metals.
Phase 2: Biological treatment	
5. Loading material into a vehicle	Non-compostable material is transferred to landfill. Compostable material is taken to the composting tunnel. The material is loaded into a lorry by shovel loader.
6. Unloading transfer vehicle at compost tunnel	The vehicle is reversed into a tipping bay at the reception hall where a banksman may be used to signal the stopping point. The driver operates the vehicle tipping mechanism to empty the contents of the vehicle. The driver may have to drive forwards a short distance to fully empty the contents of the vehicle.
7. Loading material into hopper	An operative gets into the cab of a shovel loader to load the waste material into the hopper of the conveyor transfer system. The conveyor transports the material into the in-vessel.
8. Opening and closing doors of in-vessel	The top halves of the metal front doors are opened manually. The bottom sections of the in-vessel doors are opened using a shovel loader. This is repeated 4 times in the process as the material is reloaded into a second tunnel.
9. Transferring material between vessels and to maturation pad	A shovel loader is used to transfer waste from the first in-vessel to the second. Once the second stage barrier is completed, the material is transferred to the maturation pad.

Component	***Comments***
10. Inserting temperature probes	The temperature probes are inserted from the roof top of the in-vessel.
Phase 3: Maturation and bio-drying	
11. Turning windrows	Material located on the maturation pad is usually turned once a week (this will differ depending on the moisture content of the compost) using a dedicated vehicle.
Phase 4: Mechanical treatment – screening and milling	
12. Loading of material into screener/miller	The matured compost is fed through a final screener and milling machine. A shovel loader is used to transfer the material into the hopper of the screener.
13. Loading lorries	Articulated lorries are used to transfer the material off site. Shovel loaders are used to load the lorries.
14. Onward vehicle movements	Articulated lorry enters site and drives via weighbridge to loading area and leaves via same route once loaded. It is assumed that the driver leaves and re-enters the vehicle cab as part of this activity.
15. General housekeeping	General cleaning to remove debris from the floor etc.
16. Maintenance	Machinery maintenance is likely to occur at irregular intervals, with some scheduled maintenance activities. An operative is required to manually unblock the air holes in the in-vessel piping, which blows air through the composting material.

Table B64 In-vessel composting

Component	***Comments***
1. Inward vehicle movements	After the vehicle has been checked in at the weighbridge, it is driven to the reception building where the mixed food and garden waste is tipped. The vehicle is reversed into a tipping bay where a banksman may be used to signal the stopping point. RCVs, articulated lorries and Stillage vehicles are considered.
2. Unloading vehicle	A collection worker operates the vehicle tipping mechanism to empty the contents of the vehicle, or a fork-lift truck is used to empty stillages. The driver may have to drive forwards a short distance to fully empty the contents of the vehicle.
3. Manual pre-sorting	An operative will visually screen the waste and remove any unwanted materials such as gas canisters.
4. Loading material into shredder (mobile or stationery)	A shovel loader is used to transfer the material into the shredder/screener. Another operative may sweep up any material that does not drop into the shredding machine. The screening process at the start of the composting process will occur in the reception building.
5. Loading material into bulk container	A shovel loader is used to transfer the screened material into a container truck (possibly tractor and trailer). If it is transported in the open it has to be sealed. Where the sheeting of the truck is manual an operative will manually pull it over the material.
6. Opening and closing doors of in-vessel	The metal front door of in-vessel is removed/replaced using the shovel loader.
7. Loading first vessel	The container truck is reversed into the in-vessel. The container is raised using a hydraulic arm operated from within the cab.
8. Transferring material between vessels and to maturation pad	A shovel loader is used to transfer waste from the first in-vessel to the second and to the maturation pad. Once the second stage barrier is completed, the material is transferred to the maturation pad using either a shovel loader or container truck.
9. Inserting temperature probes	If the in-vessel has a removable roof, an operative climbs onto the bio-waste to hang temperature probes from hooks. If the in-vessel has a fixed roof, the temperature probes are inserted from the roof top. When temperature probes are in place, the doors and roof are closed. The roof closure is operated from an electrical panel.

Component	***Comments***
10. Turning windrows	Material located on the maturation pad is usually turned once a week (will differ depending on the moisture content of the compost) using a dedicated vehicle.
11. Finished product taken to stockpiles	Shovel loader used to take material from windrows to stockpile.
12. Screening material and bagging finished product	Material loaded into screener using shovel loader. This is generally carried out outdoors.
13. Loading lorries	Articulated lorries are used to transfer the material off site. Shovel loaders are used to load the lorries.
14. Onward vehicle movements	Articulated lorry enters site and drives via weighbridge to loading area and leaves via same route once loaded. It is assumed that the driver leaves and re-enters the vehicle cab as part of this activity.
15. General housekeeping	General cleaning requirements to remove debris from the floor etc.
16. Maintenance	Machinery maintenance is likely to occur at irregular intervals, with some scheduled maintenance activities.

Table B65 Open windrow composting

Component	***Comments***
1. Inward vehicle movements	After the delivery vehicle has been checked in at the weighbridge, it is driven to an appropriate outdoor tipping area. The vehicle is reversed onto the concrete pad where a banksman may be used to signal the stopping point. RCVs and large lorries are considered.
2. Unloading vehicle	A collection worker operates the vehicle tipping mechanism to empty the contents of the vehicle. If the vehicle is sheeted and there is no automatic mechanism, this will have to be manually removed. The driver may need to drive forwards a short distance to fully empty the contents of the vehicle.
3. Manual pre-sorting	An operative will visually screen the waste and remove any unwanted materials such as gas canisters.
4. Loading material into shredder	A shovel loader is used to transfer the material into a mobile shredder. The shredded material is then transferred into a screening machine. Another operative may sweep up any material that does not drop into the shredding machine.
5. Loading material into truck to be taken to windrows	A shovel loader is used to transfer the screened material into a container truck (possibly tractor and trailer). Sometimes the material is taken directly to windrows using shovel loader.
6. Loading material onto windrow	Material is taken to windrow and is either tipped directly onto windrow or a shovel loader is used to load windrow.
7. Monitoring compost process (temperature/visual observations)	Samples, visual observations and measurements of the compost are taken. This is assumed to be carried out manually.
8. Turning windrows	Material in windrow is turned using a dedicated vehicle.
9. Finished product taken to stockpiles	Shovel loader used to take material from windrows to stockpile.
10. Screening material and bagging finished product	Material loaded into screener using shovel loader. This is carried out outdoors.
11. Loading lorries	Non-useable material is loaded by shovel loaders into container trucks and may be taken for use in adding structure to piles in-vessel or to landfill. Usable material loaded onto separate lorry. Note this may be first bagged.

Component	***Comments***
12. Onward vehicle movements	Articulated lorry enters site and drives via weighbridge to loading area and leaves via same route once loaded. It is assumed that the driver leaves and re-enters the vehicle cab as part of this activity.
13. General housekeeping	General cleaning requirements to remove debris from the floor etc.
14. Maintenance	Machinery maintenance is likely to occur at irregular intervals, with some scheduled maintenance activities.

Table B66 Incineration

Component	***Description***
1. Inward vehicle movements	Vehicle driven to tipping hall area and then reversed into tipping bay. Vehicle reverses as far as edge of tipping bay. Driver halts vehicle when rear tyres come into contact with the edge of the bay, using banksmen/rear CCTV for guidance.
2.Unloading vehicle	Vehicle tipping mechanics operated manually/automatically and waste tipped into pit. (Variation depending upon vehicle type, i.e. whether driver needs to exit cab to unload). RCVs and large lorries have been considered.
3. Removal of large items of waste from feed chute	Occasionally bulky items such as fridge freezers can get stuck in the incinerator feed chute, blocking it. In such instances smaller manually operated grab cranes are used to remove the item and unblock the chute.
4. Delivery of hazardous substances in bulk	Lime, urea and activated carbon are delivered to site via tankers that blow compounds into storage silos via pipes. Compounds transferred into incineration process via pipes controlled automatically; no manual intervention is normally required.
5. Removal of by-products	Mobile plant (shovel loader) deposits ash / into top of container on vehicle. Once full, vehicle is sheeted across open top. APC residue is removed via an automated process, stored in silos and blown via pipes into tankers for removal.
6. Onward vehicle movements	Articulated lorry enters site and drives via weighbridge to loading area and leaves via same route once loaded. It is assumed that the driver leaves and re-enters the vehicle cab as part of this activity.
7. General housekeeping	General housekeeping duties such as sweeping tipping hall, around silos, pipe work, chimney base floor area, collecting halls etc.
8. Maintenance	Plant is cleaned and inspected to ascertain what work is required, and work is completed as necessary.

Table B67 Landfill

Component	***Description***
1. Driving on access road	Driving collection vehicle to tipping face along the access road.
2. Reversing	Collection vehicle reverses to the edge of the tipping area (guided by CCTV).
3. Tipping collection vehicle	Vehicle tipping mechanics operated manually/automatically, waste tipped onto landfill. (Variation depending upon vehicle type i.e. whether driver needs to exit cab to unload).
4. Driving compaction vehicles	Driving of large landfill site vehicles, around site, for shovelling of waste and soil or compacting. Compactor driver drives over the waste several times to compact down the waste.
5. General housekeeping	Conducted by operatives on foot. Operative uses litter picking stick (grabber) and black plastic sack.
6. Maintenance	Operatives dip the wells using a reading tape, pushed down into the well. This operation is preformed to check the leachate level is compliant. The environment team also take gas readings to ensure compliance. A risk assessment is performed on the day dips are taken. A permit to work is required. This activity captures the regular maintenance and other periodic activities that are carried out on a landfill site.

APPENDIX C RISK ASSESSMENT METHODOLOGY

C1 INTRODUCTION

The present appendix describes the work carried out for the third work package, that is to develop a methodology for the assessment of risks for the various waste and recyclables management systems.

Thus, the objectives of Work Package 3 are as follows:

- Develop a methodology for the assessment of risk for the various waste and recyclable management systems;
- Ensure the methodology has maximum utility for Local Authorities in terms of a decision making tool; and
- Take account of those local factors that will have an effect on the level of risk.

C1.1 SCOPE

The scope of the present work package is to develop a methodology that can be used to assess the risk for the full range of systems identified in Appendix A for detailed assessment, namely:

- Collection from wheeled bins;
- Collections from boxes with kerbside sort;
- Collection from bags;
- Collection from small bins (food waste);
- Collection from communal bin stores;
- Door-to-door collection from flats;
- Transfer station;
- Materials Recycling Facility (MRF);
- Mechanical Biological Treatment (MBT);
- Composting;
- Incineration; and
- Landfill.

It is emphasised that the purpose of this project is not to provide a definitive assessment of the level of risk of different waste and recycling systems. This would not possible and indeed it would be inappropriate to present a definitive comparative risk assessment as part of this project as this would not be representative of any real situation and could be subject to challenge. Instead the purpose of the project is to develop a methodology for carrying out comparative risk assessments that can be utilised by LAs, or others, using their own local factors. It is only when these local factors have been incorporated that the output of the assessment methodology would have real meaning.

C1.2 STRUCTURE OF APPENDIX

The remainder of the appendix is structured as follows:

- Section C2 outlines the rationale that led to the risk assessment approach that has been adopted;
- Section C3 describes the risk assessment methodology;
- Section C4 provides a summary of the risk assessment approach;
- Section C5 describes how the risk assessment methodology is to be populated by the HSL project team; and
- Section C6 provides overall conclusions and recommendations.

C2 RISK ASSESSMENT FRAMEWORK

This section outlines the rationale that led to the approach that was adopted, including the purpose of the risk assessment (Section C2.1), the scope of the risk assessment (Section C2.2), the approach adopted (Section C2.3) and an introduction to how local factors are incorporated (Section C2.4).

C2.1 PURPOSE OF RISK ASSESSMENT

The purpose of the risk assessment is to allow a comparison of the level of health and safety risk between different waste and recyclables management systems. It is not the purpose to calculate the absolute level of risk for a system. The risk assessment methodology is to be used as a tool to help inform Local Authorities of the most appropriate waste and recycling system in terms of the level of health and safety risk to workers. It is emphasised that this tool would be only one input into the overall decision-making process of determining the most appropriate waste and recycling system. Other factors, including environmental targets and costs would also need to be considered, alongside the health and safety factors, for determining the most appropriate waste and recycling management system. Use of the tool in such decision-making without taking account of these other factors would be inappropriate.

C2.2 SCOPE

It is an aim of the project that the risk assessment methodology can be used to provide a relative measure of risk for different systems, for different components within the system and also for different hazards. For the purpose of the methodology, a waste and recyclables system can be thought of as a system made up of a number of sub-systems. The system is the overall waste and recyclables life cycle from collection through to disposal (i.e. landfill or incineration) or through to being converted to a raw material and a sub-system is a life cycle stage such as collection, transfer or disposal etc. Each sub-system is then made of a number of components or activities that each have a number of hazards associated with them. Figure C1 illustrates diagrammatically the relationship between the system and hazards. For example, consider one system being the collection of residual waste in wheeled bins that is taken directly to an incinerator for disposal. The sub-systems in this case would be collection of residual waste in wheeled bins, and incineration. A component would be pulling the bin from kerbside to vehicle and the associated hazards would be slips, trips and falls, musculoskeletal disorders (MSDs) etc.

It is also an aim of the project that the risk assessment approach can be applied to the comparison of systems over different user defined populations, for example a single round, an area within the LA’s control or the entire LA region. Therefore the methodology must be sufficiently sensitive over a large range in size of collection areas.

Three key questions that define the scope of any risk assessment are explored in the next three sub-sections:

- Risk of what?
- Risk to what?
- Risk from what?

C2.2.1 Risk of what?

The risk assessment methodology will attempt to capture all types of harm including both safety related and ill-health effects (acute and chronic). In terms of acute effects, the level of harm will cover the full spectrum from minor injury to fatality. The risk from acute effects and chronic effects may be assessed separately due to the difficulty in drawing equivalence between the two effects. However, consideration will be given to making an approximate comparison to allow an overall risk rating to be derived. For any particular hazard the potential consequences can also vary quite widely. It is, therefore, often practice to represent this variation by either a most likely outcome or realistic worst case or both. Use of both or the most likely outcome will be considered for the methodology.

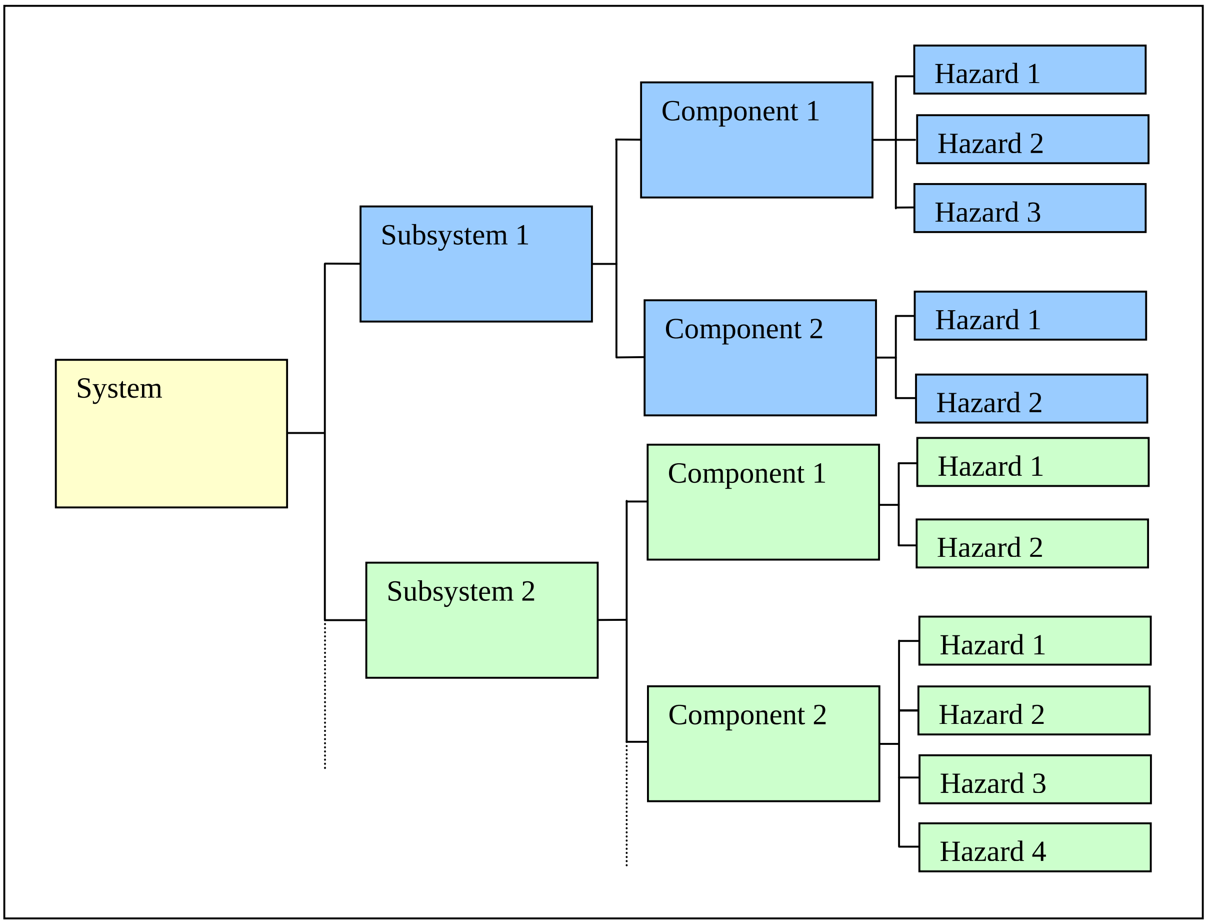

Figure C1 Structure of waste/recyclables management system

C2.2.2 Risk to what?

The methodology will only address the risk to workers, i.e. occupational risk. The risk to members of the public and to people outside the United Kingdom, for example when waste and recyclables are exported, is outside of the scope of the methodology. However, where possible, it will be indicated that there is a ‘risk gap’. In terms of workers it will be the risk to all workers involved in an activity or system that will be assessed. Where a particular part of the system is contracted out, for example, the risk to those workers will still be within scope. The risk to the environment is outside scope of this methodology, however.

C2.2.3 Risk from what?

The risk assessment will assess the level of risk from all reasonable foreseeable non-trivial hazards that relate directly to the activities being carried out as part of waste and recyclables management. It is important to note that risk will be assessed for standard management practices so that the risk from different systems can be compared.

C2.3 RISK ASSESSMENT APPROACH

A key output from this work is information and guidance that will enable Local Authorities (LAs), or others, to balance the risks to the health and safety of workers against other factors, when selecting waste and recyclables management systems. It is therefore essential that an appropriate methodology is developed that can provide meaningful comparisons of risk between different systems.

The key challenges in the development of such an appropriate methodology include:

- The wide variety of systems to be considered;
- The range of hazards and associated possible consequences arising from the different systems, necessitating comparison of the risk to different groups of people, from different sorts and levels of harm (i.e. both safety related effects such as fatality, major and minor injury, and ill health effects); and
- The need to ensure the ‘units’ of risk used in the assessment for each system have a degree of commonality, in order that sensible comparisons can be made.

The type of risk assessment to be used could range from the qualitative, i.e. a qualitative risk matrix, to a full blown quantified risk assessment. However, given that the purpose of the risk assessment is to carry out a comparative assessment then a detailed quantified risk assessment would be unnecessary, and would potentially give misleading results. In addition, as it is necessary for the risk assessment to be able to show differences in risk at the hazard level as well as at the overall system level, some way of combining the risk for each hazard into an overall risk measure is required, so a qualitative risk assessment approach is also unsuitable. Therefore, a semi-quantified risk ranking approach is considered to be most appropriate.

In terms of the overall risk assessment approach, for each system to be assessed, the sub-systems and the components that make up the sub-system will be identified. For each component all relevant hazards will be identified (see Figure C1), and for each hazard an assessment will be made of the level of risk it presents. To adequately take into account the wide range of factors that will influence the level of risk for collection systems, for these systems, the assessment of risk for each hazard will be carried out by estimating the level of risk for a representative range of scenarios and performing a weighted sum (using appropriate local information) to produce an overall single risk rating for each hazard. This will result in an estimate of risk for each hazard, for each component, for each sub-system.

From these risk estimates, the following risk scores will be collated to allow a comparison between different systems of:

- The level of risk from individual hazards;
- The level of risk from individual components or activities;
- The level of risk from specific sub-systems, i.e. life cycle stages; and
- The level of risk from the overall system.

The approach taken can be thought of as breaking up a range of waste and recycling systems into a number of small building blocks, or activities, each of which has a number of hazards associated with it. The overall level of risk for a particular system can then be estimated by selecting the relevant building blocks and combining the risk from each of their hazards.

C2.3.1 Risk measure

The measure of risk used in the risk calculation also needs to be defined at the outset. There are three risk measures in common use:

- Individual risk – this is the probability of harm per year to which an individual is exposed. Individual risk can be used to indicate the level of tolerability of the risk against HSE's criteria (Reference 44). Individual risk is dependent solely on the hazardous processes which give rise to the risk and other factors which may affect those processes (e.g. the weather); it is not dependent on the size of the population exposed.
- Collective risk – this is the average number of equivalent fatalities[20] or injuries per year (across a defined group) that would be expected to occur from exposure of that group to a defined set of hazards. Collective risk is not the risk to an individual but is the cumulative risk to the defined exposed population.
- Societal risk – this is the frequency of accidents leading to multiple fatalities or injuries. Societal risk indicates the vulnerability to multiple fatality/injury accidents and provides a means for taking into account public aversion to such incidents.

For the purpose of this work collective risk has been selected on the basis that this captures the level of risk to all those exposed. It is essentially a measure of the inherent risk of the system and is the closest equivalent to accident rates.

It is important to point out, however, that in order to manage risk it is important to consider both the collective risk and also individual risk, as people's individual risk can vary vastly depending on the specific activity. Knowledge of the relative level of collective risk for a system provides no indication of the level or tolerability of individual risk arising from different activities or from the system as a whole. However, consideration of individual risk is outside the scope of the methodology described here.

C2.3.2 Risk units

It is essential that the 'units' of risk used in the assessment have a degree of commonality in order that sensible comparisons can be made. This is particularly important given that one of the aims of the assessment is to combine the risk from the collection life cycle stage with the post-collection life cycle stage. These stages are very different in that collective risk in the collection stage is related to the number of collections and in the post-collection stages, to the amount or tonnage of waste and recyclables. It therefore makes most sense to consider a fixed period of time, e.g. a year and a fixed area, e.g. a round or a LA controlled area. Both the number of collections and tonnage of waste and recyclables can then be derived from the same fixed time period and area. Therefore, overall the level of collective risk will be derived per defined time period per defined area (number of households).

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[20] *Equivalent fatalities are an overall measure of fatalities, major and minor injuries where the major and minor injuries are weighted to give equivalence to fatalities. 1 fatality to 10 majors to 100 or 200 minors is often used.*

C2.4 FACTORS IN THE RISK ASSESSMENT

An additional requirement of the risk assessment approach is to be able to take account of local variations, for example local geography (urban or rural environments) and distribution of housing types (e.g. detached, terraced housing or high-rise flats). Factors that potentially need to be taken into account are discussed in detail in Section C3.2.

C3 RISK ASSESSMENT METHODOLOGY

As stated in Section C2.3, for each system to be assessed, the sub-systems and the components that make up the system will be identified. For each component all relevant hazards will be identified, and for each hazard an assessment will be made of the level of collective risk it presents. The collective risk estimates for each system will then be collated to allow a comparison between different systems of:

- The level of collective risk from individual hazards;
- The level of collective risk from individual components or activities;
- The level of collective risk from specific sub-systems, i.e. life cycle stages; and
- The level of collective risk from the overall system.

Collective risk is proportional to two factors: the likelihood that harm occurs and the consequences. Directly estimating the likelihood that harm occurs (relevant to different local situations with different exposed populations) is difficult. Therefore, the likelihood that harm occurs has been broken into two factors: exposure frequency and a conditional probability that the exposure causes harm. The first factor, exposure frequency, is situation specific, whereas the conditional probability is generic assuming a standard level of control and safety management system. Therefore overall, collective risk can be expressed as the product of the following three factors (also illustrated in Figure C2):

- **Exposure to the hazard** – this is the frequency at which the activity that gives rise to the hazard is carried out.
- **Criticality of the exposure** – this is the likelihood (or conditional probability) that harm occurs due to the exposure.
- **Consequences –** this is a measure of the different harm outcomes given that exposure to the hazard causes harm.

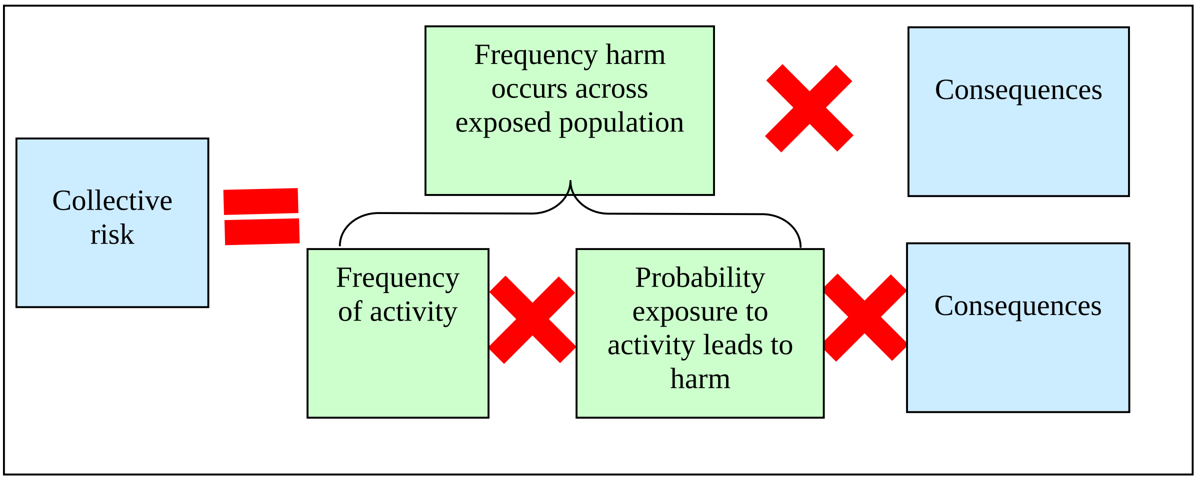

Figure C2 Illustration of calculation of risk

As discussed earlier, the scope of this risk assessment is to allow a comparison between hazards, components, and the system in terms of risk. Therefore a relative measure of collective risk is required. Two approaches are adopted to achieve this, the first being a pseudo-quantitative assessment of relative collective risk and second a risk ranking approach whereby an overall risk rating will be assigned to each hazard.

Quantitative approach

The calculation of risk using a risk rating approach has a limitation in that the risk index from each hazard cannot be combined easily to give an overall measure of risk for the component, subsystem or overall system. Therefore, an alternative approach to the calculation of risk is also proposed, which is based on a fully quantified approach. Taking the three risk elements: exposure frequency, conditional probability and consequence the level of risk, R, can be calculated as:

$$R = \text{exposure frequency} \times \text{conditional probability} \times \text{consequence}$$

where:

- exposure frequency can be calculated directly – see Section C3.1.1;
- conditional probability can be calculated using the probability rating discussed in Section C3.1.2; and
- consequence can be calculated using the consequence rating discussed in Section C3.1.3.

As a change in probability or consequence rating by 1 is assumed to represent a change in probability or consequence by a factor of 10, these can be expressed as:

$$\text{conditional probability} = C_p \times 10^{pI}$$

$$\text{consequence} = C_c \times 10^{cI}$$

where C_p and C_c are constants, and pI and cI are the probability and consequence ratings respectively.

Therefore risk, R can be expressed as:

$$\begin{aligned} R &= \text{exposure frequency} \times C_p \times 10^{pI} \times C_c \times 10^{cI} \\ &= C \times \text{exposure frequency} \times 10^{pI} \times 10^{cI} \end{aligned}$$

where C is a constant. The above can be simplified by removing the constant C as:

$$r = \text{exposure frequency} \times 10^{pI} \times 10^{cI}$$

where r is a measure of relative risk and $R = C \times r$.

It is r divided by 10^6 that is calculated for each hazard by the Risk Comparator Tool. The factor of 10^6 is introduced solely to scale the overall calculated risk value to a more manageable range.

The risk of a component, subsystem or system can be calculated by summing the risk of each hazard. The value calculated is proportional to the level of collective risk.

Risk index approach

As the risk is calculated from the following three elements:

- Exposure frequency;
- Conditional probability of exposure leading to harm; and
- Consequences

a rating scale will be used for each of the three elements, and these ratings can be combined by summing to give an overall risk rating for the hazard. A basic justification of this approach is presented in Annex C1.

For each risk element it is proposed that a scale of 1 to 5 be used initially, as this should give sufficient sensitivity in the overall risk ratings, and each of the elements can be defined on such a scale. In addition, it is important to ensure that the overall risk rating is as sensitive to the consequence element as to the frequency element. Therefore, the consequence rating is doubled prior to combining with the exposure frequency and probability ratings. The overall risk rating for any hazard will then vary between 4 and 20. It is recommended that following initial development of the methodology, further investigation is carried out to determine whether the proposed size of the rating scales is appropriate, or whether, for example, the use of wider scales may be more appropriate to ensure sufficient sensitivity in the overall risk ratings.

As stated above, some of the elements of the risk can be assessed generically (e.g. conditional probability and the nature of the consequences) while others are situation specific, being determined by local factors. For the methodology to have maximum utility, the need for it to be easy to use (i.e. requiring a minimum number of readily obtainable inputs) needs to be balanced with the need for it to include sufficient local information that the outputs from the assessments are meaningful. To achieve this, the generic elements of risk will be estimated by the HSL project team (and will be essentially ‘hard wired’ into the methodology) and will be combined within the methodology with situation specific elements that are input by the LAs when the methodology is utilised.

The following sub-sections describe:

- how each of the above risk elements are assessed including the rating scales for each of these elements of risk (Section 0);
- how local factors influence the above elements of the risk estimation (Section C3.2);
- how these factors are combined in the risk assessment (Section C3.3); and
- the factors that need to be estimated both by LAs and by the HSL project team (Section C3.4).

C3.1 RISK ELEMENTS

C3.1.1 Exposure

Exposure to a specific hazard will vary depending on the activity being carried out, and the exposure units will vary depending on the subsystem or component. However, in order to simplify the assessment, two base exposures will be input and other measures of exposure, relevant to specific hazards, will be calculated as a factor of the base exposure. These factors will initially be estimated by the HSL project team and will be hard wired into the methodology utilised by Local Authorities. It is also recommended that an industry workshop is held in order to try to improve the robustness of the exposure modifiers by incorporating industry knowledge and experience into the estimates. It is emphasised, however, that the assumptions made will also be able to be changed if not relevant for a particular Local Authority's circumstances.

In terms of the collection sub-systems, the base exposure will be based on the maximum number of households that waste is collected from per defined period (for example, per year). This would be based on a defined area. Factors such as the set-out rate[21] for the given waste or recyclable will be a LA input to adjust the exposure frequency. The exposure to some activities and the associated hazards will be at this adjusted frequency, for example the number of boxes lifted, whereas some activities may only occur once for every 10 household collections, for example the number of entry/exits from the vehicle. In this latter example, a modifier of 1/10 will be multiplied to the adjusted base exposure frequency. For each component and the associated hazards, modifiers will be estimated. In estimating the modifiers, assumptions will need to be made about the number of employees involved in particular activities; in all cases where this is relevant, the 'average' or 'most typical' number of employees will be assumed and all assumptions will be clearly stated within the methodology.

For the non-collection subsystems the base exposure frequency appears to be better described by the tonnage of waste or given recyclable(s) per year. There are then two approaches for relating the rate activities occur and the resultant exposure to the hazards to the mass of material by: (1) estimating modifiers that give the number of operations per tonne of waste for specific activities and the associated hazards; (2) applying no modifier to the exposure frequency but having a criticality factor that is the likelihood of harm occurring per tonne of material. In terms of being able to estimate the relationship better and for consistency with the approach taken for collection subsystems the first option has been selected.

In summary the exposure frequency will be calculated for each hazard as follows:

Collection subsystems

Exposure frequency = number of households ×
number of collections (per defined period of time) ×
set-out rate (proportion) ×
activity specific modifier

Non-collection subsystems

Exposure frequency = tonnage of material (per defined period of time) ×
number of operations per tonne of material modifier

where the *number of households*, the *number of collections*, the *set-out rate* and the *tonnage of material per year* will be LA specific inputs and the two modifiers will be assumed to be generic and will be estimated as part of the assessment to be carried out in Work Package 4 of this project. These generic values will be hard wired into the tool produced for LAs, but it is again emphasised that they will be able to be changed if considered to be inappropriate.

An important point to note is that to enable systems to be compared, the amount of material collected should be equal to the amount of material processed. That is the tonnage of material in

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[21] *Set-out rate is the average proportion of households who leave the relevant receptacle out for emptying.*

the post-collection systems under consideration should be the same as that collected from the given number of households, i.e. the system is closed.

The following sub-section (Section C3.1.1.1) presents the rating scale that has been chosen for exposure frequency.

C3.1.1.1 Exposure frequency ranking

As this risk assessment methodology could be applied to areas containing small to very large numbers of households, which will have a direct effect on the exposure frequency, it is important that the exposure frequency scale is not fixed, but slides according to the base exposure. This will ensure that the risk assessment methodology is sufficiently sensitive to allow it to be applied no matter the size of the area of interest. It is therefore proposed to use the frequency scale shown in Table C1 initially.

Table C1 Exposure frequency rating scale

Exposure frequency ranking	*Exposure frequency (mid point)*
1	*N* ÷ 1000 or lower
2	Up to *N* ÷ 100
3	Up to *N* ÷ 10
4	Up to number of collections per year, *N*
5	*Greater than N*

In order to allow the risk scores to be combined for components in the collection life cycle stage with components in the post-collection life cycle stage, the same frequency scale will have to be used. However, it is not clear at this point whether the range of frequency captured in Table C1 will be valid for the post-collection life cycle stages. If not, either additional categories will have to be used, the factor difference between categories increased or different scales will need to be utilised for collection and post-collection, with the post-collection activities rated twice for exposure frequency. This will become apparent when the assessment is carried out as part of this project (in Work Package 4).

The exposure frequency ranking will be calculated dynamically based on LA inputs whenever the methodology is utilised.

C3.1.2 Probability that exposure leads to harm

The probability that exposure leads to harm is a conditional probability that denotes the likelihood that for a given exposure to a hazard some form of harm occurs to someone in the exposed population. An implicit assumption in the methodology is that hazards will generally only affect single people at a time. This is thought to be a reasonable assumption. However, it will be possible to modify the methodology, if necessary, to incorporate multiple person events if this becomes apparent following completion of Work Package 4.

The probability will vary between components and hazards. This will therefore have to be estimated for each of the components and the associated hazards. These probabilities will initially be estimated during the assessment to be carried out during Work Package 4 of this project and will be hard wired into the assessment methodology. It is anticipated that the probability estimates will, where possible, be based on industry data/estimates. Where this is not possible, estimates will be made by the project team. In addition, it is also recommended that an industry workshop is held in order to try to improve the robustness of the conditional probabilities by incorporating industry knowledge and experience directly into the estimates. In all cases estimates will only be needed to the nearest order of magnitude or against some risk scale. The scale proposed for ranking probability is presented below (Section C3.1.2.1). As stated earlier, the conditional probabilities are generic assuming a standard level of control and safety management system.

C3.1.2.1 Probability ranking

The probability ranking is the conditional probability that exposure to the hazard leads to harm to someone in the exposed population. It therefore has a value of between 0 and 1. This will be fairly difficult to estimate accurately, but it should be possible to estimate it to the nearest order of magnitude as required by this methodology. Table C2 shows the probability ratings[22] that are proposed in the risk assessment methodology. An upper value of C has been set in the rating scale, which is a constant that each of the other rating categories are relative to. This has been done to ensure that the rating scale is used in a relative way and that absolute numbers are not used in a misleading way. What is important is that the scale is applied in a consistent way. It is also important to point out that this scale will be applied by the HSL project team in populating the risk assessment methodology and not by LAs.

Table C2 Probability rating scale

Probability ranking	*Conditional probability (mid point)*	*Descriptor*[23]
1	C ÷ 10000 or lower	Rare
2	C ÷ 1000	Unlikely
3	C ÷ 100	Possible
4	C ÷ 10	Probable
5	C or greater	Likely

C3.1.3 Consequences

For each hazard (and for each representative scenario in the case of collection systems) the level of harm will be estimated for the best estimate and realistic worst case or most likely outcome should an incident occur. In addition, as discussed earlier, given that some hazards may lead to an acute outcome, whereas others may lead to a chronic outcome, two different consequence scales will be used due to the difficulty in drawing equivalence between chronic and acute

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[22] *The probabilities are not the probability of an individual being harmed, but are the probability that someone in the exposed population is harmed, as the risk measure within the methodology is collective risk.*

[23] *The descriptors are relative and should not be treated as absolute.*

effects. While in most cases it is anticipated that a particular hazard will lead to either an acute or a chronic outcome, it is also anticipated that in some cases a hazard may lead to both acute and chronic ill health effects. If this is the case, the most likely acute outcome and the most likely chronic outcome will both be estimated, and the overall risk rating for these hazards will be equal to the sum of the acute and chronic risk ratings. Initial consequence estimates will be made by the HSL project team as part of Work Package 4, and these estimates will be hard wired into the methodology. In addition, it is also recommended that an industry workshop is held in order to try to improve the robustness of the consequence estimates by incorporating industry knowledge and experience. The proposed rating scales are illustrated below in Section C3.1.3.1.

C3.1.3.1 Consequence ranking

Table C3 shows the consequence rating scale proposed for acute outcomes and Table C4 shows a rating scale for chronic outcomes. Examples will be produced to illustrate the rating scales before they are utilised. Again, these rating scales will only be used by the HSL project team for populating the risk assessment methodology.

Table C3 Acute consequence rating scale

Acute consequence ranking	*Safety*	*Health*	*Descriptor*
1	Slight, minor injury with no absence or less	Minor health effect with no absence, e.g. fainting	Negligible
2	Requires first aid treatment	Minor health effect requiring treatment	Low
3	> 3 day loss time accident	Moderate health effect leading to > 3 day absence	Moderate
4	Major injury	Major health effect, e.g. permanent/ long term health effect	High
5	Single fatality	Fatality	Very high

Table C4 Chronic consequence rating scale

Chronic consequence ranking	*Safety*	*Health*	*Descriptor*
1	Not applicable	-	Negligible
2		Short term reversible	Low
3		Long term reversible	Moderate
4		Long term irreversible	High
5		Permanent severe disability/fatality	Very high

C3.2 LOCAL FACTORS

As described earlier, one of the objectives of the risk assessment methodology is for it to be sensitive to local factors such as the type of housing or the degree of urbanisation. This section therefore describes those local factors that may affect the level of risk and considers whether and how they should be incorporated into the risk assessment methodology. Some of the factors considered are only of relevance to collection activities, while others are only of relevance to post-collection activities. The following factors are considered in the following sub-sections.

Factors that directly affect the exposure frequency (Section C3.2.1):

- Number of households;
- Set-out rates;
- Frequency of collection;
- Number of containers per household (in a single collection);
- Overall tonnage of waste and recyclables; and
- Quality of the specific waste and recyclable streams.

Environmental factors (Section C3.2.2):

- Terrain (roughness and steepness);
- Road type and traffic density;
- Local geography, e.g. urban, suburban or rural environments; and
- Season and time of round.

Other factors that affect risk through the probability of harm or consequence (Section C3.2.3):

- Type of households, i.e. flats, terracing, detached and freehold properties;
- Distance from waste collection point to vehicle;
- Number and role of operatives; and

- Mass of contents in receptacles.

Factors that relate to non-routine situations (Section C3.2.4):

- Bank holidays;
- Sickness; and
- Severe weather conditions.

C3.2.1 Exposure factors

The following sub-sections discuss those factors that predominantly impact the exposure frequency estimation.

C3.2.1.1 Number of households

The number of households in a specific area defines the frequency of doing a specific task, subject to activity specific modification factors, as discussed in Section C3.1.1, and therefore feeds directly into the exposure estimation for collection systems.

C3.2.1.2 Set-out rate

The set-out rate is the proportion of households (a value between 0 and 1) that utilise the collection system under consideration, i.e. that present the receptacle for emptying. This value directly modifies the number of households in the area to give the number of collections. This therefore feeds directly into the exposure calculation for collection systems, as is illustrated in Section C3.1.1.

C3.2.1.3 Frequency of collection

The frequency of collection, for example weekly or biweekly collections, will have a direct bearing on the level of collective risk. For example, as the frequency of collections reduces, simplistically, the level of collective risk will also reduce due to a reduction in exposure of the exposed population. This aspect will be captured explicitly in the exposure frequency estimation through the number of collections made in the time period under consideration (see Section C3.1.1). For example, if the time period under consideration is 1-year 52 collections will be carried out for a weekly collection system.

Collection frequency will also have an indirect impact on risk through a change in the amount of material being collected at a specific collection. However, the amount of material is considered as a direct factor in the risk assessment, as discussed in Section C3.2.3.4. Therefore, it is unnecessary to explicitly take the frequency of collection into account in the probability or consequence elements of risk.

C3.2.1.4 Number of containers per household

Incorporating the number of containers as a variable in the risk assessment has been considered, as this may increase the exposure to certain hazards. However, it is considered that the most appropriate way of capturing this is to incorporate additional components in the risk assessment. For example if a bag and a box were to be collected then a component of collecting bags and a component of collecting boxes would be included. If the bag were placed inside the box, then carrying of the box would be included as a component, but carrying of the bag would not. However, the weight of box would have to be increased.

Therefore, to summarise, the number of containers is not an explicit variable in the risk assessment, but will be captured by selection of additional components where relevant.

C3.2.1.5 Overall mass of each waste/recyclable stream

The mass of each waste/recyclable stream collected normalises the exposure to the hazards associated with post-collection activities, i.e. the transfer and processing life cycle stages and therefore feeds directly into the exposure estimation. As mentioned previously, the mass of material considered post-collection needs to be consistent with that collected.

C3.2.1.6 Quality of recyclables

The quality of the recyclables influences how they are processed. Additional activities may be required for recyclables that are of a poor quality, for example additional sorting. This variation should be captured through the components utilised to define the system. However, it may be that a modifier, estimated by LAs, would need to be applied to the tonnage of recyclables at different life cycle stages to take account of that removed from the system as waste or separated into different streams.

C3.2.2 Environmental factors

C3.2.2.1 Terrain

The terrain impacts the level of risk in that uneven surfaces may increase the probability that exposure leads to harm. For example, slips and trips are more likely on an uneven surface. Similarly the steepness of the gradient may impact the level of risk by affecting the probability factor, as exposure to certain hazards is more likely to lead to harm on a steep gradient. Therefore, both the surface and the gradient are potential inputs. However, given that it is unlikely to distinguish between small changes in a single factor and given that it is likely to be one of the factors rather than both that are important for a specific hazard, in order to simplify the assessment, these can be grouped together:

Risk level	***Terrain***
Low	Flat to moderate gradients with even surfaces
Medium	Flat to moderate gradients with uneven surfaces or Steep gradients with even surfaces
High	Steep gradients with uneven surfaces

C3.2.2.2 Road type and density

The type of roads adjacent to properties impacts the level of risk in two ways. Firstly, the speed of the traffic impacts the consequences mainly in that if there was a collision between a vehicle and a waste operative, fatality is most likely at high speeds and some lesser consequence at lower speeds. Secondly, the density of traffic on the road is likely to impact the probability that exposure leads to harm. In other words, given a road crossing, someone is more likely to be knocked down on a busier road. Therefore, roads are initially categorised by:

Speed limit /mph	and	***Traffic density***
>50/60		sparse
30 – 50/60		free flowing
<30		congested

As with the terrain factor, it is necessary to try and group these factors in order to simplify the application of the risk assessment methodology. Therefore it is proposed that the following three road categories will be utilised:

Risk level	***Road category***
Low	Low speed, any density
Medium	Medium speed, sparse - free flowing
High	High speed, sparse - free flowing

If adopted, Local Authorities would need to be able to determine the proportion of housing that fall into each of these road/traffic categories.

C3.2.2.3 Urbanisation

The degree of urbanisation, that is whether the collection takes place in an urban, suburban or rural environment will have an impact on both the probability that exposure leads to harm and consequence elements of the risk. The frequency of carrying out different collection activities will vary in areas with different degrees of urbanisation which will affect the exposure probability to some hazards, as will the different road types and traffic densities that are likely to be encountered. In addition, the duration of certain tasks (e.g. pulling bins or carrying boxes) may be different in areas with different levels of urbanisation which will affect the consequences for certain hazards, and the consequences of some other hazards being realised may be different for different road types (where traffic speeds are higher). However, these factors are captured as direct factors in the risk assessment through the explicit consideration of housing density and road type and density and it is therefore unnecessary to also separately consider the degree of urbanisation.

C3.2.2.4 Season and time of round

The time of the round and the season of the year could affect the level of risk in a number of ways. For example, it will influence whether it is light or dark during collection activities, traffic density levels will be different at different times and in winter there is a greater likelihood of icy conditions at night or in the early hours of the morning. These factors will potentially increase the likelihood of certain hazards being realised (e.g. slip and trip incidents, being knocked down when crossing the road etc.). It is considered that it is most appropriate to capture this implicitly rather than explicitly in the risk assessment methodology. When considering the likelihood of harm for relevant hazards, the full range of conditions over which the hazards are likely to be encountered should be taken into account when deciding on an appropriate probability ranking.

C3.2.3 Other risk factors

C3.2.3.1 Housing density

The density of housing has an impact on the level of risk in that a higher housing density leads to bursts of very high frequency activity. Therefore the probability that exposure leads to harm for some hazards could be different for different housing densities. Similarly, the type of housing (housing density) may increase the exposure in terms of time for some hazards which could have an impact on the consequences for chronic health effects. As the impact that housing type has on the probability that exposure leads to harm (and consequences) will vary across different hazards then where relevant the probability factor and consequences will have to be assessed for each housing type. The following types of housing are initially considered:

Housing density	***Housing type***
Low	Small holdings
	Detached
Moderate	Semi detached
	Terraced
	Flats
High	High-rise flats

However, in order to limit the amount of analysis and due to the fact that probability is unlikely to change strongly across the range of housing, this range is simplified to three housing types:

Housing density	***Housing type***
Low	Small holdings and detached rural properties
Moderate	Detached (urban), semi detached
High	Terraced and flats

C3.2.3.2 Distance from waste collection point to vehicle

The distance from waste collection point to vehicle will have an impact on both the probability that exposure leads to harm and consequence elements of the risk. The duration of certain tasks (e.g. pulling bins or carrying boxes) will increase as a function of distance from collection point to vehicle which will affect both the likelihood of harm and the consequences for certain hazards. However, this factor is captured directly in the risk assessment through the explicit consideration of housing density.

C3.2.3.3 Number of operatives

As the approach used in the risk assessment methodology is to consider collective risk, at one level the exposed population, for example the number of operatives, is implicitly included as part of exposure estimation. The level of collective risk is a stronger function of the number of households being collected from and the tonnage of waste and recyclables being processed compared to the number of staff doing those collections. However, the number of staff can affect the level of collective risk in two main ways. Firstly, if there are fewer people carrying out a particular activity, the intensity of that task may be greater which could lead to the likelihood of an accident increasing, and would therefore impact our assumed probability factor. Secondly the exposure to a hazard may change. For example, if there are more people involved in a collection activity, the overall number of climbs in and out of a vehicle may increase. However, for other activities, such as the number of bins lifted, the exposure frequency would not change with the number of people involved. Therefore, the exposure modification factor may be a function of the number of operatives, depending on the specific activity.

It is considered that in order to take such variation into account within the risk assessment methodology would be extremely difficult and would not give huge benefit. It would be difficult to estimate how the above factors vary with the number of operatives. The uncertainty in the risk estimates and associated parameters is likely to be greater than the sensitivity of the risk to the number of operatives. As stated in Section C3.1.1, it is therefore proposed that the risk assessment will be based on assuming a typical number of operatives for the activities and this typical number will be stated and the basis for any assumption clearly explained. If these assumptions were to be invalid then put simply the fewer operatives there are, the higher the collective risk and the more operatives there are the lower the collective risk. However, it is expected that the change in collective risk is likely to be more sensitive to reducing the number of operatives than to increasing the number. The risk assessment would therefore provide a baseline assessment for adequate staffing.

The number of operatives could also be import for hazards that can harm more than one person at a time. However, an implicit assumption has been made in the methodology that hazards will generally only affect single people at a time.

To summarise, the number of operatives is not generally considered as an explicit factor in the risk assessment methodology.

C3.2.3.4 Mass in container

The mass of material collected from a specific household is likely to impact on the level of risk, particularly due to the potential ill-health effects of lifting and carrying (e.g. Musculoskeletal Disorders – MSDs). The mass of material impacts the probability that exposure leads to harm in particular as it is directly related to the frequency of lifting and carrying and the potential risk of a musculoskeletal type of injury. The postural requirements, which are influenced by the shape and size of the receptacle, and the dimensions of the vehicle containers into which the material is sorted compared to the human body, will further impact upon the risk of injury as will the suitability of the handhold on the receptacle. It is therefore proposed to break down the amount of waste or recyclables captured into the following three categories:

Container volume usage	***Mass of waste/recyclable in container (relative to container size)***
<30% used	Light
30-80% used	Average
>80% used	Heavy

C3.2.4 Special situations

C3.2.4.1 Bank Holidays

It is often the case that alterations are made to collection schedules to accommodate bank holidays. This potentially impacts on the level of risk in a number of ways depending on the precise arrangements that are put in place. In some cases there may be a larger than usual gap between collections resulting in the majority of containers being heavier than usual. This would impact on both the probability and consequence elements of the risk which would both increase particularly due to the potential ill-health effects associated with lifting and carrying. However, the overall exposure would be reduced as there would be a smaller number of collections. These situations and other similar situations where there may be greater volumes of waste than usual (e.g. over the Christmas period) are captured implicitly rather than explicitly in the risk assessment methodology. When considering the likelihood of harm and consequences for relevant hazards, the full range of conditions over which the hazards are likely to be encountered should be taken into account when deciding on appropriate probability and consequence ranking. The frequency of exposure is captured explicitly as the number of collections is a direct input to the methodology.

C3.2.4.2 Sickness

It is probable that there will be times when there will be fewer than the usual number of operatives engaged on an activity as a result of sick leave, or where alterations to collection schedules are made to accommodate sick leave. As outlined in Section C3.2.3.3 it is not possible to explicitly take this degree of variation into account in the methodology. However, it is possible to take this into account to some degree, as described above. When considering the likelihood of harm and consequences for all hazards, the full range of conditions over which the hazards are likely to be encountered (including some situations where there are fewer operatives than normal) should be taken into account when deciding on appropriate probability and consequence rankings.

C3.2.4.3 Severe bad weather

Cases of severe bad weather could affect both the probability that exposure leads to harm and the consequence elements of the risk. For example, icy conditions will potentially increase the likelihood and consequence of certain hazards (e.g. slip and trip incidents). In addition, it may sometimes be necessary to make alterations to collection schedules as a result of bad weather. This would impact on the risk in a similar way to that described in Section C3.2.4.1 for bank holidays. It is considered most appropriate to capture these situations implicitly rather than explicitly in the methodology. When considering the likelihood of harm for relevant hazards, the full range of conditions over which the hazards are likely to be encountered should be taken into account when deciding on appropriate probability and consequence rankings.

C3.3 COMBINED FACTORS

This section summarises how the factors described above (Section C3.2), that have been judged to require explicit inclusion, are to be combined and used as part of the overall risk assessment approach for the collection life cycle stage and for the post-collection stages. Collection and post-collection activities are discussed separately, as the factors that are relevant are very different in each case, and the base-line exposure is calculated differently.

The factors proposed to be taken into account are subject to confirmation after the hazard identification has been performed as part of Work Package 4, in case hazards are identified that need additional factors.

C3.3.1 Collection life cycle stage

As stated in Section C2.3 the methodological approach adopted involves estimating the level of risk for a representative range of scenarios. A suitable set of representative scenarios can be determined by considering the factors described in Section C3.2 that affect the level of risk. Taking the following factors and associated categories:

- Housing density (high, medium, low)
- Terrain risk (high, medium, low)
- Road risk (high, medium, low)
- Mass in container (heavy, average, light)

this results in 81 combinations or scenarios. If each hazard was assessed as realistic worst case and best estimate for both acute and chronic effects this would lead to 324 combinations. For each scenario to be considered it will be necessary to estimate both the probability that exposure leads to harm and the consequences for each identified hazard. It is therefore not possible to include such a large number of scenarios as the time required to derive these estimates would be prohibitive, and a simplification of the approach is therefore required.

Various approaches for simplifying the assessment have been taken. Firstly the terrain and road categories have been combined into a single environmental factor with three risk level categories (high, medium and low). This reduces the number of combinations by a factor of 3, but still the assessment approach would be unwieldy. Secondly, it is considered that estimating the level of risk for both best estimate and realistic worst case would be unnecessary and that the analysis should focus on the most likely outcome. This then reduces the number of combinations or scenarios to 54 in total, which is still large as illustrated in Figure C3.

The overall risk assessment approach would be that each hazard for every component (collection systems only) would have one of these hazard tables associated with it. Hazard tables would have consequence and probability ratings assigned for each scenario (hard wired), as represented by a cell in the table. Local factors would be used to calculate the overall risk rating for each scenario and weight the risk ratings to produce an overall single risk rating for the hazard. This rating would then be representative of the local situation. How this overall risk rating is calculated is discussed further in Annex C2.

		Housing Density	**Mass in receptacle**					
			Light		**Average**		**Heavy**	
			Acute	**Chronic**	**Acute**	**Chronic**	**Acute**	**Chronic**
Environmental risk factor	**Low**	**Low**	*a*		*b*		*c*	
		Medium	*j*		*k*		*l*	
		High	*s*		*t*		*u*	
	Medium	**Low**	*d*		*e*		*f*	
		Medium	*m*		*n*		*o*	
		High	*v*		*w*		*x*	
	High	**Low**	*g*		*h*		*i*	
		Medium	*p*		*q*		*r*	
		High	*y*		*z*		*aa*	

Figure C3 Hazard look-up table

As discussed, even with the simplifications proposed above, this still requires an assessment of risk to be made for 27 scenarios (54 if both chronic and acute consequences are relevant) for every hazard, which would still be extremely time consuming. However, further simplifications can be made. Firstly it is unlikely that every combination of factor would have to be considered for each hazard as the risk from some hazards would not be sensitive to changes in a specific factor's category. Secondly, the risk from other specific combinations of factors (or scenarios) could be estimated from neighbouring combinations. This approach can be illustrated if one considers Figure C3, where the acute scenarios have been labelled *a* to *aa*. For example, consider scenario *b*, which can be estimated based on an average of scenarios *a* and *c*. Similarly, *e* can be estimated based on an average of *a* and *i*, *j* can be estimated based on an average of *a* and *s*, *n* can be estimated based on an average of *j* and *r* (where *j* and *r* are themselves averages of their neighbours) and so forth. Thus only the level of risk at the extremes needs to be assessed. This reduces the number of combinations down to 8 for each hazard, a much more feasible task, and the risk from 27 scenarios can be derived based on these.

Thus, the level of risk would be estimated for the following scenarios for both chronic and acute effects where relevant.

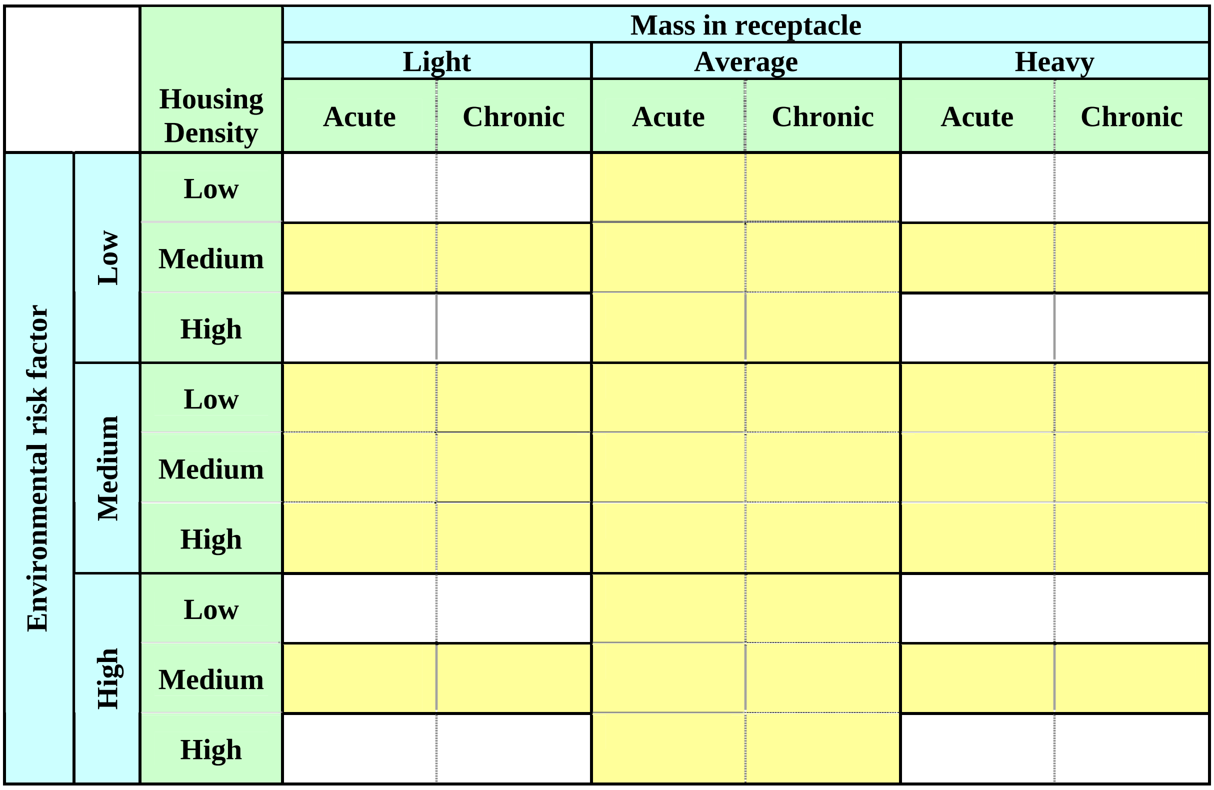
Low housing density

- Lowest environment risk and lowest container mass scenario
- Lowest environment risk and highest container mass scenario
- Highest environmental risk and lowest container mass scenario
- Highest environmental risk and highest container mass scenario

High housing density

- Lowest environment risk and lowest container mass scenario
- Lowest environment risk and highest container mass scenario
- Highest environmental risk and lowest container mass scenario
- Highest environmental risk and highest container mass scenario

Figure C4 illustrates the combination of scenarios that will be included within the assessment. Those cells in white will be assessed directly and those in yellow will be derived from these 8 scenarios. How risk is calculated for the scenarios where the level of risk is not assessed directly is presented in Annex C2.



		Housing Density	**Mass in receptacle**					
			Light		**Average**		**Heavy**	
			Acute	**Chronic**	**Acute**	**Chronic**	**Acute**	**Chronic**
Environmental risk factor	**Low**	**Low**	⬜	⬜	🟨	🟨	⬜	⬜
		Medium	🟨	🟨	🟨	🟨	🟨	🟨
		High	⬜	⬜	🟨	🟨	⬜	⬜
	Medium	**Low**	🟨	🟨	🟨	🟨	🟨	🟨
		Medium	🟨	🟨	🟨	🟨	🟨	🟨
		High	🟨	🟨	🟨	🟨	🟨	🟨
	High	**Low**	⬜	⬜	🟨	🟨	⬜	⬜
		Medium	🟨	🟨	🟨	🟨	🟨	🟨
		High	⬜	⬜	🟨	🟨	⬜	⬜

Figure C4 Hazard table – assessed and derived scenarios

The assessment of risk for the representative set of scenarios, for each hazard will be carried out as part of the generic assessment that will be completed by the HSL project team in Work Package 4 and will not need to be carried out by LAs when the methodology is utilised. Section C4.1 describes how LA inputs (local factors) will be used to 'interrogate' the hazard tables to sum the relevant risk ratings for any specific situation.

C3.3.2 Post-collection life cycle stage

From the discussion of the factors in Section C3.2 it is seen that the only factors of relevance to the post-collection life cycle stage are the mass of waste or recyclable(s) per defined time period (e.g. a year) and the quality of the waste. As neither of these factors will affect the probability or consequence elements of risk, the assessment stage will be relatively more straightforward as there will only be a single scenario (the most likely outcome) to be considered for each hazard.

C3.4 FACTORS TO BE ESTIMATED

As discussed in the above sections, in order to estimate the level of risk for a hazard, component or system, a number of inputs are required. The first set of factors are those that need to be input by Local Authorities in order to make the assessment location specific and the second set of factors are the generic factors that will be estimated as part of this project and that will be 'hard-wired' into the risk assessment methodology.

C3.4.1 LA inputs

Number of collections per defined period of time: this is the maximum number of collections that would be made per defined period of time in the area of interest and assumes 100% set-out rate. For kerbside collection this is likely to be the number of households in the area multiplied by the number of collections made per defined period of time.

Housing density: as defined in Section C3.2.3.1, housing is defined as falling into one of three density categories. The proportion of households falling in each of the three density categories is required. Therefore three values are required to be entered, and the total must sum to 1.

Set-out rate: the proportion of households participating in the waste/recyclable system being considered is required for each of the three housing density categories.

Environmental factor: the proportion of households falling into one of three environmental risk categories, high medium or low. For each housing density category it is necessary to estimate the proportion falling into each risk category, and the total across the 3 categories must sum to 1. Guidance will be produced that will allow LAs to estimate overall environmental risk factors based on the road types, traffic density and terrain.

Container weight: The amount of material in the container of interest needs to be estimated. This has been defined as the proportion of households having containers for collection that are light, average or heavy. Again the methodology will allow for this distribution to vary across the housing types. Therefore, for each housing density the proportion of households with containers falling into each weight category needs to be estimated, and the total across the categories for each housing density must sum to 1.

Mass of waste or recyclable(s) processed per defined period of time: for the system under consideration, the amount of waste or recyclables to be processed in tonnes must be entered. This should be equivalent to that collected from the households under consideration over the defined period of time.

Proportion of waste: This is the proportion (relative to that collected) of the collected waste or recyclable stream that is processed by the system under consideration. LAs must estimate this for each subsystem at the point they define the systems.

The requirements for LA localisation factors input data is summarised in Table C5. It is important to stress that each group of three factors, as illustrated by the colouring, must sum to one.

Table C5 Local authority localisation factors

Housing density		***Mass in receptacle***			***Environmental risk***		
	Proportion	Light	Average	Heavy	Low	Medium	High
Low	🟩	🟦	🟦	🟦	🟨	🟨	🟨
Medium	🟩	🟨	🟨	🟨	🟦	🟦	🟦
High	🟩	🟦	🟦	🟦	🟨	🟨	🟨

C3.4.2 Hard-wired factors

Exposure modification factors: these are only relevant for the collection life cycle stage and are required to modify the baseline exposure frequency (the number of collections per defined period of time), into an exposure frequency for the activity or component. It is anticipated that these will be estimated based on the observations made as part of Work Package 2, and will be estimated to the nearest order of magnitude. A different modification factor may be required for the different housing densities for some activities, but it is expected that the same set of factors will be valid for the hazards related to a given activity.

Number of operations per tonne of material: this is analogous to the exposure modification factor, but is only relevant to the post-collection life cycle stages. This is the number of operations/activities carried out for each tonne of material processed and needs to be estimated for each activity/component. Again, it is anticipated that the same factor will be valid for the hazards related to a given activity.

Probability (collection life cycle stage): for each identified hazard the conditional probability that exposure to the hazard leads to harm (any level) will have to be estimated for each of the eight scenarios described in Section C3.3.1. It is anticipated that both acute and chronic effects will not be relevant for all hazards, and in these cases the conditional probability will only need to be estimated for the relevant effect (either acute or chronic).

Consequence (collection life cycle stage): for each identified hazard the most likely consequence will have to be estimated for each of the eight scenarios described in Section C3.3.1. It is anticipated that both acute and chronic effects will not be relevant for all hazards, and in these cases the most likely consequence will only need to be estimated for the relevant effect (either acute or chronic).

Probability (post-collection life cycle stage): for each identified hazard the conditional probability that exposure to the hazard leads to harm (any level) will have to be estimated. Where required a different probability can be estimated for acute and chronic outcomes.

Consequence (post-collection life cycle stage): for each identified hazard the most likely consequence will have to be estimated. Where relevant both acute and chronic consequences will be estimated.

C4 SUMMARY OF RISK ASSESSMENT APPROACH

There are two key aspects of the risk assessment approach described in the previous sections: a methodology that incorporates a number of generic factors that will be determined as part of the project and will essentially be hard wired into the methodology; and the process by which LAs utilise this methodology, to input local factors to produce situation specific comparative risk assessments. This section firstly describes how the overall risk assessment will work, what it will look like and whether the risk assessment approach will have the desired utility as a decision aiding tool (Section C4.1) and secondly how to maximise its utility (Section C4.2).

C4.1 SUMMARY OF RISK ASSESSMENT PROCESS

The overall concept for the risk assessment process is shown graphically in Figure C5. Essentially LAs will define each system to be assessed by selecting the relevant components that define the system of interest and provide a limited amount of input data that roughly defines their local situation. The risk assessment methodology will take this input data and interrogate the hazard look up tables to estimate a representative risk rating for each hazard, taking account of the LA localisation factors. This stage will be carried out automatically and could be to some extent hidden away from LAs. These representative hazard risk ratings can then be combined for each system to varying sub-levels as outlined in Section C2.2.1 (or Figure C5) to produce overall risk ratings for each system.

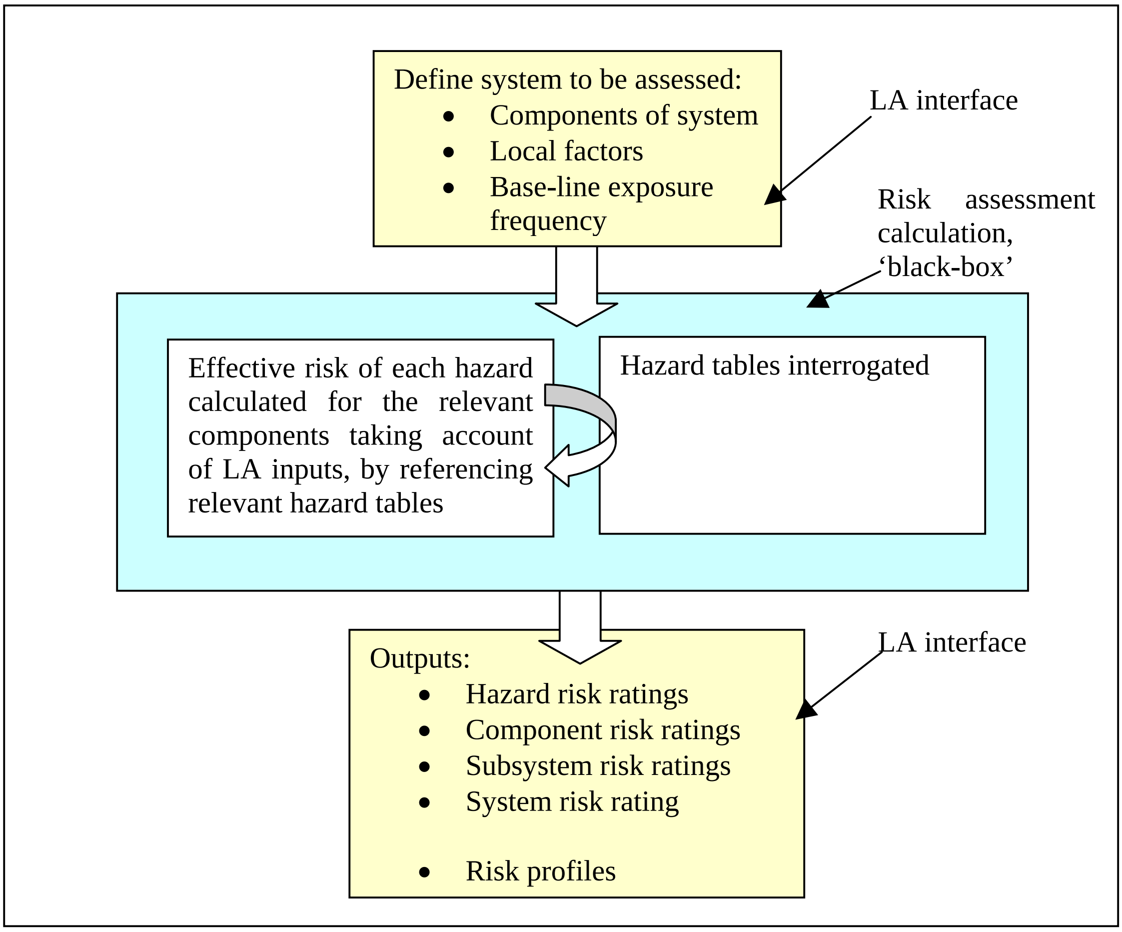


Figure C5 Risk assessment process

It is intended that the LAs will compare different systems (in terms of health and safety risk) by comparing the overall risk ratings for the systems. Guidance will be produced as part of Work Package 7 of the project to ensure the outputs are used appropriately and understood. This will include guidance on the significance of the magnitude of differences between risk rankings for different systems.

It is important to note that the risk rankings produced for the assessed systems will only allow systems to be compared for the same LA in the same defined area and time period. Comparisons across different areas or with different LAs cannot be made. In addition the risk rankings do not map directly to absolute risk. As stated at the outset, the purpose of the methodology is to produce comparative, not absolute, assessments of risk. It is crucial, however, that the output from the tool is not used in isolation or misinterpreted. It is intended that the output from the comparative assessments will provide one input into the overall decision making process with respect to which is the most appropriate system to adopt, alongside other factors such as environmental performance and cost etc. In addition, once a particular system is selected there remains a legal duty to ensure that the risk is adequately reduced and managed.

It is anticipated that the risk assessment methodology will be incorporated into a Microsoft Excel Workbook. This will then enable a simple front-end to be produced, which will be the main LA input interface, the hazard tables and risk calculations to be hidden away as required, but nonetheless still present, and an output produced of risk rating specific to the LA.

Annex C3 illustrates how the hazard sheets are utilised with the LA information to produce overall risk ratings.

C4.2 UTILITY OF RISK ASSESSMENT METHODOLOGY

For the risk assessment approach to have maximum utility as a decision-aiding tool, various issues must be considered. These issues are explored in this section.

LA input data: The success of the methodology depends on whether LAs can easily estimate the information that is required. Section C3.4 outlined the input data requirements. Generally, the methodology has been developed such that a minimal amount of information is required to be input by LAs, but at the same time sufficient information is input to ensure that the overall approach is not simplified too much to make the outputs meaningless. However, the ease by which this information can be obtained still needs to be ascertained; it is anticipated at this stage that it should not be a major issue.

Ease of use: How easy it is to use the approach will obviously influence strongly whether LAs adopt it. As discussed above (Section C4.1), it is anticipated that the methodology will be incorporated into Microsoft Excel to give a simple input and output interface, with the detailed data hidden from the user, thus making the approach as simple as possible. Together with the limited input data requirements, use of the methodology should not be too onerous in terms of time. Overall, the approach is judged to be simple to apply.

Interpretation of outputs: In order for the tool to be useful it is important that outputs can be interpreted with ease and without ambiguity. To achieve this firstly the overall concept in terms of outputs is fairly simple and secondly guidance will be produced as part of Work Package 6 to ensure that the outputs are used appropriately and understood.

Hard-wired factors: As described in Section C3.4 a range of factors will be hard-wired into the risk assessment methodology. These range from probability and consequence ratings for each hazard scenario to exposure frequency modification factors. It is therefore imperative that the factors are representative, robust and therefore defensible. If this is not the case then this has the potential to undermine the overall approach. A two-stage approach is therefore proposed in order to derive the factors, particularly the exposure modification factors. Firstly, the project team will estimate the factors based on information to hand, for example observations and discussions carried out as part of Work Package 2, company risk assessments and incident data, where available, and expert judgement by utilising specialists for particular hazards from within HSL. Secondly it is proposed to hold an industry workshop in order to try and estimate the exposure frequency modification factors based on industry knowledge and experience. Differences between the industry workshop and HSL derived values will be explored and where necessary a consensus reached on the most appropriate values. In addition, as it is anticipated that factors only need to be estimated to the nearest order of magnitude, this in itself increases confidence in the estimates.

Sensitivity of risk assessment approach: How sensitive the method is to input data and assumptions is also crucial in ensuring the tool has maximum utility. If the approach is not sufficiently sensitive then this will undermine the confidence in it as a decision-aiding tool. For example, if one system was always highest risk no matter what inputs are provided then this may be perceived as the tool being insensitive. However, that may be the case or it could be that one system has inherently higher risk. It is therefore important to demonstrate that the tool is sufficiently sensitive, for example by some trial or validation with LAs, and that alterations to the methodology be made if not.

In summary, it is believed that the approach put forward will be able to provide a useful tool for LAs. However, until the approach is tested it is not clear whether some of the issues discussed above will be significant or not. It is therefore recommended that the approach be trialled with at least one or two LAs in order to determine the significance of the issues and to demonstrate the utility of the tool.

C5 POPULATING THE RISK ASSESSMENT METHODOLOGY

Before the risk assessment methodology can be utilised by LAs, assessment of the generic factors needs to be undertaken by the HSL project team. This will provide the probability and consequence ratings for each hazard scenario and will also provide a first estimate of the hard-wired frequency modification factors. This generic assessment is to be carried out as part of Work Package 4. The approach to be adopted is outlined below.

For each system to be assessed the following tasks will be completed:

- Identify the hazards for each system component;
- For each hazard, identify the possible consequences;
- For collection systems, complete a hazard table for each of the hazards for each of the components;
- Assign probability and consequence (most likely) ratings for each scenario;
- For post-collection systems assign a probability and consequence (most likely) rating for each hazard.

For each system component, a detailed hazard identification will be completed. Hazard identification relies on a structured and systematic approach to identify potential hazards. Therefore identification of hazards (to safety and health) for each system component will be carried out using two main approaches:

1) An initial list of hazards for each component will be generated from analysis of accident data and any relevant information identified in Work Packages 1 and 2, for example based on observations of the systems. The analysis of accident data will include analysis of: company accident records, information provided in Reference 4 and relevant data from other sources, e.g. relevant RIDDOR data on accidents in other sectors.

2) The second approach will primarily involve the use of semi-structured brainstorming to supplement the initial list of hazards generated and ensure that the hazard identification studies are comprehensive and that there are no major gaps. The semi-structured brainstorming will be carried out by a team with expert knowledge of the anticipated hazards (for example, manual handling, workplace transport and slips, trips and falls).

In carrying out the hazard identification, both routine and non-routine operations and emergency or other more unusual situations will be considered. For example, hazards associated with collections during severe weather, or with reduced staffing levels as a result of sickness or at holiday times, or when volumes of waste or recycling are higher than usual (e.g. during public holidays), and with other similar non-routine operations will be considered.

Following hazard identification, the next step in the assessment will be to identify the possible range of consequences for each hazard. The consequence assessment will be carried out in parallel with the hazard identification, as the same approach is appropriate and the data sources and expertise requirements are the same. In identifying the consequences for each hazard, both safety related (i.e. fatality, major and minor injuries, e.g. broken bones, cuts etc.) and ill-health effects (acute and chronic, e.g. musculoskeletal disorders, inhalation exposure to dust, chemicals and bioaerosols, and dermal problems from exposure to chemicals and dusts) will be considered. At this stage it is the range of outcomes, the most likely and realistic worst case consequences that will be identified.

Following the hazard identification and consequence assessment, the probability and consequences will be rated for each hazard scenario, following the approach outlined in this report. Exposure frequency modification factors will also be estimated at this point.

A further step has also been suggested in this report to ensure that the exposure frequency modification factors are as reliable and robust as possible. That is a workshop is held with a representation of the industry in order to estimate the factors.

The above can be summarised into the following four stages:

- Stage 1 – initial hazard identification based on industry information, data and project observations;
- Stage 2 – hazard identification and consequence assessment based on a structured brainstorm approach; and
- Stage 3 – rating of hazard probability and consequences, and initial estimation of the exposure frequency modification factors via project team structured brainstorming; and
- Stage 4 – an industry workshop is held to derive the exposure frequency modification factors independently of those estimated at Stage 3.

In order to facilitate the identification of hazards at Stage 2 a list of injury mechanisms will be utilised where for each component, the team will consider how and whether someone could be harmed in the ways suggested. At least the following injury mechanisms will be considered:

- Crushed – whole body;
- Trapped – individual limbs;
- Entanglement;
- Falling (including slips and trips) whether at height or not;
- Being hit;
- Burned;
- Cut;
- Electric shock;
- Asphyxiation;
- Violence;
- Extreme heat;
- Extreme cold;
- Noise;
- Vibration;
- Musculoskeletal disorders;
- Exposure via inhalation, ingestion or puncture;
- Exposure via contact;
- Viral or bacterial infection; and

- Stress (plus physical effects).

In addition to the injury mechanisms, normal operation, perturbed operations, emergency situations and maintenance will be considered.

To assist with the rating of probability, consequence and estimation of exposure frequency modification factors a template has been devised to capture the required information and to capture any assumptions made; this is shown in Annex C4.

The overall hazard identification and assessment process will where necessary be repeated for each of the main waste and recyclables, as described in Appendix A. A different component will be set up for the different waste streams where the hazards differ or where the hazard ratings may differ.

C6 CONCLUSIONS AND RECOMMENDATIONS

C6.1 CONCLUSIONS

The methodology developed for the assessment of occupational health and safety risks of different waste and recyclables management systems has been described. Also described are the data requirements for this methodology, at a high-level what the methodology will do and look like, and some areas requiring further investigation.

Overall the methodology should allow LAs to compare the relative risk from different waste and recyclables management systems at various levels of detail from the hazard level to the system level. The methodology can only be used to compare the risk between systems when LA specific input data has been included. It would be inappropriate to use this methodology to produce a generic comparative assessment of different waste and recyclables systems.

C6.2 RECOMMENDATIONS

In order to ensure the tool is as robust as possible and has maximum utility as a decision-aiding tool, the following recommendations for further investigations are made:

1. A workshop is held with relevant representatives of industry to independently derive the exposure frequency modification factors and compare these with those estimated by the HSL team.

2. Further investigation is carried out, to determine the most appropriate size of the rating scale for exposure frequency, probability and consequence. Currently scales of 1 to 5 are proposed, but wider scales may be more appropriate.

3. Further investigation is carried out to determine whether the number of categories for the local factors is sufficiently sensitive, i.e. 3, and whether additional or different factors should be incorporated.

4. Testing of the approach is carried out using hypothetical examples by the project team to investigate sensitivity and potential usability of the approach.

5. Trials or validation is carried out in conjunction with a few Local Authorities, again to investigate sensitivity and potential usability of the approach.

6. The methodology is revised accordingly taking account of the above findings.

C7 ANNEX C1 – JUSTIFICATION FOR ADDITION OF RISK INDICES

Considering each element of risk discussed in Section 0, and presented in Tables C1 to C4, each can be expressed as follows:

Exposure frequency, $f = C_f \times 10^{fI}$

Conditional probability, $p = C_p \times 10^{pI}$

consequence, $c = C_c \times 10^{cI}$

where C_f, C_p and C_c are constants and fI, pI and cI are the frequency, probability and consequence rankings respectively. Risk can therefore be calculated as:

$$\begin{aligned}\text{risk} &= \text{frequency} \times \text{probability} \times \text{consequence} \\ &= C_f \times 10^{fI} \times C_p \times 10^{pI} \times C_c \times 10^{cI} \\ &= C_R \times 10^{RI}\end{aligned}$$

where C_R is a constant ($C_f \times C_p \times C_c$) and RI is the risk index.

As $10^x \times 10^y \times 10^z = 10^{(x+y+z)}$, the risk rating RI can be expressed as:

$$RI = fI + pI + cI$$

Adding the frequency, probability and consequence rankings only works if the changes in the frequency, probability and consequence estimates (as represented by the changes in their corresponding ranking numbers) are separated by the same factor, in this case 10.

C8 ANNEX C2 – OVERALL HAZARD RISK ESTIMATION

A risk rating will be calculated for each hazard as described in Section C3.3. For collection systems each hazard also has 27 scenarios associated with it (each with either an acute risk rating, a chronic risk rating or both). As discussed earlier, some of the scenario risk ratings will be based on direct estimates hard-wired into the risk assessment, whereas the others will be estimated based on these; this is illustrated in Section C8.1. From the scenario risk ratings, an overall risk rating will be derived for each hazard. This will be a weighted representative risk rating that takes into account the local features of the area of interest. How the effective risk rating is calculated is discussed in Section C8.2.

The effective risk rating for each hazard will then be combined, by summing, to give the overall risk rating for the component, sub-system or system. Combining the risk ratings for the collection and post-collection life cycle stages can be done as the rating scales have been chosen to give consistent risk ratings. However, it is important to stress that this will only be valid if all the waste and recyclables collected are considered in the post-collection assessment.

C8.1 DERIVING SCENARIO RISK ESTIMATES

As discussed in Section C3.3, in order to reduce the number of scenarios that are explicitly assessed, assessment is only carried out for a number of scenarios and the others are derived based on this. For the scenarios where the risk index is explicitly estimated, namely:

$$RI(m_1, e_1, h_1)$$

$$RI(m_3, e_1, h_1)$$

$$RI(m_1, e_1, h_3)$$

$$RI(m_3, e_1, h_3)$$

$$RI(m_1, e_3, h_1)$$

$$RI(m_3, e_3, h_1)$$

$$RI(m_1, e_3, h_3)$$

$$RI(m_3, e_3, h_3)$$

where m is the mass in receptacle with the subscript representing the mass category, 1 being light, 2 average and 3 heavy; e is the environmental risk with the subscript representing the risk category, 1 being low, 2 medium and 3 high; and h is the housing density with the subscript representing the housing density category, 1 being low density, 2 medium density and 3 high density. The risk indices (RIs) for the remaining scenarios can be calculated as an average of their neighbours, i.e.:

$$RI(m_1, e_1, h_2) = [RI(m_1, e_1, h_1) + RI(m_1, e_1, h_3)\ ] / 2$$

$$RI(m_3, e_1, h_2) = [RI(m_3, e_1, h_1) + RI(m_3, e_1, h_3)\ ] / 2$$

$$RI(m_2, e_1, h_1) = [RI(m_1, e_1, h_1) + RI(m_3, e_1, h_1)\ ] / 2$$

$$RI(m_2, e_1, h_2) = [RI(m_1, e_1, h_2) + RI(m_3, e_1, h_2)\ ] / 2$$

$$RI(m_2, e_1, h_3) = [RI(m_1, e_1, h_3) + RI(m_3, e_1, h_3)\ ] / 2$$

$RI(m_1, e_3, h_2) = [RI(m_1, e_1, h_1) + RI(m_1, e_1, h_3)] / 2$

$RI(m_3, e_3, h_2) = [RI(m_3, e_1, h_1) + RI(m_3, e_1, h_3)] / 2$

$RI(m_2, e_3, h_1) = [RI(m_1, e_1, h_1) + RI(m_3, e_1, h_1)] / 2$

$RI(m_2, e_3, h_2) = [RI(m_1, e_1, h_2) + RI(m_3, e_1, h_2)] / 2$

$RI(m_2, e_3, h_3) = [RI(m_1, e_1, h_3) + RI(m_3, e_1, h_3)] / 2$

$RI(m_1, e_2, h_1) = [RI(m_1, e_1, h_1) + RI(m_1, e_3, h_1)] / 2$

$RI(m_1, e_2, h_2) = [RI(m_1, e_1, h_2) + RI(m_1, e_3, h_2)] / 2$

$RI(m_1, e_2, h_3) = [RI(m_1, e_1, h_3) + RI(m_1, e_3, h_3)] / 2$

$RI(m_2, e_2, h_1) = [RI(m_1, e_1, h_1) + RI(m_3, e_3, h_1) + RI(m_1, e_3, h_1) + RI(m_3, e_1, h_1)] / 4$

$RI(m_2, e_2, h_2) = [RI(m_1, e_2, h_2) + RI(m_3, e_2, h_2)] / 2$

$RI(m_2, e_2, h_3) = [RI(m_1, e_1, h_3) + RI(m_3, e_3, h_3)] + RI(m_1, e_3, h_3) + RI(m_3, e_1, h_3)] / 4$

$RI(m_3, e_2, h_1) = [RI(m_3, e_1, h_1) + RI(m_3, e_3, h_1)] / 2$

$RI(m_3, e_2, h_2) = [RI(m_3, e_1, h_2) + RI(m_3, e_3, h_2)] / 2$

$RI(m_3, e_2, h_3) = [RI(m_3, e_1, h_3) + RI(m_3, e_3, h_3)] / 2$

C8.2 ESTIMATING OVERALL EFFECTIVE RISK

Part of the methodology will allow Local Authorities to assess the risk for specific systems and compare the risk for these systems, but having taken account of their local factors, for example the density of housing, weight of receptacles etc. To do this the distribution of a number of factors will be entered by the Local Authority and a weighted risk index will be calculated for each hazard taking account of the distribution of housing types, environmental factors and mass in receptacle. Assuming the factors used to weight the risk values across the scenarios are as shown in Table C6 then the overall weighted risk ranking, *ER*, can be expressed as shown in Equation C1.

Table C6 Local authority localisation factors

Housing density		***Mass in receptacle***			***Environmental risk***		
	Proportion	Light	Average	Heavy	Low	Medium	High
Low	P_1	$M_{1,1}$	$M_{2,1}$	$M_{3,1}$	$E_{1,1}$	$E_{1,2}$	$E_{1,3}$
Medium	P_2	$M_{1,2}$	$M_{2,2}$	$M_{3,2}$	$E_{2,1}$	$E_{2,2}$	$E_{2,3}$
High	P_3	$M_{1,3}$	$M_{2,3}$	$M_{3,3}$	$E_{3,1}$	$E_{3,2}$	$E_{3,3}$

$$ER = \sum_{i=1,3} \sum_{j=1,3} \sum_{k=1,3} P_k M_{i,k} E_{j,k} RI_{i,j,k} \tag{C1}$$

where:

$$\begin{gathered}
\sum_{k=1,3} P_k = 1 \\
\sum_{i=1,3} M_{i,1} = 1 \\
\sum_{i=1,3} M_{i,2} = 1 \\
\sum_{i=1,3} M_{i,3} = 1 \\
\sum_{j=1,3} E_{j,1} = 1 \\
\sum_{j=1,3} E_{j,2} = 1 \\
\sum_{j=1,3} E_{j,3} = 1
\end{gathered} \tag{C2}$$

C9 ANNEX C3 – ILLUSTRATION OF RISK ASSESSMENT METHODOLOGY

This appendix illustrates the mechanism of the risk assessment approach. It is stressed that the steps shown in this appendix are for illustrative purposes and will be automated and can be hidden away from the user of the methodology.

Assuming a collection system has one component with two hazards, hazard A and hazard B, where each hazard only had an acute outcome. The underlying hazard tables would then look something like that shown in Tables C7 and C8. The values in the white squares have been assessed by the HSL project team and those in yellow have been calculated as shown in Section C8.1.

Associated with this component are frequency modification factors of 1, 0.1, 0.05 for the low, medium and high housing densities respectively (applicable to both hazards).

The effective risk for each hazard can then be calculated based on Local Authority factors. The factors used for this illustrative example are shown in Tables C9 and C10.

Table C7 Completed hazard table for Hazard A

			Mass in receptacle											
			Light				**Average**				**Heavy**			
			Acute		**Chronic**		**Acute**		**Chronic**		**Acute**		**Chronic**	
		Housing Density	*Prob*	*cons*	*Prob*	*cons*	*Prob*	*cons*	*Prob*	*cons*	*Prob*	*cons*	*Prob*	*cons*
Environmental risk factor	**Low**	**Low**	2	2	*0*	*0*	*2.5*	*2.5*	*0*	*0*	3	3	*0*	*0*
		Medium	*2.5*	*2*	*0*	*0*	*2.75*	*2.5*	*0*	*0*	*3*	*3*	*0*	*0*
		High	3	2	*0*	*0*	*3*	*2.5*	*0*	*0*	3	3	*0*	*0*
	Medium	**Low**	*2.5*	*2.5*	*0*	*0*	*2.75*	*3*	*0*	*0*	*3*	*3.5*	*0*	*0*
		Medium	*2.75*	*2.75*	*0*	*0*	*3*	*3.125*	*0*	*0*	*3.25*	*3.5*	*0*	*0*
		High	*3*	*3*	*0*	*0*	*3.25*	*3.25*	*0*	*0*	*3.5*	*3.5*	*0*	*0*
	High	**Low**	3	3	*0*	*0*	*3*	*3.5*	*0*	*0*	3	4	*0*	*0*
		Medium	*3*	*3.5*	*0*	*0*	*3.25*	*3.75*	*0*	*0*	*3.5*	*4*	*0*	*0*
		High	3	4	*0*	*0*	*3.5*	*4*	*0*	*0*	4	4	*0*	*0*

Table C8 Completed hazard table for Hazard B

			Mass in receptacle											
			Light				**Average**				**Heavy**			
			Acute		**Chronic**		**Acute**		**Chronic**		**Acute**		**Chronic**	
		Housing Density	*Prob*	*cons*	*Prob*	*cons*	*Prob*	*cons*	*Prob*	*cons*	*Prob*	*cons*	*Prob*	*cons*
Environmental risk factor	**Low**	**Low**	1	1	*0*	*0*	*2*	*2*	*0*	*0*	3	3	*0*	*0*
		Medium	*1*	*1.5*	*0*	*0*	*2*	*2.25*	*0*	*0*	*3*	*3*	*0*	*0*
		High	1	2	*0*	*0*	*2*	*2.5*	*0*	*0*	3	3	*0*	*0*
	Medium	**Low**	*1.5*	*1.5*	*0*	*0*	*2.25*	*2.25*	*0*	*0*	*3*	*3*	*0*	*0*
		Medium	*1.5*	*2.25*	*0*	*0*	*2.25*	*2.75*	*0*	*0*	*3*	*3.25*	*0*	*0*
		High	*1.5*	*3*	*0*	*0*	*2.25*	*3.25*	*0*	*0*	*3*	*3.5*	*0*	*0*
	High	**Low**	2	2	*0*	*0*	*2.5*	*2.5*	*0*	*0*	3	3	*0*	*0*
		Medium	*2*	*3*	*0*	*0*	*2.5*	*3.25*	*0*	*0*	*3*	*3.5*	*0*	*0*
		High	2	4	*0*	*0*	*2.5*	*4*	*0*	*0*	3	4	*0*	*0*

Table C9 LA frequency inputs

		Housing density	**Set-out rate**
Number of houses in area of interest	**10000**	**Low**	**0.9**
Time period of interest	**1 year**	**Medium**	**0.8**
Number of collections per household in time period	**52**	**High**	**0.6**

Table C10 LA localisation factor inputs

		Mass in receptacle			Environmental risk		
Housing density	**Proportion**	**Light**	**Average**	**Heavy**	**Low**	**Medium**	**High**
Low	0.1	0.1	0.6	0.3	0.2	0.2	0.6
Medium	0.7	0.3	0.3	0.4	0.2	0.6	0.2
High	0.2	0.4	0.3	0.3	0.2	0.4	0.4

Table C11 Exposure frequency scale

Exposure frequency ranking	Exposure frequency (mid point)
1	52 or lower
2	Up to 520
3	Up to 5200
4	Up to 52000
5	Greater than 52000

Based on the data in Table C9, first the exposure frequency rating scale would be set, where N in Table C1 would be equal to 52 thousand (10000 × 52). The exposure frequency rating scale would then look like that shown in Table C11. The exposure frequency for the hazard can then be calculated utilising the data in Table C9 and applying the frequency modification factors. Thus because in the example a different modification factor has been given for each housing density category, the exposure frequency will vary as a function of housing density. Exposure frequency is calculated using the equation given in Section C3.1.1 as follows:

Low housing density

Exposure frequency = (10000 × 52) × 0.9 × 1 = 46800

Medium housing density

Exposure frequency = (10000 × 52) × 0.8 × 0.1 = 4160

High housing density

Exposure frequency = (10000 × 52) × 0.6 × 0.05 = 1560

This therefore leads to the following exposure frequency rating:

Low housing density:	4
Medium housing density:	3
High housing density:	3

These exposure frequency ratings can then be combined with the probability and consequence ratings given in Tables C7 and C8 to give a risk index for each scenario, remembering that the risk index for a scenario is calculated by summing the individual ratings (but doubling the consequence ratings). The resultant risk ratings are shown in Tables C12 and C13.

Table C12 Completed risk table for Hazard A

		Housing Density	**Mass in receptacle**					
			Light		**Average**		**Heavy**	
			Acute	*Chronic*	*Acute*	*Chronic*	*Acute*	*Chronic*
Environmental risk factor	**Low**	**Low**	10	*0*	11.5	*0*	13	*0*
		Medium	10.5	*0*	11.75	*0*	13	*0*
		High	11	*0*	12	*0*	13	*0*
	Med.	**Low**	10.5	*0*	11.75	*0*	13	*0*
		Medium	11.25	*0*	12.25	*0*	13.25	*0*
		High	12	*0*	12.75	*0*	13.5	*0*
	High	**Low**	12	*0*	13	*0*	14	*0*
		Medium	13	*0*	13.75	*0*	14.5	*0*
		High	14	*0*	14.5	*0*	15	*0*

Table C13 Completed risk table for Hazard B

		Housing Density	**Mass in receptacle**					
			Light		**Average**		**Heavy**	
			Acute	*Chronic*	*Acute*	*Chronic*	*Acute*	*Chronic*
Environmental risk factor	**Low**	**Low**	7	*0*	10	*0*	13	*0*
		Medium	8	*0*	10.5	*0*	13	*0*
		High	9	*0*	11	*0*	13	*0*
	Med.	**Low**	7.5	*0*	9.75	*0*	12	*0*
		Medium	9	*0*	10.75	*0*	12.5	*0*
		High	10.5	*0*	11.75	*0*	13	*0*
	High	**Low**	9	*0*	10.5	*0*	12	*0*
		Medium	11	*0*	12	*0*	13	*0*
		High	13	*0*	13.5	*0*	14	*0*

From Equation C1 in Section C8.2, it is seen that the weighting of a particular scenario can be expressed as:

$$P_k M_{i,k} E_{j,k} \tag{2}$$

where P_k, $M_{i,k}$ and $E_{j,k}$ are the LA localisation factor inputs (variables are defined in Table C6 (Section C8.1) and the values are given in Table C10 above). The weighting factors for each scenario can be calculated; the results of this are shown in Table C14.

Table C14 Weighting factors

		Housing Density	**Mass in receptacle**		
			Light	**Average**	**Heavy**
Environmental risk factor	**Low**	**Low**	0.002	0.012	0.006
		Medium	0.042	0.042	0.056
		High	0.016	0.012	0.012
	Med.	**Low**	0.002	0.012	0.006
		Medium	0.126	0.126	0.168
		High	0.032	0.024	0.024
	High	**Low**	0.006	0.036	0.018
		Medium	0.042	0.042	0.056
		High	0.032	0.024	0.024

Combining the values in Table C14 with the relevant risk values for each scenario for a specific hazard (either Table C12 or C13) gives the weighted risk ratings. Taking the sum of these weighted risk ratings for a specific hazard gives the overall effective risk rating for the hazard. Tables C15 and C16 show the weighted scenario risk ratings. The overall effective risk for the two hazards is then:

Hazard A: 12.7

Hazard B: 11.3.

Table C15 Weighted risk ratings for Hazard A

		Housing Density	**Mass in receptacle**					
			Light		**Average**		**Heavy**	
			Acute	*Chronic*	*Acute*	*Chronic*	*Acute*	*Chronic*
Environmental risk factor	**Low**	**Low**	0.02	0	0.138	0	0.078	0
		Medium	0.441	0	0.4935	0	0.728	0
		High	0.176	0	0.144	0	0.156	0
	Med.	**Low**	0.021	0	0.141	0	0.078	0
		Medium	1.4175	0	1.5435	0	2.226	0
		High	0.384	0	0.306	0	0.324	0
	High	**Low**	0.072	0	0.468	0	0.252	0
		Medium	0.546	0	0.5775	0	0.812	0
		High	0.448	0	0.348	0	0.36	0

Table C16 Weighted risk ratings for Hazard B

		Housing Density	**Mass in receptacle**					
			Light		**Average**		**Heavy**	
			Acute	*Chronic*	*Acute*	*Chronic*	*Acute*	*Chronic*
Environmental risk factor	**Low**	**Low**	0.014	0	0.12	0	0.078	0
		Medium	0.336	0	0.441	0	0.728	0
		High	0.144	0	0.132	0	0.156	0
	Med.	**Low**	0.015	0	0.117	0	0.072	0
		Medium	1.134	0	1.3545	0	2.1	0
		High	0.336	0	0.282	0	0.312	0
	High	**Low**	0.054	0	0.378	0	0.216	0
		Medium	0.462	0	0.504	0	0.728	0
		High	0.416	0	0.324	0	0.336	0

C10 ANNEX C4 – PROJECT TEAM RISK ESTIMATION SHEETS

Component assessment sheet

System		ID	
Subsystem			
Component			

Hazards	**ID**	**Consequences**	**Assumptions**

Collection systems only:

Housing density	**Exposure modification factor**
Low	
Medium	
High	

Justification:

Post-collection systems only

Exposure modification factor	

Justification

Other assumptions:

Hazard assessment sheet

System		
Subsystem		ID
Component		
Hazard		

For collection systems:

Scenario	**Consequence rating**			**Probability rating**	
	Acute	**Chronic**	**Justification**	**Rating**	**Justification**
#1					
#2					
#3					
#4					
#5					
#6					
#7					
#8					

Where the scenarios are defined by:

Low housing density

- #1 Lowest environment risk and lowest container mass scenario
- #2 Lowest environment risk and highest container mass scenario
- #3 Highest environmental risk and lowest container mass scenario
- #4 Highest environmental risk and highest container mass scenario

High housing density

- #5 Lowest environment risk and lowest container mass scenario
- #6 Lowest environment risk and highest container mass scenario
- #7 Highest environmental risk and lowest container mass scenario
- #8 Highest environmental risk and highest container mass scenario

For non-collection systems

Consequence rating			**Probability rating**	
Acute	**Chronic**	**Justification**	**Rating**	**Justification**

Other assumptions:

APPENDIX D POPULATION OF THE RISK COMPARATOR TOOL

D1 INTRODUCTION

Before the risk assessment methodology, outlined in Appendix C, can be utilised assessment of the generic factors needs to be undertaken. This will provide the probability and consequence ratings for each hazard scenario and will also provide an estimate of the hard-wired frequency modification factors.

The present appendix describes the work carried out for the fourth work package, that is to populate the Risk Comparator Tool for the various waste and recyclables management systems.

Thus, the aim of Work Package 4 is to carry out assessments of the occupational health and safety risks of the various system components identified in Work Package 2.

As outlined in Appendix C, Section C5, for each system to be assessed the following tasks will be completed:

- Estimate frequency modification factors for each component;
- Identify the hazards for each system component;
- For each hazard, identify the possible consequences;
- For collection systems, complete a hazard table for each of the hazards for each of the components;
- Assign probability and consequence (most likely) ratings for each scenario; and
- For post-collection systems assign a probability and consequence (most likely) rating for each hazard.

D1.1 OUTLINE APPROACH

The same general approach has been utilised to carry out each of the above tasks. This has involved:

- ***Analysis of available information*** – this has included analysis of information gathered during the observation of a range of systems, as outlined in Appendix B, discussion with operatives of the observed systems, analysis of any risk assessments, accident data and operating procedures that were provided from the operators of the systems observed and review of other relevant information, for example the analysis of RIDDOR accidents presented in the HSE Research Report 240 (Reference 4).
- ***Semi structured brainstorming*** – the HSL project team, supplemented by experts in particular areas, for example noise, vibration, manual handling, stress, violence, workplace transport, microbiology and pedestrian safety, utilised a structured brainstorming approach to supplement the information gathered at the analysis stage. This was carried out in order to ensure that the hazard identification study was comprehensive and had no major gaps. The same team brainstorming approach was also used to derive initial frequency modification factors, and probability and consequence ratings for each hazard.
- ***Sense checking the outputs*** – following initial population of the Risk Comparator Tool, the data in the tool was sense checked by the project team. This was carried out by

comparing the risk ratings for individual hazards across all the relevant activities and also by examining the overall hazard risk rating profile.

- ***Industry workshops*** – a number of workshops were held with representatives of the waste industry with the aim of validating the hazard ratings derived from the three stages above. Details of these workshops are presented in Annex D2.

The outcome of applying this approach is summarised in the following sections.

D1.2 STRUCTURE OF APPENDIX D

The remainder of this appendix is structured as follows:

- Section D2 describes derivation of the frequency modification factors;
- Section D3 presents the identification of hazards for each component/activity;
- Section D4 presents the probability and consequence ratings that were assigned to each hazard;
- Section D5 summarises the work carried out as part of Work Package 4;
- Annex D1 presents the hazard identification tables;
- Annex D2 provides background to the risk assessment workshops; and
- Annex D3 presents the final hazard probability and consequence ratings.

D2 ACTIVITY FREQUENCY MODIFICATION FACTORS

D2.1 INTRODUCTION

As described in Appendix C, Section C3.1.1, modification factors are required to adjust the baseline exposure frequency into an exposure frequency that is relevant for each component. A modification factor is therefore required for each component/activity. The baseline frequency for collection activities is the number of collections (for a defined area and a defined time period) and for post-collection activities is the total mass of waste collected (for the same area and time period).

The exposure frequency is calculated as follows:

Collection subsystems

Exposure frequency = number of households ×
number of collections (per defined period of time) ×
set-out rate (proportion) ×
activity specific modifier

Post-collection subsystems

Exposure frequency = tonnage of material (per defined period of time) ×
number of operations per tonne of material modifier

where the *number of households*, the *number of collections*, the *set-out rate* and the *tonnage of material* are LA specific inputs and the two modifiers are assumed to be generic and are described below. The derivation of the modification factors are presented for collection and post-collection components in Sections D2.2 and D2.3 respectively.

It is recommended that the modification factors are reviewed for each application of the Risk Comparator Tool as they have been derived based on observations, project team estimates and limited discussion with different parts of the industry and there will be variation in these factors for any specific site or operation.

The following generic assumptions are used in the derivation of the frequency modification factors presented in Sections D2.2 and D2.3:

- Number of houses collected from per shift: 350, 900 and 1200 in low, medium and high housing density
- Operatives per vehicle: 2, 2.5 and 3 in low, medium and high housing density
- Vehicle payloads: RCV – 11 tonnes
  Kerbsider – 6 tonnes
  Stillage vehicle – 3 tonnes
- Shovel loader bucket capacity: 1 tonne
- Large lorry payload: 30 tonnes.

D2.2 COLLECTION COMPONENTS

For collection components it is assumed that the frequency modification factors vary as a function of housing density. That is for the following three housing density categories, introduced in Section C3.2.3.1 (Appendix C), a separate modification factor can be specified:

Housing density	***Housing type***
Low	Small holdings and detached rural properties
Medium	Detached (urban), semi detached
High	Terraced and flats

The modification factors utilised in the risk tool are summarised in Table D1. Derivations of these factors are summarised below the table. Where not explicitly stated it has been assumed that only one person at a time is exposed to the hazards from the given activity.

Table D1 Collection modification factors

		Housing density		
Component		***Low***	***Medium***	***High***
1. Assembling of collection crew at start of shift and pre-round activities		0.0057	0.0028	0.0025
2. Driving from location to location		0.0057	0.0028	0.0025
3. Getting in and out of cab		2	0.033	0.0125
4. High-rise bags collect		N/A	N/A	1
5. Disposable bags collect		1	0.33	0.25
6. Reusable bags collect and bag return		1	1	1
7. Big wheeled bins collect and bin return	Euro	2	2	2
	Palladin	2	2	2
8. Food waste collect and receptacle return		1	1	1
9. Kerbside box collect and box return		1	1	1
10. Slave wheeled bin collect		N/A	0.14	0.14
11. Slave bag/box collect		N/A	0.5	0.5
12. Wheeled bin collect and bin return		1	1	1
13. Disposable bags empty		1	0.5	0.5
14. Reusable bags empty		1	1	1

		Housing density		
Component		***Low***	***Medium***	***High***
15. Big wheeled bins empty	Euro	2	2	2
	Palladin	2	2	2
16. Food waste empty		1	1	1
17. High-rise slave sacks empty		N/A	N/A	0.167
18. Wheeled bins empty		1	1	1
19. Kerbsider box sort and empty		1	1	1
20. Stillage vehicle box sort and empty (same operative collects and sorts[24])		1	1	1
21. Stillage vehicle box sort and empty (separate operative collects and sorts)		1	1	1
22. Slave wheeled bin empty		N/A	0.14	0.14
23. Walking to and from collection point		N/A	1	1
24. Operating vehicle machinery – RCV compaction		0.167	0.167	0.167
25. Operating vehicle machinery – Kerbsider hopper empty		0.05	0.05	0.05
26. Emptying collection vehicle		0.003	0.002	0.002

Assembling of collection crew at start of shift and pre-round activities – it is assumed that crew members assemble once per round. If there are *n* properties that are collected from on a round and *c* crew members then the collective number of assembly activities per household collection is given by *c*/*n*. Assuming that 350, 900 and 1200 properties are collected from a round of low, medium and high density housing respectively, and that there are 2, 2.5 and 3 operatives on average on rounds on low, medium and high density properties then the modification factors are calculated as follows:

Low density:	2/350 =	0.0057
Medium density:	2.5/900 =	0.0028
High density:	3/1200 =	0.0025

Driving from location to location – this is assumed to occur once per shift and captures the totality of the driving that occurs as part of a collection round. Taking account of the number of operatives on board, then the collective number of driving activities per household collection is the same as for the assembly of collection crew component.

---

[24] *The difference between same operative collects and sorts and separate operative sorts is in the former case the same operator collects the receptical then sorts and empties it, whereas in the latter case an operative collects the receptical then passes it to a different operative who sorts and empties it.*

Getting in and out of cab – the number of climbs per collection can be calculated as:

$$\frac{\text{number of climbs per shift x number of operatives}}{\text{number of collections per shift}}$$

Assuming the crew get out of the vehicle for every property for low density housing, 12 times per shift for medium density housing and 5 times per shift for high density housing then the modification factors are calculated as follows:

Low density:	350x2/350 =	2
Medium density:	12x2.5/900 =	0.033
High density:	5x3/1200 =	0.0125

High-rise bags collect – one bag is assumed to be collected per flat, which gives a factor of 1. It is noted that for this component the medium and low housing densities are not applicable.

Disposable bags collect – it is assumed that 3 to 4 bags are collected at a time in medium and high density housing, whereas 1 bag is collected at a time for low density housing. For high density housing this would equate to the operative getting one bag from the first property, before going to the next collecting that bag and so forth, before taking the four bags to the vehicle. Implicit in this assumption is that only one bag is left for collection per household. Therefore the number of trips to the collection vehicle per household is given by:

Low density:	1/1 =	1
Medium density:	1/3 =	0.33
High density:	1/4 =	0.25

Reusable bags collect and bag return – it is assumed that one person collects one bag, which gives a factor of 1. The housing density is considered to be irrelevant.

Euro or Palladin bins collect and bin return – it is assumed that two operatives would collect each bin, which gives a modification factor of 2.

Food waste collect and receptacle return – it is assumed that one person would collect one receptacle, which gives a factor of 1. The housing density is considered to be irrelevant.

Kerbside box collect and box return – it is assumed that one person would collect one box, which gives a factor of 1. The housing density is considered to be irrelevant.

Slave wheeled bin collect – it is assumed that the bin is emptied once per 7 collections. Therefore the activity of taking the slave bin to the collection vehicle occurs 1/7 times per household. It is also assumed that this modification factor is valid for both high and medium density housing, but is not applicable for low density housing. Note that exposure to certain hazards within this component will have to be increased by 7 as emptying a receptacle into the wheeled bin will occur once for every property.

Slave bag/box collect – this is analogous to the slave wheeled bin collect, except it is assumed that the slave container is emptied more often due to a smaller capacity. A factor of 1/2 has been assumed, that is the container is emptied once for every 2 properties.

Wheeled bin collect and return – it is assumed that one bin is collected at a time irrespective of the housing density. Therefore, the number of trips to the collection vehicle per household is assumed to be 1.

Disposable bags empty – it is assumed that an operative throws two bags, for medium and high housing density, and one bag at a time, for low density housing, into the collection vehicle. Therefore the number of emptying operations per household is given by:

Low density:	1/1 =	1
Medium density:	1/2 =	0.5
High density:	1/2 =	0.5

Reusable bags empty – it is assumed that an operative empties one reusable bag at a time, which gives a factor of 1. The housing density is considered to be irrelevant.

Euro or Palladin bins empty – it is assumed that two operatives would empty each bin, which gives a modification factor of 2.

Food waste empty – it is assumed that an operative would empty one food waste container at a time, which gives a factor of 1. The housing density is considered to be irrelevant.

High-rise slave sacks empty – it is assumed that each slave sack would contain the recyclables of about 6 flats on average. This would therefore equate to one emptying operation per 6 flats and a modification factor of 1/6. It is noted that for this component the medium and low housing densities are not applicable.

Wheeled bins empty – it is assumed that one bin is emptied at a time. Therefore the number of emptying operations per household is 1. The housing density is considered to be irrelevant.

Kerbsider box sort and empty – it is assumed that an operative empties one box at a time, which gives a factor of 1. The housing density is considered to be irrelevant.

Stillage vehicle box sort and empty (same operative collects and sorts) – it is assumed that an operative empties one box at a time, which gives a factor of 1. The housing density is considered to be irrelevant.

Stillage vehicle box sort and empty (separate operative collects and sorts) – it is assumed that an operative empties one box at a time, which gives a factor of 1. The housing density is considered to be irrelevant.

Slave wheeled bin empty – it is assumed that the bin is emptied on average once per 7 properties collected from, which gives a modification factor of 0.14. It is also assumed that this modification factor is valid for both high and medium density housing, but is not applicable for low density housing.

Walking to and from collection point – it is assumed that each operative walks once between each receptacle/property, which gives a modification factor of 1. This would be valid for both medium and high housing density, but would not be applicable for low housing density.

Operating vehicle machinery (RCV compaction) – it is assumed that the compaction on an RCV is operated on average once per 6 loads emptied into the vehicle, for wheeled bins or bags, which gives a modification factor of 1/6. This is assumed to be independent of housing density. Implicit in this assumption, for low housing density in particular, is that compaction does not have to be operated before the vehicle drives to the next collection point.

O*perating vehicle machinery (Kerbsider hopper empty)* – it is assumed that hoppers are emptied once every 30 minutes of collection, that between 30 and 50 (an average of 40) boxes are emptied in this time and 2 operatives are exposed to the hazards associated with this activity. This therefore gives the number of hopper empties per collection as 2/40 (0.05). The housing density is assumed to be irrelevant.

Emptying collection vehicle – for low density housing it is assumed that emptying occurs once per shift and that 350 properties are collected from per shift. For medium density housing it is assumed that emptying occurs twice per shift, and 900 houses are collected from in this time. For high density housing it is assumed that the collection vehicle is emptied 2 to 3 times (2.5 on average) per shift and that 1200 collections are made over the duration of an average shift. In all cases it is assumed that only one operative is exposed to the hazards from the emptying operation. Where this is not the case a modifier can be applied at the hazard level. Therefore the number of emptying operations per household is given by:

Low density:	1x1/350 =	0.003
Medium density:	1x2/900 =	0.002
High density:	1x2.5/1200 =	0.002

D2.3 POST-COLLECTION COMPONENTS

Tables D2 to D8 list the modification factors assumed for each post-collection subsystem. The assumptions made in their derivation are described below each table. In this case there is no variation with housing density as this was considered to be irrelevant. Therefore one modification factor is stated for each component.

It should be noted that the frequency of some components, particularly maintenance and general housekeeping, will vary dependent on the size of the processing plant and the number of staff involved in this activity at any one time. It is recommended that these are altered at the point of assessment. However, initial figures are proposed below and some of the modification factors are relative to these assumptions. For all systems it has been assumed that they process 100,000 tonnes per annum and 400 tonnes per day.

Where not explicitly stated it has been assumed that only one person at a time is exposed to the hazards from the given activity.

D2.3.1 Transfer/bulking station

It has been assumed that the transfer/bulking station processes 100,000 tonnes of material per annum.

Table D2 Transfer/bulking station modification factors

Component		*Modification factor*
1. Inward vehicle movements	RCV	0.09
	Stillage	0.33
	Kerbsider	0.17
2. Unloading vehicle	RCV	0.09
	Stillage	1.6
	Kerbsider	0.17
3. Handling heavy/hazardous waste		0.001
4. Loading lorries		1
5. Onward vehicle movements		0.033
6. General housekeeping		0.0025
7. Maintenance		0.0025

Inward vehicle movements (RCV) – for RCVs it is assumed that the vehicle comes into site tips its contents and leaves. Assuming that the average mass of contents in an RCV is 11 tonnes, then there are 1/11 movements (0.09) per tonne of material.

Inward vehicle movements (Stillage) – for Stillage vehicles there is huge variation in vehicle movements depending on the site and the vehicle design (number of stillages to be emptied). For example, on some sites the vehicle must go back to the weighbridge after each stillage has been removed. Assuming that the vehicle does not have to move between stillages being removed and that there is on average 3 tonnes of material on the Stillage vehicle, the modification factor is then 1/3 movements per tonne of material.

Inward vehicle movements (Kerbsider) – for Kerbsider vehicles, assuming that there are on average 6 tonnes of material brought onto site, the modification factor is then 1/6 movements per tonne of material.

Unloading vehicle – this is generally assumed to occur at the same frequency as with vehicle movements. The only exception is with Stillage vehicles where each stillage is unloaded one at a time. The number of stillages and the mass of material in each will vary depending on vehicle design and material collected. However, it is assumed that there are 4 to 6 stillages, each containing in the region of 0.5 to ¾ tonne of material (0.625 tonne average). Therefore the number of empties per tonne of material is assumed as 1.6 (1/0.62).

Handling of heavy/hazardous waste – this is assumed to occur very infrequently for each tonne of material handled and has been arbitrarily assumed to be once for every 1000 tonnes, giving a modification factor of 1/1000 (0.001) per tonne of material.

Loading lorries – it is assumed that the vehicle is loaded using a shovel loader and that each load of the shovel is of the order of 1 tonne. Therefore a modification factor of 1 loading operation per tonne of material can be assumed.

Onward vehicle movements – it is assumed that vehicles taking the material out of the transfer/bulking station have a capacity of 30 tonnes. Therefore a modification factor of 1/30 movements per tonne of material is assumed.

General housekeeping – it is assumed that the transfer/bulking station deals with 100,000 tonnes of material per annum, which equates to 400 tonnes per day and that housekeeping occurs once per day. Therefore housekeeping occurs 1/400 times per tonne of material.

Maintenance – it is assumed that the transfer/bulking station deals with 100,000 tonnes of material per annum, which equates to 400 tonnes per day and that maintenance occurs once per day. Therefore housekeeping occurs 1/400 times per tonne of material.

It should be noted that the frequency of the general housekeeping component will vary dependent on the size of the transfer/bulking station and the number of staff involved in this activity at any one time. It is recommended that these are altered at the point of assessment.

D2.3.2 MRF

It has been assumed that the MRF processes 400 tonnes of material per day.

Table D3 MRF modification factors

Component		***Modification factor***
1. Inward vehicle movements	RCV	0.09
	Artic	0.033
2. Unloading vehicle	RCV	0.09
	Artic	0.033
3. Pre-sorting materials		0.09
4. Loading material onto conveyors and mechanical sorting		1
5. Manual sorting		2
6. Baling materials		3
7. Storage of recovered factions	Fork-lift	1.4
	Shovel loader	1
8. Loading lorries	Fork-lift	1.4
	Shovel loader	1
9. Onward vehicle movements		0.033

Component	*Modification factor*
10. General housekeeping	0.0025
11. Maintenance	0.0025

Inward vehicle movements – for RCVs the same assumption has been made as with the transfer/bulking station. For articulated lorries it is assumed that the average load is 30 tonnes, giving 1/30 vehicle movements per tonne of material.

Unloading vehicle – this is assumed to occur at the same frequency as with vehicle movements, hence 1/11 and 1/30 for RCVs and articulated lorries respectively.

Pre-sorting materials – it has been assumed that this is carried out for each RCV equivalent load of material, i.e. once for every 11 tonnes of material, giving 1/11.

Loading material onto conveyors and mechanical sorting – it is assumed that a shovel loader is used to load the conveyors. If each shovel load weighs approximately 1 tonne, this leads to a modification factor of 1 load per tonne of material.

Manual sorting – it has been assumed that there is between 45 and 90 kg (average 70 kg) per hour per operative picked off a conveyor belt. Assuming an 8 hour shift, each operator would pick approximately 560 kg of material. As this is effectively a continuous process (very high frequency of repetitive actions) an action in this case has been equated to exposure over a shift. Therefore a modification factor of 2 (1.79) actions per tonne of material has been assumed.

Baling materials – the mass of the bales will depend on material type and be between 250 kg and 500 kg, but could be up to 1 tonne. Taking an average mass of 0.35 tonne, then there are 3 (2.86) baling operations per tonne of material.

Storage of recovered fractions and loading lorries – this is assumed to be carried out by fork-lift for baled materials and by shovel loader for loose materials. For baled material, taking an average bale mass of 0.35 tonne and assuming that 2 bales are loaded at a time, this gives 1.4 loading operation per tonne of material. Using the shovel loader, assuming a shovel load of 1 tonne, the number of loading actions per tonne is 1.

Onward vehicle movements – it is assumed that vehicles taking the material out of the transfer/bulking station have a capacity of 30 tonnes. Therefore a modification factor of 1/30 movements per tonne of material is assumed.

Maintenance – it is assumed that the MRF deals with 400 tonnes per day and that maintenance/cleaning (cleaning of equipment not general housekeeping) is carried out on a daily basis. This therefore gives 1/400 maintenance operations per tonne of material.

General housekeeping – it is assumed that housekeeping occurs once per day. If the MRF deals with 400 tonnes per day then the frequency of cleaning operations is 1/400 per tonne of material.

D2.3.3 MBT

It has been assumed that the MBT plant processes 400 tonnes of material per day.

Table D4 MBT plant modification factors

Component		*Modification factor*
1. Inward vehicle movements	RCV	0.09
	Artic	0.033
2. Unloading vehicle	RCV	0.09
	Artic	0.033
3. Visual inspection of waste		0.09
4. Loading material into sorting drum and mechanical sorting		1
5. Loading material into a vehicle		1
6. Unloading transfer vehicle at compost tunnel		0.1
7. Loading material into hopper		1
8. Opening and closing doors of in-vessel		0.1
9. Transferring material between vessels and to maturation pad		1
10. Inserting temperature probes		0.006
11. Turning windrows		0.0005
12. Loading material into screener/miller		1
13. Loading lorries		1
14. Onward vehicle movements		0.033
15. General housekeeping		0.0025
16. Maintenance		0.0025

Inward vehicle movements and unloading vehicle – the same factors have been assumed as with the MRF.

Visual inspection of waste – it has been assumed that this is carried out for each RCV equivalent load of material, i.e. once for every 11 tonnes of material, giving 1/11.

Loading material – it is assumed that, unless stated otherwise below, a shovel loader is used to load material. If each shovel load weighs approximately 1 tonne, this leads to a modification factor of 1 load per tonne of material.

Reversing / unloading of transfer vehicle at compost tunnel – it has been assumed that 10 tonnes of material is carried on the vehicle used to take material to the compost site, i.e. a tractor and trailer. Therefore this activity is carried out 1/10 times per tonne of material.

Opening and closing doors of in-vessel – these have been assumed to be opened and closed once for each load of material taken (i.e. 10 tonnes), giving 1/10 times per tonne of material.

Inserting temperature probes – each in-vessel is assumed to hold 165 tonnes of material with temperature probes being inserted once per vessel. This gives a modification factor of 1/165 per tonne of material. If this task is repeated at different points in the processing then this would have to be scaled up at the point of assessment.

Turning windrows – windrows are assumed to be turned about 5 times over the 3 months of processing, up to weekly. If it is assumed that 400 tonnes of material is delivered per day, then the amount of material added every 3 months is 26000 tonnes (5 days multiplied by 13 weeks multiplied by 400 tonnes). Therefore windrows are turned around 5/26000 times per tonne of material ($2x10^{-4}$). If weekly turning is assumed this gives 1/(400 x 5 tonnes per week) turning per tonne of material processed ($5x10^{-4}$). The most conservative of these two estimates has been taken.

Onward vehicle movements – it is assumed that vehicles taking the material out of the MBT plant have a capacity of 30 tonnes. Therefore a modification factor of 1/30 movements per tonne of material is assumed.

Maintenance and general housekeeping – modification factors derived for the MRF have been used here.

D2.3.4 In-vessel composting

It has been assumed that the in-vessel composting plant processes 100,000 tonnes of material per annum, which equates to 400 tonnes per day.

Table D5 In-vessel composting modification factors

Component		*Modification factor*
1. Inward vehicle movements	RCV	0.09
	Stillage	1.6
	Artic	0.033
2. Unloading vehicle	RCV	0.09
	Stillage	1.6
	Artic	0.033

Component	*Modification factor*
3. Manual pre-sorting	0.09
4. Loading material into shredder	1
5. Loading material into bulk container	1
6. Opening and closing doors of in-vessel	0.1
7. Loading first vessel	1
8. Transferring material between vessels and to maturation pad	1
9. Inserting temperature probes	0.006
10. Turning windrows	0.0005
11. Finished product taken to stockpiles	0.1
12. Screening material and bagging finished product	1
13. Loading lorries	1
14. Onward vehicle movements	0.033
15. General housekeeping	0.0025
16. Maintenance	0.0025

Inward vehicle movements and unloading vehicle – for RCVs and articulated lorries the same factors have been assumed as with the MRF. For Stillage vehicles it is assumed that one stillage weighing on average 0.625 tonnes contains compostables, the modification factor is then 1.6 movements per tonne of material.

Unloading collection vehicle – for RCVs and articulated lorries again the same factors have been assumed as with the MRF. For stillages it is assumed that one stillage contains compostables, weighing on average 0.625 tonnes, giving 1.6 (1/0.625) emptying operation per tonne of material.

Loading material – it is assumed that, unless stated otherwise below, a shovel loader is used to load material. If each shovel load weighs approximately 1 tonne, this leads to a modification factor of 1 load per tonne of material.

Opening and closing doors of in-vessel – these have been assumed to be opened and closed once for each load of material taken (i.e. 10 tonnes), giving 1/10 times per tonne of material, in line with the MBT assumption.

Inserting temperature probes – the same modification factor as derived for MBT has been assumed.

Turning windrows – the same modification factor as derived for MBT has been assumed.

Finished product taken to stockpiles – it has been assumed that this is by tractor and trailer having a capacity of 10 tonnes and therefore occurs 1/10 times per tonne of material.

Onward vehicle movements – it is assumed that vehicles taking the material out of the composting plant have a capacity of 30 tonnes. Therefore a modification factor of 1/30 movements per tonne of material is assumed.

General housekeeping – it is assumed that housekeeping occurs once per day. If the MRF deals with 400 tonnes per day then the frequency of cleaning operations is 1/400 per tonne of material.

Maintenance – it is assumed that the composting plant deals with 400 tonnes per day and that maintenance/cleaning (cleaning of equipment not general housekeeping) is carried out on a daily basis. This therefore gives 1/400 maintenance operations per tonne of material.

D2.3.5 Open windrow composting

It has been assumed that the open-windrow composting site processes 100,000 tonnes of material per annum, which equates to 400 tonnes per day.

Table D6 Open windrow composting modification factors

Component		***Modification factor***
1. Inward vehicle movements	RCV	0.09
	Artic	0.033
2. Unloading vehicle	RCV	0.09
	Artic	0.033
3. Manual pre-sorting		0.09
4. Loading material into shredder		1
5. Loading material into truck to be taken to windrows		1
6. Loading material onto windrow		0.1
7. Monitoring compost process (temperature/visual observations)		0.0025
8. Turning windrows		0.0005
9. Finished product taken to stockpiles		0.1
10. Screening material and bagging finished product		1
11. Loading lorries		1

Component	*Modification factor*
12. Onward vehicle movements	0.033
13. General housekeeping	0.0025
14. Maintenance	0.0025

The derivation of all modification factors are generally based on those described for in-vessel composting and, therefore, are not all reiterated here. The only points to note are:

Loading material onto windrow – it has been assumed that this is by tractor and trailer having a capacity of 10 tonnes, which can tip the material directly on the windrow. This, therefore, occurs 1/10 times per tonne of material.

Monitoring compost process – it has been assumed that this occurs once per day and given that the site is assumed to process 400 tonnes of material a day, it gives a modification factor of 1/400 times per tonne of material.

Finished product taken to stockpiles – again a tractor and trailer with 10 tonne capacity has been assumed, giving a modification factor of 0.1 per tonne. The loading of material by shovel loader would occur once per tonne assuming each shovel load is 1 tonne. Therefore for hazards relating to the loading as opposed to movement, a hazard modification factor of 10 would be required (these are described later in Section D4).

D2.3.6 Incineration

It has been assumed that the incinerator processes 100,000 tonnes of material per annum, which equates to 400 tonnes per day (based on a 5 day week, 50 week year).

Table D7 Incineration modification factors

Component		*Modification factor*
1. Inward vehicle movements	RCV	0.09
	Artic	0.033
2. Unloading vehicle	RCV	0.09
	Artic	0.033
3. Removal of large items of waste from feed chute		0.0005
4. Delivery of hazardous substances in bulk		0.0006
5. Removal of by-products		0.2
6. Onward vehicle movements		0.0067
7. General housekeeping		0.0025
8. Maintenance		0.0025

Inward vehicle movements and unloading vehicle – for RCVs and articulated lorries the same factors have been assumed as with the MRF.

Removal of large items of waste from feed chute – based on discussions with personnel at the observed incinerator, the frequency of this task varies from daily to yearly and is dependent on the quality of waste delivered. Therefore, an average weekly frequency of unblocking has been assumed. Given that 2000 tonnes of waste is assumed to be processed per week (400 x 5), the modification factor is calculated as 1/2000 unblocking operations per tonne of material.

Delivery of hazardous substances in bulk – from discussion with personnel at the observed incineration plant, the following deliveries are made: lime is delivered by tanker in 18 tonne loads with approximately five deliveries every two weeks; urea is delivered in one tonne bags with one delivery every two weeks of 22 tonnes; and activated carbon is delivered by tanker in 18 tonne loads, with approximately five deliveries per year. Therefore in total there are approximately 150 deliveries per year relative to a plant waste throughput of 250,000 tonnes of waste per year (for the observed plant). This gives a modification factor of 150/250000 deliveries per tonne of waste.

Removal of by-products – it is assumed that 200 kg of ash is produced per tonne of waste incinerated and that 1 tonne of ash is loaded onto a vehicle at a time. Therefore the number of shovel loads per tonne of waste processed equates to 1/5.

Onward vehicle movements – it is assumed that vehicles taking the material out of the incinerator have a capacity of 30 tonnes. Given that 1 tonne of ash is assumed to be produced for every 5 tonne of waste processed (see removal of by-products) a modification factor of 1/30 x 1/5 (0.0067) movements per tonne of material is assumed.

General housekeeping – it is assumed that housekeeping occurs once per day. If the incinerator deals with 400 tonnes per day then the frequency of housekeeping operations is 1/400 per tonne of material.

Maintenance – it is assumed that the incinerator deals with 400 tonnes of waste per day and that maintenance is carried out on a daily basis. This therefore gives 1/400 maintenance operations per tonne of material.

D2.3.7 Landfill

It has been assumed that the landfill site processes 100,000 tonnes of material per annum, which equates to 400 tonnes per day (based on a 5 day week, 50 week year).

Table D8 Landfill modification factors

Component	***Modification factor***
1. Driving on access road	0.09
2. Reversing	0.09
3. Tipping collection vehicle	0.09

4. Driving compaction vehicles	0.005
5. General housekeeping	0.0025
6. Maintenance	0.0025

Driving on access road – assuming vehicles are RCVs and that the average mass of contents in an RCV is 11 tonnes, then there are 1/11 movements (0.09) per tonne of material.

Reversing – 1/11 reversing operations per tonne of material in line with driving on the access road.

Tipping collection vehicle – 1/11 tipping operations per tonne of material in line with driving on the access road.

Driving compaction vehicles – as this is carried out continuously, it is assumed to be equivalent to one activity per day per compactor. Therefore taking the mass of material processed per day as 400 tonnes, and two compactors operating together, the number of compaction activities per tonne of material is 2/400.

General housekeeping – it is assumed that housekeeping occurs once per day. If the landfill deals with 400 tonnes of material per day then the frequency of housekeeping operations is 1/400 per tonne of material.

Maintenance – it is assumed that the landfill deals with 400 tonnes of waste per day and that maintenance is carried out on a daily basis. This therefore gives 1/400 maintenance operations per tonne of material.

D3 HAZARD IDENTIFICATION

D3.1 INTRODUCTION

Hazard identification relies on a structured and systematic approach to identify potential hazards. Therefore identification of hazards (to safety and health of workers) for each system component was carried in four stages. The purpose of the four stage approach was to ensure that the hazard identification was comprehensive with no major gaps.

Stage 1

An initial list of hazards for each component were generated from accident data, company risk assessments and any relevant information identified in Work Packages 1 and 2, for example based on observations of the systems. The accident data included analysis of: company accident records, where provided, information provided in the BOMEL report (Reference 4) and relevant data from other sources, e.g. relevant RIDDOR data on accidents in other sectors.

Stage 2

The second approach primarily involved the use of semi-structured brainstorming to supplement the initial list of hazards generated and ensure that the hazard identification studies were comprehensive and that there were no major gaps. The semi-structured brainstorming was carried out by a team with expert knowledge of the anticipated hazards (including: manual handling, workplace transport, slips, trips and falls, stress, microbiology). In carrying out the hazard identification, both routine and non-routine operations and emergency or other more unusual situations were considered. For example, hazards associated with collections during severe weather, or with reduced staffing levels as a result of sickness or at holiday times, or when volumes of waste or recycling are higher than usual (e.g. during public holidays), and with other similar non-routine operations were considered.

In order to facilitate the identification of hazards a list of injury mechanisms were utilised where, for each component, the team considered how and whether someone could be harmed in the ways suggested. At least the following injury mechanisms were considered:

- Crushed – whole body;
- Trapped – individual limbs;
- Entanglement;
- Falling (including slips and trips) whether at height or not;
- Being hit;
- Burned;
- Cut;
- Electric shock;
- Asphyxiation;
- Violence;
- Extreme heat;
- Extreme cold;

- Noise;
- Vibration;
- Musculoskeletal disorders;
- Exposure via inhalation, ingestion or puncture;
- Exposure via contact;
- Viral or bacterial infection; and
- Stress (plus physical effects).

During this stage the possible consequences for each hazard were identified. The consequence assessment was carried out in parallel with the hazard identification, as the same approach is appropriate and the data sources and expertise requirements are the same. In identifying the possible consequences for each hazard, consideration of both safety related (i.e. fatality, major and minor injuries, e.g. broken bones, cuts etc.) and ill-health effects (acute and chronic, e.g. musculoskeletal disorders, inhalation exposure to dust, chemicals and bioaerosols, and dermal problems from exposure to chemicals and dusts) was made. At this stage both the average (most likely) and the realistic worst case consequences were identified.

Stage 3

A workshop with representatives from industry, as outlined in Annex D2, was used to sense check the hazards identified as part of the first two stages. This utilised the knowledge in terms of operations, and health and safety of personnel from all aspects of the industry.

Stage 4

Review of the finalised hazard identification by attendees from the workshops and by the project Advisory Committee was used as a final sense check, mainly to ensure that information from the workshops was interpreted appropriately.

The following subsections summarise the results of the hazard identification study, which are then taken forward as the basis for probability and consequence assessment, as summarised in Section D4.

D3.1.1 Scope of hazard identification

The hazard identification has focused only on those waste and recyclables management systems that were recommended in Work Package 1, as summarised in Section A10.1. In addition, it must be stressed that every particular site will have features that may mean some hazards identified are irrelevant and indeed additional hazards exist. Where possible, therefore, a typical, large site has been assumed. The scope of the hazard identification has focused on the key activities associated with collection and processing of waste and recyclables. Activities at the periphery of this, such as engineering works at a landfill site to expand its capacity, or power production, have been assumed to be outside scope. It would therefore not be appropriate for a specific operator to utilise this hazard identification as a comprehensive hazard identification study for their operation or site. Notwithstanding this, it may still form a useful source of information for an operation or site.

D3.2 HAZARD IDENTIFICATION SUMMARY

The output from Stage 1 of the hazard identification process is summarised in Tables D9 to D14. Each table summarises the hazards as a function of the key activities for the subsystem considered. The only exceptions are:

- MBT plant, which is not shown as the hazards can be considered to be covered by those at an MRF (Table D11) and a composting site (Table D12); and
- Composting (Table D12), which combines the hazards at both in-vessel and open windrow composting.

Table D9 Collection hazard summary

Task	*Hazard/hazard outcome*
Assembling of collection crew at start of shift	• Workplace transport[25] – reversing activity in confined spaces, segregation of pedestrians and vehicles • Slips and trips – access / egress to cab, uneven surfaces in yard
Driving collection vehicle (from location to location)	• Workplace transport – risk of collision with other road users, driving during rush hour • Electrocution – from contact with low bridges / pylons (e.g. if hoppers raised) • Fatigue – e.g. early starts post weekend • Poor weather conditions
Getting in and out of the cab	• Fall from height • Crushing – falling from the cab and landing underneath the vehicle whilst still in motion • Slips and trips

Collection of receptacles
• Handling from presentation point to collection vehicle
• Emptying receptacle into vehicle
• Returning receptacle to household
	• Manual handling – pushing, pulling, lifting, carrying of heavy loads, highly repetitious task, non-neutral postures to empty receptacles, uneven surfaces / steps / kerbs, loss of control of loads (runaway bins)
	• Workplace transport:
	  ◦ Collection vehicle – reversing operations, risk of collision with other road users (unpredictable activity / high traffic density at rush hour, narrow / busy roads), collision with pedestrians/ operatives
	  ◦ Collection operatives – struck / crushed by collection vehicle, struck by other road traffic (e.g. when crossing road)
	• Struck by falling objects – struck by falling waste (e.g. during raising bins), struck by falling bins, struck by moving hopper (e.g. through mechanical failure)
	• Entanglement – risk of entanglement in RCV leading to limb injury/amputation
	• Slips and trips – access / egress to cab / other parts of vehicle, uneven road and pavement surfaces, handling up and down stairs
	• Cuts / lacerations – handling sharp objects concealed in waste
	• Microbiological hazards – needlestick injuries, chemical / hazardous substances, airborne particles

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[25] *A wider definition of workplace transport has been used here compared to HSE's definition. Here anywhere a vehicle hits a worker, wherever it is, it has been classed as a workplace transport issue.*

Task	*Hazard/hazard outcome*
	• Chemical hazards – exposure to chemicals which have been inappropriately discarded in waste/recyclable material • Noise – emptying hoppers into main body of vehicle, emptying receptacles into hoppers (e.g. glass) • Fatigue – long collection rounds, job and finish so run between receptacles, heavy receptacles • Violence from members of public – e.g. during very early morning collection • Risk of bite/scratch/sting from animals and insects
Walking from one presentation point to another	• Slips and trips • Workplace transport
Reversing activities / banksmen duties	• Crushing e.g. driver accidentally backing into the banksmen or the banksmen walking into oncoming traffic • Slips and trips – not being able to concentrate on where they are going, going up and down kerbs, uneven floor surface etc.
Operating of vehicle machinery/hydraulics	• Mechanical failure – e.g. failure of hydraulics, leads to manual intervention such as climbing on hopper, overloading axle of vehicle • Electrocution – due to lifting of hoppers into overhead power cables • Being hit by falling object – waste falling out of the hoppers / body of the machinery • Crushing
Emptying collection vehicle contents at drop-off point (e.g. transfer/bulking station, incinerator, landfill, MRF, MBT)	• Workplace transport – reversing operations: collision with other collection vehicles, collision / crushing of pedestrians, reversing too far into bay / pit (failure of CCTV) • Slips and trips – access / egress to cab • Noise – emptying main body of vehicle into bay / pit (especially for glass collections) • Cuts / lacerations – from shards of glass in bays and surrounding areas • Mechanical failure – e.g. failure of hydraulics, leads to manual intervention such as climbing on hopper
Re-fuelling of vehicle	• Fire
General hazards applicable to all stages of collection process	• Stress – long working hours, job and finish, highly repetitious tasks, negative dealings with public • Fatigue

Table D10 Transfer/bulking station hazard summary

Task	***Hazard/hazard outcome***
Reversing operations / banksmen duties	• Crushing e.g. driver accidentally backing into the banksmen, loss of line of sight, reversing too far into the tipping bay, limited space for manoeuvring • Slips and trips – not being able to concentrate on where they are going, uneven floor surface etc.
Unloading of collection vehicle contents at transfer site	• Workplace transport – collision with other vehicles, collision / crushing of operatives, reversing too far into bays (failure of CCTV) • Mechanical failure – e.g. failure of hydraulics, leads to manual intervention such as climbing on hopper • Noise – particularly of unloading glass / cans • Crushed – by content • Visibility – of operatives • Vehicle / stillages tipping over – e.g. when removing stillages from vehicle using fork-lift truck, risk of either vehicle or stillage tipping over if not loaded properly • Cuts / lacerations – unloading sharp objects, inappropriate choice of footwear
Getting in and out of the cab	• Fall from height – out of cabin • Crushing – falling from the cab and landing underneath the vehicle whilst still in motion • Slips and trips – in yard, if poor housekeeping
Handling of heavy / hazardous waste	• Manual handling – heavy items, such as fridges / freezers • Chemicals – e.g. oil, batteries
Loading of material into articulated lorries	• Workplace transport – use of shovel loader • Falls from height – sheeting of vehicle • Struck by object – material falling out of loader
Screening of material / sorting	• Covered under the MRF hazard write-up (Table D11)
General housekeeping	• Workplace transport – working in proximity to vehicles • Microbiological hazards – exposure to hazardous substances, airborne particles, dust • Slips and trips
General hazards applicable to all stages of collection process	• Stress / fatigue – long working hours • Weather conditions • Visibility – Operatives not visible due to lighting/lack of hi-visibility clothing, working early in morning so still dark • Dust

Table D11 MRF hazard summary

Task	***Hazard/hazard outcome***
Assembling of MRF operatives at start of shift	• Workplace transport – reversing activity in confined spaces, segregation of pedestrians and vehicles • Slips and trips – uneven surfaces in yard
Reversing operations of unloading vehicles / banksmen duties	• Crushing e.g. driver accidentally backing into the banksmen, loss of line of sight • Slips and trips – not being able to concentrate on where they are going, uneven floor surface etc.
Unloading of vehicle contents at drop-off point	• Workplace transport – reversing operations: collision with other collection vehicles, collision / crushing of operatives, reversing too far into bay (failure of CCTV). Lots of vehicles manoeuvring in a confined space • Slips and trips – in yard / reception area • Falls from height – access / egress to cab • Mechanical failure – e.g. failure of hydraulics, leads to manual intervention such as climbing on hopper • Cuts / lacerations – from unloading glass / tins, not wearing appropriate footwear • Noise – particularly during unloading of glass/cans
Getting in and out of the cab	• Fall from height – out of cabin • Crushing – falling from the cab and landing underneath the vehicle whilst still in motion • Slips and trips
Driving workplace transport (e.g. shovel loader, fork-lift truck)	• Vibration • Workplace transport – reversing operations: collision with other collection vehicles, collision / crushing of operatives • Poor weather conditions • Exposure to airborne hazards – cabs of vehicles used on-site fitted with air filters to remove particulate dust • Overloading forks – bales can fall
Loading of material onto conveyors for sorting (using shovel loader)	• Mechanical failure – e.g. failure of hydraulics on shovel arm or grab • Struck by falling debris – from loader • Microbiological hazards – exposure to hazardous substances, airborne particles
Maintenance / cleaning of balers and conveyors	• Entrapment in machinery • Crushing • Electrocution

Task	***Hazard/hazard outcome***
Manual sorting of material	• Cuts/lacerations – sharp objects / tins / needles may be present in the material to be sorted • Upper limb disorders – leaning forward over conveyor belt, out-stretched reach, highly repetitious, rapid line speeds • Lower limb disorders – standing in the same place for the duration of the day • Manual handling – pace of work controlled by machine • Noise – especially if no separate sorting cabin • Microbiological hazards – dust, no functioning air-conditioning, Weil's disease • Chemical hazards – chemical contamination in material presented • Pinching / entrapment in conveyor
Baling materials	• Entrapment in baling machine • Bales of bottles exploding • Struck by falling bales – stacked poorly
Loading of articulated lorry with unusable / sorted material (using shovel loader)	• Mechanical failure – e.g. failure of hydraulics on shovel arm or grab • Struck by falling debris – from loader • Workplace transport – visibility obstructed by lorries, risk of collision with other vehicles, lots of reversing activities
Securing of tarpaulin over the vehicle	• Fall from height – Requirement for driver to wear a harness attached to a fall arrest
Maintenance of automatic sorting / baling equipment	• Noise • Entrapment in machinery – e.g. unblock conveyors • Microbiological hazards – exposure to hazardous substances, airborne particles
General housekeeping duties	• Workplace transport – working in proximity to vehicles, need for high visibility clothing • Use of hazardous cleaning products • Microbiological hazards – exposure to hazardous substances, airborne particles • Inhalation of dust – droplet damping system used
General hazards applicable to all stages of process	• Stress – long working hours, highly repetitious tasks • Weather conditions – material deposited outside can be blown around on windy days – struck by flying objects • Visibility – Operatives not visible due to lighting/lack of hi-visibility clothing • Untrained staff – high staff turnover, use of agency staff (can be non-English speaking) • Slips and trips

Table D12 Composting hazard summary

Task	*Hazard/hazard outcome*
Assembling of composting operatives at start of shift	• Workplace transport – reversing activity in confined spaces, segregation of pedestrians and vehicles • Slips and Trips – uneven surfaces in yard
Reversing operations / banksmen duties	• Crushing e.g. driver accidentally backing into the banksmen, loss of line of sight • Slips and trips – not being able to concentrate on where they are going, uneven floor surface etc. • Poor weather conditions
Unloading of vehicle contents at drop-off point	• Workplace transport – reversing operations: collision with other collection vehicles, collision / crushing of operatives, reversing too far into bay, failure of CCTV • Slips and trips – access / egress to cab • Falls from height • Mechanical failure – e.g. failure of hydraulics, leads to manual intervention such as climbing on hopper
Getting in and out of the cab	• Fall from height – out of cabin • Crushing – falling from the cab and landing underneath the vehicle whilst still in motion • Slips and trips
Driving workplace transport vehicles (e.g. shovel loader, tractor)	• Vibration • Workplace transport – reversing operations: collision with other collection vehicles, collision / crushing of operatives • Mechanical failure – e.g. failure of hydraulics on shovel arm, leads to manual intervention • Poor weather conditions • Exposure to airborne hazards – cabs of vehicles used on-site fitted with air filters to remove particulate dust
Loading of material into screener / shredder (using shovel loader)	• Mechanical failure – e.g. failure of hydraulics on shovel arm • Struck by falling debris – from loading arm • Microbiological hazards – exposure to hazardous substances, airborne particles • Noise – screener / shredder in action can be very noisy – ear defenders are provided
Maintenance / cleaning of screening machine / shredding machine / loading machine (MBT)	• Entrapment in machinery – poor / no guarding, stop controls overridden • Microbiological hazards – exposure to hazardous substances, airborne particles
Loading of material into bulk container (using shovel loader)	• Falls from height – sheeting top of container on vehicle • Microbiological hazards – exposure to hazardous substances, airborne particles
Opening / closing door of in-vessel	• Microbiological hazards – exposure to hazardous substances, airborne particles • Door coming loose from attachment on shovel loader • Workplace transport – where manually opening doors, will be doing so in close proximity to workplace transport activity
Inserting temperature probes into top of in-vessel	• Falls from height – need to access roof of vessel to insert probes • Slips and trips

Task	***Hazard/hazard outcome***
Driving windrow turning machine	• Falls from height – on entering cabin
General housekeeping duties	• Workplace transport – working in proximity to vehicles, need for high visibility clothing • Use of hazardous cleaning products • Microbiological hazards – exposure to hazardous substances (leachate / wheel-wash, airborne particles) • Jet-washing floors – use high pressure hose • Cleaning of air holes – contaminant build up in holes, may be working near workplace transport
General hazards applicable to all stages of collection process	• Stress – long working hours, highly repetitious tasks • Fatigue • Weather conditions • Visibility – operatives not visible due to lighting/lack of hi-visibility clothing • Machinery operated automatically – parts of plant machinery operates automatically and may start up without warning; should be key lockout system • Biological agents / bioaerosols – during composting process

Table D13 Incineration hazard summary

Task	*Hazard/hazard outcome*
Reversing operations / banksmen duties	• Crushing e.g. driver accidentally backing into the banksmen / other operatives, loss of line of sight, reversing too far into the tipping bay, limited space for manoeuvring • Slips and trips – banksmen not being able to concentrate on where they are going (fall into pit), uneven floor surface etc.
Unloading of collection vehicle contents at drop-off point	• Workplace transport – reversing operations: collision with other collection vehicles, collision / crushing of operatives, reversing too far into bay (failure of CCTV), multiple vehicle movements in relatively small turning area • Mechanical failure – e.g. failure of hydraulics leads to manual intervention such as climbing on hopper
Getting in and out of the cab	• Fall from height – out of cabin • Crushing – falling from the cab and landing underneath the vehicle whilst still in motion • Slips and trips – in yard
Removal of large items of waste from feed chute using manually operated crane	• Struck by falling objects (from crane)
Delivery of hazardous substances in bulk (e.g. urea)	• Microbiological hazards – exposure to hazardous substances, airborne particles, urea / lime / activated carbon • Operatives manual feed into system – when auto system does not function • Chemical spills
Removal of ash by-product (loaded into articulated lorries using shovel loader)	• Dust – from large amounts of dust being produced • Workplace transport – collision with other vehicles, lots of movements within limited space
Securing of tarpaulin over the vehicle	• Falls from height – requirement for driver to wear a harness attached to a fall arrest
Removal of APC residue (loaded into articulated lorries using shovel loader)	• Dust – inhalation risk from large amounts of dust being produced • Workplace transport – collision with other vehicles, lots of movements within limited space
General housekeeping duties (e.g. sweeping tipping hall)	• Workplace transport – working in proximity to vehicles • Microbiological hazards – exposure to hazardous substances, airborne particles, urea / lime • Falling into waste pit – if operatives are working near edge of tipping bay, should clip onto rails at edge
Maintenance of incinerator components	• Noise – particularly in turbine room • Chemical spills • Entrapment in machinery • Microbiological hazards – exposure to hazardous substances, airborne particles
General hazards applicable to all stages of collection process	• Stress – long working hours, highly repetitious tasks • Fatigue • Visibility – operatives not visible due to lighting/lack of hi-visibility clothing • Dust – inhalation of airborne particles

Table D14 Landfill hazard summary

Task	***Hazard/hazard outcome***
Reversing operations / banksmen duties	• Crushing e.g. driver accidentally backing into the banksmen / operatives and loss of line of sight • Slips and trips – not being able to concentrate on where they are going, uneven floor surface etc.
Unloading of collection vehicle contents at landfill	• Workplace transport – reversing operations: collision with other vehicles, collision / crushing of operatives, reversing too far at tipping face (failure of CCTV) • Slips and trips – walking on landfill surface • Falls from height – access /egress to cab • Mechanical failure – e.g. failure of hydraulics, leads to manual intervention such as climbing on hopper • Driving over ill-defined area – possible poor visibility, collision risk • Vehicle becoming stuck in waste • Vehicle overturning – in high winds
Getting in and out of the cab	• Fall from height – out of cabin • Crushing – falling from the cab and landing underneath the vehicle whilst still in motion • Slips and trips – in yard, on landfill • Microbiological / chemical hazards – exposure to hazardous substances, airborne particles
Operation of large compaction vehicles	• Vibration – operatives spending long time operating vehicles on uneven surfaces • Poor visibility – collision with other vehicles / operatives unloading (not wearing hi visibility clothing)
Applying day cover of soil	• Microbiological / chemical hazards – exposure to hazardous substances, airborne particles • Poor visibility – apply cover at end of day, may be getting dark
Check leachate levels	• Fall from height – into leachate well • Slips and trips – walking on landfill • Chemical hazard – blast of methane gas during maintenance • Explosive atmosphere – pressure change in gas value in well
Litter picking	• Workplace transport – working in proximity to vehicles • Microbiological hazards – exposure to hazardous substances, airborne particles, dust • Slips and trips – walking on surface of landfill
General hazards applicable to all stages of collection process	• Stress – long working hours, highly repetitious tasks • Fatigue • Weather conditions • Visibility – operatives not visible due to lighting/lack of hi-visibility clothing • Dust

D3.3 FINAL HAZARD TABLES

This section includes the final hazard tables for each subsystem. Details on why hazards have or have not been included for a specific activity are described in Section D4 as part of the rating of each hazard. The hazard tables, Tables D25 to D53, that resulted from Stages 1 and 2 of the hazard identification process are listed in Annex D1. These tables show the initial hazard categories, the hazards captured within them, the range of consequences and harm outcomes, and assumptions and other information. A separate hazard table is shown for each different activity. It is noted that the range of activities included is not fully consistent with those finally assessed due to the progressive approach taken for the hazard identification. Following Stages 3 and 4 of the hazard identification further activities were included and others were modified due to discussion with representatives from the industry.

The following tables provide a cross reference between each activity and relevant hazard, where the hazard was assessed as presenting a non-trivial level of risk, for each of the subsystems within scope. These tables present the final view of the hazards as identified following the 4-stage process. It is this that forms the basis for the assessments described in Section D4. The discussion in Section D4 also clarifies the scope of each of the hazard categories.

- Table D15 – collection
- Table D16 – transfer/bulking station
- Table D17 – MRF
- Table D18 – MBT
- Table D19 – in-vessel composting
- Table D20 – open windrow composting
- Table D21 – incineration
- Table D22 – landfill

Table D15 Collection hazard matrix

Component		***Hazard category***																									
		Exposure to chemicals	***Collision with other vehicles***	***Exposure to dust***	***Exposure to electricity***	***Injured by moving mechanism***	***Falling objects (bins)***	***Falling objects (other)***	***Falling over (standing when vehicle moving)***	***Falls from height***	***Fire/explosion***	***Handling sharp objects***	***Exposure to extreme temperature and sunshine***	***High-pressure hose***	***Insects and vermin bites***	***Manual handling***	***Microbiological***	***Ejection of material***	***Noise***	***Other animals***	***Slips and trips***	***Stress***	***Minor trapping***	***Vehicle tipping over***	***Vibration***	***Violence***	***Workplace transport***
1. Assembling of collection crew at start of shift and pre-round activities		√	√		√	√				√				√					√		√	√	√				√
2. Driving from location to location			√					√	√	√[26]	√		√									√		√	√	√	√
3. Getting in and out of cab										√											√		√				√
4. High-rise bags collect		√		√						√		√	√		√	√	√			√	√	√				√	
5. Disposable bags collect		√								√		√	√		√	√	√			√	√	√				√	√
6. Reusable bags collect and bag return		√								√		√	√		√	√	√			√	√	√				√	√
7. Big wheeled bins collect and bin return	Euro	√					√	√				√	√		√	√	√			√	√	√	√			√	√
	Palladin	√					√	√				√	√		√	√	√			√	√	√	√			√	√

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[26] *Two scenarios are captured here –falls whilst riding on vehicle tailgate and falls whilst riding on Stillage vehicle body.*

	Hazard category																									
Component	***Exposure to chemicals***	***Collision with other vehicles***	***Exposure to dust***	***Exposure to electricity***	***Injured by moving mechanism***	***Falling objects (bins)***	***Falling objects (other)***	***Falling over (standing when vehicle moving)***	***Falls from height***	***Fire/explosion***	***Handling sharp objects***	***Exposure to extreme temperature and sunshine***	***High-pressure hose***	***Insects and vermin bites***	***Manual handling***	***Microbiological***	***Ejection of material***	***Noise***	***Other animals***	***Slips and trips***	***Stress***	***Minor trapping***	***Vehicle tipping over***	***Vibration***	***Violence***	***Workplace transport***
8. Food waste collect and receptacle return									√			√		√	√	√			√	√	√				√	√
9. Kerbside box collect and box return									√			√		√	√	√			√	√	√				√	√
10. Slave wheeled bin collect	√		√			√					√	√		√	√	√		√	√	√	√	√			√	√
11. Slave bag/box collect	√		√								√	√		√	√	√		√	√	√	√				√	√
12. Wheeled bin collect and bin return	√					√			√		√	√		√	√	√			√	√	√	√			√	√
13. Disposable bags empty											√	√		√	√	√			√	√	√				√	√
14. Reusable bags empty	√		√						√		√	√		√	√	√			√	√	√				√	√
15. Big wheeled bins empty Euro			√		√	√							√	√	√	√		√	√	√	√	√			√	√
Palladin			√		√	√							√	√	√	√		√	√	√	√	√			√	√
16. Food waste empty									√			√		√	√	√			√	√	√				√	√

	Hazard category																									
Component	**Exposure to chemicals**	**Collision with other vehicles**	**Exposure to dust**	**Exposure to electricity**	**Injured by moving mechanism**	**Falling objects (bins)**	**Falling objects (other)**	**Falling over (standing when vehicle moving)**	**Falls from height**	**Fire/explosion**	**Handling sharp objects**	**Exposure to extreme temperature and sunshine**	**High-pressure hose**	**Insects and vermin bites**	**Manual handling**	**Microbiological**	**Ejection of material**	**Noise**	**Other animals**	**Slips and trips**	**Stress**	**Minor trapping**	**Vehicle tipping over**	**Vibration**	**Violence**	**Workplace transport**
17. High-rise slave sacks empty												√		√	√	√			√	√	√				√	√
18. Wheeled bins empty			√		√	√							√	√	√	√		√	√	√	√	√			√	√
19. Kerbsider box sort empty	√										√	√		√	√	√	√	√	√	√	√	√			√	
20. Stillage box sort and empty (same operative collects and sorts)	√						√		√		√	√		√	√	√	√	√	√	√	√	√			√	√
21. Stillage box sort and empty (separate operative collects and sort)	√						√	√	√		√	√		√	√	√	√	√	√	√	√	√			√	√
22. Slave wheeled bin empty			√		√	√							√	√	√	√		√	√	√	√	√			√	√
23. Walking to and from collection point												√				√			√	√	√				√	√
24. Operating vehicle machinery – RCV compaction					√								√	√		√	√	√	√		√				√	

Component	Hazard category																								
	Exposure to chemicals	*Collision with other vehicles*	*Exposure to dust*	*Exposure to electricity*	*Injured by moving mechanism*	*Falling objects (bins)*	*Falling objects (other)*	*Falling over (standing when vehicle moving)*	*Falls from height*	*Fire/explosion*	*Handling sharp objects*	*Exposure to extreme temperature and sunshine*	*High-pressure hose*	*Insects and vermin bites*	*Manual handling*	*Microbiological*	*Ejection of material*	*Noise*	*Other animals*	*Slips and trips*	*Stress*	*Minor trapping*	*Vehicle tipping over*	*Vibration*	*Violence*	*Workplace transport*
25. Operating vehicle machinery – Kerbsider hopper empty				√	√								√	√				√	√		√				√	
26. Emptying collection vehicle		√	√		√		√		√				√	√		√		√		√		√	√		√	√

Table D16 Transfer/bulking station hazard matrix

		Hazard category																								
Component		***Chemical***	***Collision with other vehicles***	***Exposure to dust***	***Exposure to electricity***	***Moving mechanism***	***Falling objects***	***Falls from height***	***Fire and explosion***	***Handling sharp objects***	***Exposure to extreme temperature and sunshine***	***High-pressure hose***	***Hot pipe work and steam***	***Insects and vermin bites***	***Manual handling***	***Exposure to methane gas***	***Microbiological***	***Ejection of material***	***Noise***	***Slips and trips***	***Stress***	***Minor trapping***	***Vehicle tipping over***	***Vibration***	***Violence***	***Workplace transport***
1. Inward vehicle movements	RCV		√					√												√			√			√
	Stillage		√					√												√			√			√
	Kerbsider		√					√												√			√			√
2. Unloading vehicle	RCV			√		√	√	√				√		√			√		√	√		√	√		√	√
	Stillage		√	√		√	√	√				√		√			√		√	√		√	√	√	√	√
	Kerbsider			√		√	√	√				√		√			√		√	√		√	√		√	√
3. Handling heavy/hazardous waste		√				√	√		√	√	√			√	√		√					√	√	√		√
4. Loading lorries			√	√			√	√									√		√	√	√	√	√	√		√
5. Onward vehicle movements			√					√												√		√				√
6. General housekeeping		√		√	√			√		√	√	√		√	√		√		√	√		√				√

	Hazard category																										
Component	***Chemical***	***Collision with other vehicles***	***Exposure to dust***	***Exposure to electricity***	***Moving mechanism***	***Falling objects***	***Falls from height***	***Fire and explosion***	***Handling sharp objects***	***Exposure to extreme temperature and sunshine***	***High-pressure hose***	***Hot pipe work and steam***	***Insects and vermin bites***	***Manual handling***	***Exposure to methane gas***	***Microbiological***	***Ejection of material***	***Noise***	***Slips and trips***	***Stress***	***Minor trapping***	***Vehicle tipping over***	***Vibration***	***Violence***	***Workplace transport***
7. Maintenance	√		√	√	√	√	√	√	√	√	√		√	√		√		√	√	√	√				

Table D17 MRF hazard matrix

			Hazard category																								
Component			***Chemical***	***Collision with other vehicles***	***Exposure to dust***	***Exposure to electricity***	***Moving mechanism***	***Falling objects***	***Falls from height***	***Fire and explosion***	***Handling sharp objects***	***Exposure to extreme temperature and sunshine***	***High-pressure hose***	***Hot pipe work and steam***	***Insects and vermin bites***	***Manual handling***	***Exposure to methane gas***	***Microbiological***	***Ejection of material***	***Noise***	***Slips and trips***	***Stress***	***Minor trapping***	***Vehicle tipping over***	***Vibration***	***Violence***	***Workplace transport***
1.	Inward vehicle movements	RCV		√					√												√			√			√
		Artic		√					√												√			√			√
2.	Unloading vehicle	RCV			√		√	√	√				√		√					√	√		√	√		√	√
		Artic			√		√	√	√				√		√					√	√		√	√		√	√
3.	Pre-sorting materials		√		√						√				√	√		√		√	√	√					√
4.	Loading material onto conveyors and mechanical sorting			√	√		√	√	√	√								√		√		√	√	√	√		√
5.	Manual sorting		√		√		√	√			√				√	√		√		√	√	√	√				
6.	Baling materials			√	√		√	√	√	√						√		√	√	√	√		√	√	√		√

Component			***Hazard category***																								
			Chemical	***Collision with other vehicles***	***Exposure to dust***	***Exposure to electricity***	***Moving mechanism***	***Falling objects***	***Falls from height***	***Fire and explosion***	***Handling sharp objects***	***Exposure to extreme temperature and sunshine***	***High-pressure hose***	***Hot pipe work and steam***	***Insects and vermin bites***	***Manual handling***	***Exposure to methane gas***	***Microbiological***	***Ejection of material***	***Noise***	***Slips and trips***	***Stress***	***Minor trapping***	***Vehicle tipping over***	***Vibration***	***Violence***	***Workplace transport***
7.	Storage of recovered fractions	Fork-lift		√			√	√	√									√		√		√	√	√	√		√
		Shovel loader		√	√			√	√									√		√		√	√	√	√		√
8.	Loading lorries	Fork-lift		√			√	√	√									√		√		√	√	√	√		√
		Shovel loader		√	√			√	√									√		√		√	√	√	√		√
9.	Onward vehicle movements			√					√												√						√
10.	General housekeeping		√		√	√			√		√	√	√		√	√		√		√	√		√				√
11.	Maintenance		√		√	√	√	√	√	√	√	√	√		√	√		√		√	√	√	√				

Table D18 MBT hazard matrix

			Hazard category																								
Component			***Chemical***	***Collision with other vehicles***	***Exposure to dust***	***Exposure to electricity***	***Moving mechanism***	***Falling objects***	***Falls from height***	***Fire and explosion***	***Handling sharp objects***	***Exposure to extreme temperature and sunshine***	***High-pressure hose***	***Hot pipe work and steam***	***Insects and vermin bites***	***Manual handling***	***Exposure to methane gas***	***Microbiological***	***Ejection of material***	***Noise***	***Slips and trips***	***Stress***	***Minor trapping***	***Vehicle tipping over***	***Vibration***	***Violence***	***Workplace transport***
1.	Inward vehicle movements	RCV		√					√												√			√			√
		Artic		√					√												√			√			√
2.	Unloading vehicle	RCV			√		√	√	√				√		√			√		√	√		√	√		√	√
		Artic			√		√	√	√				√		√			√		√	√		√	√		√	√
3.	Visual inspection of waste		√		√						√				√	√		√		√		√					√
4.	Loading material into sorting drum and mechanical sorting			√	√		√	√	√	√								√		√		√	√	√	√		√
5.	Loading of material into a vehicle			√	√			√	√									√		√		√	√	√	√		√
6.	Unloading transfer vehicle at compost tunnel			√	√				√									√		√			√	√	√		√
7.	Loading material into hopper			√	√			√	√									√		√		√	√	√	√		√

	Hazard category																								
Component	***Chemical***	***Collision with other vehicles***	***Exposure to dust***	***Exposure to electricity***	***Moving mechanism***	***Falling objects***	***Falls from height***	***Fire and explosion***	***Handling sharp objects***	***Exposure to extreme temperature and sunshine***	***High-pressure hose***	***Hot pipe work and steam***	***Insects and vermin bites***	***Manual handling***	***Exposure to methane gas***	***Microbiological***	***Ejection of material***	***Noise***	***Slips and trips***	***Stress***	***Minor trapping***	***Vehicle tipping over***	***Vibration***	***Violence***	***Workplace transport***
8. Opening and closing doors of in-vessel		√														√		√				√	√		√
9. Transferring material between vessels and to maturation pad		√	√			√	√									√		√		√	√	√	√		√
10. Inserting temperature probes							√						√	√		√		√	√		√				
11. Turning windrows		√	√				√									√		√		√	√	√	√		
12. Loading material into screener/miller		√	√		√	√	√									√	√	√		√	√	√	√		√
13. Loading lorries		√	√			√	√									√		√	√	√	√	√	√		√
14. Onward vehicle movements		√					√												√		√				√
15. General housekeeping	√		√	√			√		√	√	√		√	√		√		√	√		√				√
16. Maintenance	√		√	√	√	√	√	√	√	√	√		√	√	√	√		√	√	√	√				

Table D19 In-vessel composting hazard matrix

			Hazard category																								
Component			***Chemical***	***Collision with other vehicles***	***Exposure to dust***	***Exposure to electricity***	***Moving mechanism***	***Falling objects***	***Falls from height***	***Fire and explosion***	***Handling sharp objects***	***Exposure to extreme temperature and sunshine***	***High-pressure hose***	***Hot pipe work and steam***	***Insects and vermin bites***	***Manual handling***	***Exposure to methane gas***	***Microbiological***	***Ejection of material***	***Noise***	***Slips and trips***	***Stress***	***Minor trapping***	***Vehicle tipping over***	***Vibration***	***Violence***	***Workplace transport***
1.	Inward vehicle movements	RCV		√					√												√			√			√
		Stillage		√					√												√			√			√
		Artic		√					√												√			√			√
2.	Unloading vehicle	RCV			√		√	√	√				√		√			√		√			√	√		√	√
		Stillage		√	√		√	√	√				√		√			√		√	√		√	√		√	√
		Artic			√		√	√	√				√		√			√		√			√	√		√	√
3.	Manual pre-sorting		√		√						√				√	√		√		√	√	√					√
4.	Loading material into shredder			√	√		√	√	√									√	√	√		√	√	√	√		√
5.	Loading material into bulk container			√	√			√	√									√		√		√	√	√	√		√
6.	Opening and closing doors of in-vessel			√														√		√				√	√		√

	Hazard category																								
Component	***Chemical***	***Collision with other vehicles***	***Exposure to dust***	***Exposure to electricity***	***Moving mechanism***	***Falling objects***	***Falls from height***	***Fire and explosion***	***Handling sharp objects***	***Exposure to extreme temperature and sunshine***	***High-pressure hose***	***Hot pipe work and steam***	***Insects and vermin bites***	***Manual handling***	***Exposure to methane gas***	***Microbiological***	***Ejection of material***	***Noise***	***Slips and trips***	***Stress***	***Minor trapping***	***Vehicle tipping over***	***Vibration***	***Violence***	***Workplace transport***
7. Loading first vessel		√	√			√	√									√		√		√	√	√	√		√
8. Transferring material between vessels and to maturation pad		√	√			√	√									√		√		√	√	√	√		√
9. Inserting temperature probes							√						√	√		√		√	√		√				
10. Turning windrows		√	√				√									√		√		√	√	√	√		
11. Finished product taken to stockpiles		√	√			√	√									√		√		√	√	√	√		√
12. Screening material and bagging finished product		√	√		√	√	√							√		√		√	√	√	√	√	√		√
13. Loading lorries		√	√			√	√									√		√		√	√	√	√		√
14. Onward vehicle movements		√					√												√		√				√
15. General housekeeping	√		√	√			√		√	√	√		√	√		√		√	√		√				√

Component	*Hazard category*																								
	Chemical	***Collision with other vehicles***	***Exposure to dust***	***Exposure to electricity***	***Moving mechanism***	***Falling objects***	***Falls from height***	***Fire and explosion***	***Handling sharp objects***	***Exposure to extreme temperature and sunshine***	***High-pressure hose***	***Hot pipe work and steam***	***Insects and vermin bites***	***Manual handling***	***Exposure to methane gas***	***Microbiological***	***Ejection of material***	***Noise***	***Slips and trips***	***Stress***	***Minor trapping***	***Vehicle tipping over***	***Vibration***	***Violence***	***Workplace transport***
16. Maintenance	√		√	√	√	√	√	√	√	√	√		√	√	√	√		√	√	√	√				

Table D20 Open windrow composting hazard matrix

		Hazard category																								
Component		***Chemical***	***Collision with other vehicles***	***Exposure to dust***	***Exposure to electricity***	***Moving mechanism***	***Falling objects***	***Falls from height***	***Fire and explosion***	***Handling sharp objects***	***Exposure to extreme temperature and sunshine***	***High-pressure hose***	***Hot pipe work and steam***	***Insects and vermin bites***	***Manual handling***	***Exposure to methane gas***	***Microbiological***	***Ejection of material***	***Noise***	***Slips and trips***	***Stress***	***Minor trapping***	***Vehicle tipping over***	***Vibration***	***Violence***	***Workplace transport***
1. Inward vehicle movements	RCV		√					√												√			√			√
	Artic		√					√												√			√			√
2. Unloading vehicle	RCV			√		√	√	√				√		√			√		√	√		√	√		√	√
	Artic			√		√	√	√				√		√			√		√	√		√	√		√	√
3. Manual pre-sorting		√		√				√		√				√	√		√		√	√	√					√
4. Loading material into shredder			√	√		√	√	√									√	√	√		√	√	√	√		√
5. Loading material into truck to be taken to windrows			√	√			√	√									√		√		√	√	√	√		√
6. Loading material onto windrow			√	√			√	√									√		√			√	√	√		√

	Hazard category																								
Component	***Chemical***	***Collision with other vehicles***	***Exposure to dust***	***Exposure to electricity***	***Moving mechanism***	***Falling objects***	***Falls from height***	***Fire and explosion***	***Handling sharp objects***	***Exposure to extreme temperature and sunshine***	***High-pressure hose***	***Hot pipe work and steam***	***Insects and vermin bites***	***Manual handling***	***Exposure to methane gas***	***Microbiological***	***Ejection of material***	***Noise***	***Slips and trips***	***Stress***	***Minor trapping***	***Vehicle tipping over***	***Vibration***	***Violence***	***Workplace transport***
7. Monitoring compost process (temperature/visual observations)													√	√		√			√						√
8. Turning windrows		√	√				√									√		√		√	√	√	√		
9. Finished product taken to stockpiles		√	√			√	√									√		√		√	√	√	√		√
10. Screening material and bagging finished product		√	√		√	√	√							√		√		√	√	√	√	√	√		√
11. Loading lorries		√	√			√	√									√		√	√	√	√	√	√		√
12. Onward vehicle movements		√					√												√		√				√
13. General housekeeping	√		√	√			√		√	√	√		√	√		√		√	√		√				√
14. Maintenance	√		√	√	√	√	√	√	√	√	√		√	√	√	√		√	√	√	√				

Table D21 Incineration hazard matrix

		Hazard category																								
Component		***Chemical***	***Collision with other vehicles***	***Exposure to dust***	***Exposure to electricity***	***Moving mechanism***	***Falling objects***	***Falls from height***	***Fire and explosion***	***Handling sharp objects***	***Exposure to extreme temperature and sunshine***	***High-pressure hose***	***Hot pipe work and steam***	***Insects and vermin bites***	***Manual handling***	***Exposure to methane gas***	***Microbiological***	***Ejection of material***	***Noise***	***Slips and trips***	***Stress***	***Minor trapping***	***Vehicle tipping over***	***Vibration***	***Violence***	***Workplace transport***
1. Inward vehicle movements	RCV		√					√												√			√			√
	Artic		√					√												√			√			√
2. Unloading vehicle	RCV			√		√	√	√				√		√			√		√	√		√	√		√	√
	Artic			√		√	√	√				√		√			√		√	√		√	√		√	√
3. Removal of large items of waste from feed chute																	√		√					√		
4. Delivery of hazardous substances in bulk		√	√			√		√	√						√		√		√	√		√				√
5. Removal of by-products			√	√			√	√									√		√	√	√	√	√	√		√
6. Onward vehicle movements			√					√												√		√				√
7. General housekeeping		√		√	√			√		√	√	√	√	√	√		√		√	√		√				√

	Hazard category																								
Component	***Chemical***	***Collision with other vehicles***	***Exposure to dust***	***Exposure to electricity***	***Moving mechanism***	***Falling objects***	***Falls from height***	***Fire and explosion***	***Handling sharp objects***	***Exposure to extreme temperature and sunshine***	***High-pressure hose***	***Hot pipe work and steam***	***Insects and vermin bites***	***Manual handling***	***Exposure to methane gas***	***Microbiological***	***Ejection of material***	***Noise***	***Slips and trips***	***Stress***	***Minor trapping***	***Vehicle tipping over***	***Vibration***	***Violence***	***Workplace transport***
8. Maintenance	√		√	√	√	√	√	√	√	√	√	√	√	√		√		√	√	√	√				

Table D22 Landfill hazard matrix

Component	*Hazard category* *Chemical*	*Collision with other vehicles*	*Exposure to dust*	*Exposure to electricity*	*Moving mechanism*	*Falling objects*	*Falls from height*	*Fire and explosion*	*Handling sharp objects*	*Exposure to extreme temperature and sunshine*	*High-pressure hose*	*Hot pipe work and steam*	*Insects and vermin bites*	*Manual handling*	*Exposure to methane gas*	*Microbiological*	*Ejection of material*	*Noise*	*Slips and trips*	*Stress*	*Minor trapping*	*Vehicle tipping over*	*Vibration*	*Violence*	*Workplace transport*
1. Driving on access road		√				√																√	√		
2. Reversing		√																				√			√
3. Tipping collection vehicle			√		√	√	√				√		√			√			√		√	√		√	√
4. Driving compaction vehicles		√	√				√			√						√		√		√	√	√	√		√
5. General housekeeping	√			√			√		√	√			√	√		√		√	√	√	√				√
6. Maintenance	√			√	√		√	√	√	√	√		√	√	√	√		√	√	√	√				

D4 HAZARD RATINGS

D4.1 INTRODUCTION

Following the identification of hazards and the range of consequences (summarised in Section D3), the next step in the assessment was to assign probability and consequence ratings for each hazard scenario. The approach taken followed that described in Appendix C. For each hazard, the probability that exposure to the hazard leads to harm and the consequence were each rated for both an acute and chronic outcome where relevant. For collection hazards, the ratings were also carried out for a number of scenarios as described in Appendix C:

- Low housing density   low environmental risk   low receptacle content mass
- Low housing density   low environmental risk   high receptacle content mass
- Low housing density   high environmental risk   low receptacle content mass
- Low housing density   high environmental risk   high receptacle content mass
- High housing density   low environmental risk   low receptacle content mass
- High housing density   low environmental risk   high receptacle content mass
- High housing density   high environmental risk   low receptacle content mass
- High housing density   high environmental risk   high receptacle content mass

The probability that given exposure to the hazard, this leads to harm was rated using the scale shown in Table D23 and the consequences were rated using the scales shown in Table D24. It is stressed that the probability rating was that which led to any level of acute or chronic harm (both health and safety where relevant) and the consequence rating was the most likely outcome and not the worst case.

Table D23 Probability rating scale

Conditional probability ranking	***Descriptor[27]***
1	Rare
2	Unlikely
3	Possible
4	Probable
5	Likely

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[27] *The descriptors are relative and should not be treated as absolute.*

Table D24 Consequence rating scale

Ranking	*Descriptor*	*Acute effects*		*Chronic effects*
		Safety	*Health*	*Health*
1	Negligible	Slight, minor injury with no absence, or less	Minor health effect with no absence, e.g. fainting	
2	Low	Requires first aid treatment	Minor health effect requiring treatment	Short term reversible
3	Moderate	> 3 day loss time accident	Moderate health effect leading to > 3 day absence	Long term reversible
4	High	Major injury	Major health effect, e.g. permanent/ long term health effect	Long term irreversible
5	Very high	Single fatality	Fatality	Permanent severe disability/ fatality

Again, as with the identification of hazards, a multistage approach has been taken in order to maximise the robustness of the ratings. The following 3 stages have been followed.

Stage 1

Initial ratings were assigned mainly based on judgement by the project team, utilising the system observation information, risk assessments (and the ratings within) relating to the observed systems and any accident data where supplied and where relevant. In addition, specialists from within HSL were utilised to supplement the HSL core team.

Stage 2

A workshop with representatives from industry, as outlined in Annex D2, was used to assign ratings to the hazards. Ratings were assigned based on judgement but also using accident and incident data to support those judgements. Attendees were asked to consult before hand or bring along their organisation’s accident and incident data. The project team ratings, from Stage 1, were not used by the workshop attendees and did not influence the judgments reached. In addition, the attendees at each workshop were broken into a number of smaller groups for a selection of the hazards. Different groups rated the same hazards as a way of checking consistency and also demonstrating robustness.

Stage 3

Information produced from the first two stages was compared and an overall balanced view reached. As part of this process risk profiles were generated and examined to try and sense check the overall ratings.

Stage 4

Review of the finalised hazard identification by attendees from the workshops and by the project Advisory Committee was used as a final sense check, mainly to ensure that information from the workshops was interpreted appropriately.

It is the results of following this four stage process, that is the probability and consequence ratings for each hazard, that is presented in Sections D4.2 to D4.28. Each of the hazard categories highlighted in the hazard matrix tables (Tables D15 to D22) are discussed one by one in the following sections. This includes:

- Introduction of each hazard category – including clarification of what the hazard category captures;
- The justification for including or excluding the particular hazard category for specific components;
- Justification for the hazard probability and consequence ratings that are shown in Annex D3; and
- Any hazard specific modification factors, which take account of when exposure to a hazard is at a different frequency to that which the overall activity takes place.

D4.1.1 Assumptions and health warning

The ratings presented are based on observations, project team brainstorming and discussions at a number of industry risk assessment workshops. These hazard ratings are utilised by the Risk Comparator Tool and are critical in determining the overall risk ratings. However, it must be stressed that the ratings are based on a generic assessment of the perceived risk posed by specific activities from across the industry. The risk from specific operations may differ from that portrayed here. It is therefore critical that the assessments presented are not taken as definitive assessments, but taken in the light in which they have been generated, as one input in helping to compare the risk from different waste and recyclables management systems.

Assumptions that were made during these assessments include:

- Average risk management practices have been assumed, which implicitly captures a combination of both good and bad practices;
- Some of the discussion and ratings are based on custom job and practice, based on the project team’s observations and knowledge of attendees at the workshops, and may represent bad practice and indeed prohibited activities; and
- Where variations occur that affect risk and that have not been explicitly captured such as time of year, time of day, weather, etc, an average has been considered over a 12 month period (or shorter if an activity only occurs at a certain time of the year).

Given the ratings have been generated mainly by judgement, but supported by data where possible, there will be much uncertainty. This uncertainty could be reduced over time if more and more accident and incident data is used to support the judgments. However, a limitation presently is that the incident data is not captured consistently across different organisations and generally not in sufficient detail, i.e. down to component level. Until such time as there is a vast improvement in this area, the approach taken is considered to be fit-for-purpose for supporting a risk comparison tool.

D4.2 CONTACT WITH CHEMICALS

D4.2.1 Introduction

This hazard captures all scenarios where there is the potential for contact with substances that have the potential to cause harm, including those captured under the Control of Substances Hazardous to Health (COSHH) Regulations. This may lead to a range of effects (Reference 45) including:

- Skin irritation or dermatitis from direct skin contact;
- Asthma as a result of developing an allergy to substances used at work;
- Losing consciousness as a result of being overcome by toxic fumes; and
- Cancer, which may appear long after the exposure to the chemical that caused it.

Infection from bacteria and other micro-organisms (biological agents) are ignored here as they are captured under the microbiological hazard category (Section D4.18). Also captured here are effects such as burns to the skin or damage to the eyes from contact with chemicals found in the waste stream, or substances used as part of collecting or processing waste and recyclables.

As part of collection and processing waste and recyclables, operatives may come into contact with materials that have the potential to cause harm from directly handling the waste and recyclables. For example, this could arise from the contents of bleach bottles in plastic collection/sorting, from a range of substances in the residual waste stream, cleaning materials, and vehicle fluids and fuels etc.

It is assumed that operatives generally wear suitable gloves and clothing that will provide good protection in most cases.

D4.2.2 Component cross-reference

This hazard category is considered to be an issue mainly where operatives directly handle waste and recyclables, or may be in contact with hazardous substances as part of the activity for example maintenance (machinery and vehicle), cleaning and housekeeping.

The reasoning behind inclusion of this hazard category for specific components is summarised in the following subsections.

D4.2.2.1 Collection

For the following components it is assumed that there is no contact with the waste stream or other hazardous materials. This hazard category is therefore neglected for the following components:

- ***Driving from location to location*** – within the vehicle away from the waste.
- ***Getting in and out of cab*** – no contact with the waste stream.

- ***Food waste collect and receptacle return*** – assumed that hazardous contaminants are very unlikely and, therefore, the hazard category has been neglected.
- ***Kerbside box collect and box return*** – there is generally no contact with the material in the boxes during this activity.
- ***Big wheeled bins (Euro and Palladin) empty*** – there is generally no contact with the material in the bin during this activity.
- ***Food waste empty*** – there is generally no contact with the material in the food bin during this activity.
- ***Disposable bags empty*** – it is assumed that contact with the contents of the bags is unlikely during placing the bags in the collection vehicle.
- ***High-rise slave sacks empty*** – there is generally no contact with the material in the bags during this activity.
- ***Wheeled bins empty –*** there is generally no contact with the material in the bin during this activity.
- ***Slave wheeled bin empty*** – no contact with waste stream or chemicals during this activity.
- ***Walking to and from collection point*** – no contact with waste stream or chemicals during this activity.
- ***Operating vehicle machinery (RCV compaction and Kerbsider hopper empty)*** – some discussion at the industry workshop considered whether compression during the compaction on an RCV could expose operatives to hazardous substances. However, it has been judged that vehicle design, distance of operatives from vehicle and a lack of other evidence, for example in the accident statistics, makes this very unlikely.
- ***Emptying collection vehicle*** – it is assumed to be unlikely to contact material directly through the emptying operation. Implicit in this assumption is an automated emptying/tipping operation. This hazard, has therefore been neglected.

Exposure to this hazard is considered in the following activities:

- ***Assembling of collection crew at start of shift*** – assumed that there may be contact with hazardous substances through the vehicle checks that are carried out before a vehicle goes on its round.
- ***High-rise bags collect*** – possible contact with waste while emptying materials into the slave sack.
- ***Disposable bags collect*** – slight possibility of contact if bags split, although thought to be fairly unlikely.
- ***Reusable bags collect and bag return*** – depending on the material being collected, there may be a small chance of exposure to chemicals.
- ***Big wheeled bins (Euro and Palladin) collect and bin return*** – unless these bins are overflowing it is considered very unlikely that operatives would come into contact with hazardous material. However, for overflowing bins the hazard is included for this activity.
- ***Slave receptacle collect*** – as part of this activity involves emptying dry recyclables into the slave container (bag, box or wheeled bin), there may be contact with chemicals during this activity.

- ***Wheeled bin collect and bin return*** – generally there should be little contact with the waste during this activity. However, when the bins are overfull, waste may be removed, or waste at the side of the bin may be picked up. Therefore, this hazard has been included for this activity.
- ***Reusable bags empty*** – because operatives may have to physically shake these bags empty and may push the waste material into the back of the collection vehicle there is the possibility of contact with chemicals.
- ***Box sort and empty*** – the operative is in direct contact with recyclables during the sorting operation, which could be contaminated with substances hazardous to health.

D4.2.2.2 Post-collection

For the post-collection systems it is assumed that this hazard category is only an issue where operatives are in direct contact with the waste stream, from for example manual sorting or handling the waste or from maintenance, cleaning and housekeeping activities. For the other activities it is assumed that exposure to chemicals is extremely unlikely and this has therefore been neglected.

D4.2.3 Hazard ratings and justification

Tables D59 to D61 in Annex D3 list the probability and consequence ratings assumed for this hazard category.

In terms of consequences it has been assumed that the main outcome is an acute effect from contact with the hazardous substance. In these cases the consequences have been assessed as low, requiring first aid treatment (rating of 2). A chronic outcome may be possible, from for example skin conditions from long term exposure. These have been judged as ranging from short term reversible to long term irreversible. Therefore an average rating has been assumed (rating of 3). It is noted that the chronic outcome is unlikely for accidental exposure to hazardous substances, and is more likely for activities where exposure to hazardous substances occurs routinely, for example when undertaking vehicle checks, and carrying out maintenance, cleaning and housekeeping activities. Therefore, chronic outcomes have only been assessed for these activities.

The probability of a chronic outcome has been judged as rare in all cases and has been rated at 1. For the acute outcomes a range of probability ratings have been assumed based on the waste stream generally handled and whether contact with hazardous substances are a regular part of the activity. With the exception of the activities of ‘handling of heavy/hazardous waste’ (transfer/bulking station), ‘Delivery of hazardous substances in bulk’ (incineration), which are rated at 3 because of the intrinsically more hazardous nature of the materials being handled, and ‘manual sorting’ (MRF), which has also been rated as 3 to account for that this has been rated per shift and not per activity, all other ratings are in the range of 1 to 2, i.e. in the rare to unlikely region. Activities where hazardous materials are handled routinely have been assessed as 2 and where accidentally handled as 1 or 1½, depending on the volume of waste (high mass scenario) or the waste stream (residual waste compared to dry recyclables). The environmental risk scenarios were considered irrelevant in this case.

D4.2.4 Hazard specific modifiers

Hazard specific modifiers are generally 1, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity, with the exception of the following activities:

- ***Slave wheeled bin collect*** – 7 has been assumed as contact with chemicals occurs for each receptacle emptied into the slave bin and not each time the slave bin is taken to the collection vehicle, which was assumed as 0.14 per household collection (Table D1). Therefore, 7 was the result of 1/0.14.
- ***Slave bag/box collect* –** 2 has been assumed as contact with chemicals occurs for each receptacle emptied into the slave bag/box and not each time the slave container is taken to the collection vehicle, which was assumed as 0.5 per household collection (Table D1). Therefore, 2 was the result of 1/0.5.
- ***Wheeled bin collect and bin return*** – handling the waste is assumed to occur in only 1 in ten overflowing bins that are handled. Therefore a hazard specific modifier of 0.1 has been assigned.

D4.3 COLLISION WITH OTHER VEHICLES

D4.3.1 Introduction

This hazard category covers those scenarios where a vehicle involved in the collection or movement of waste or recyclables is involved in a collision with another vehicle. This could occur on public roads with any vehicle or with vehicles or mobile plant on-sites. As only occupational risk is within scope, the risk to third parties is neglected. Where vehicles come into contact with pedestrians, this is not captured here, but under the workplace transport hazard category.

D4.3.2 Component cross-reference

For collection activities collision with other vehicles occurs predominantly with the following components:

- ***Assembling of collection crew at start of shift and pre-round activities*** – vehicle movements in the depot;
- ***Driving from location to location*** – collision with vehicles on public roads; and
- ***Emptying collection vehicle*** – vehicle movements on the site.

There is the potential for collisions by other vehicles into a stationary collection vehicle across most of the collection activities. However, it is considered that the risk here is predominantly to occupants of the other vehicle and is therefore neglected.

For post-collection subsystems, collision between vehicles is considered for all those components where vehicle movements, including of mobile plant, occur. Again, where the vehicle involved in the activity is stationary, for example tipping waste or recyclables (unless a fork-lift is used), then the hazard is considered to be not applicable as it would be captured in the other components.

D4.3.3 Hazard ratings and justification

Tables D62 and D63 in Annex D3 list the probability and consequence ratings assumed for this hazard category for collection and post-collection activities respectively.

Ratings have generally been assessed based on speed of vehicles (increasing consequences), number of vehicles (increasing probability) and direction of travel (probability increases with reversing activities). The type of vehicle has also been considered, for example it is assumed that a fork-lift driver will have less protection than RCV occupants, and therefore this may mean higher consequences are relevant for a fork-lift truck driver. In all cases it has been assumed that the consequences will be acute and that chronic issues are not credible.

For activities involving road vehicles in depots and other sites a negligible consequence has been assumed (rating of 1) as generally the speeds are likely to be low and in many cases the outcome of a collision with another vehicle is likely to be just economic loss (i.e. damage to vehicles). For the following components the consequences are assumed to be different:

- ***Driving from location to location (collection)*** – because of the speeds generally involved the result of a collision could result in serious injuries. Therefore consequences of low (requires first aid treatment) and moderate (greater than 3 day absence) have been assumed for low and high environmental risk scenarios respectively. In this case the environmental risk is capturing the speed of traffic, density of traffic and type of roads.
- ***Unloading or loading using a fork-lift truck*** – for unloading Stillage vehicles where a fork-lift is generally used it is assumed that the consequences may be slightly higher. They have therefore been assessed as low (2, requiring first aid treatment). Similarly, loading/moving bales with a fork-lift truck the consequences have been assessed as slightly higher.
- ***Driving on access road (landfill)*** – speed of vehicles is assumed to be higher than in depots leading to higher consequences.
- ***Driving of compaction vehicles (landfill)*** – the size of a compaction vehicle is assumed to give rise to higher consequences on average compared to collisions within depots.

In terms of the probability ratings, except for landfill sites for all other activities within depots and processing sites a rating of between 2 and 3 has been assumed. It is assumed that a collision between vehicles is a fairly common occurrence due to the many vehicle movements, with reversing activities increasing the likelihood of a collision, hence the rating of 3 in those cases. Although assumed to be relatively frequent events, as discussed above the health and safety consequences are generally negligible. In the following components a different probability rating has been assumed:

- ***Driving from location to location (collection)*** – given the amount of driving that is undertaken, serious incidents are fairly rare (ignoring manoeuvring operations on streets, e.g. reversing and turning around). Therefore, a rare rating (1) has been assumed with the low environmental risk scenarios and an unlikely rating (2) where the environmental risk is high.
- ***Driving on access road and driving of compaction vehicles (landfill)*** – given the amount of space and more limited vehicle movements, it has been assumed that a collision is rare.

D4.3.4 Hazard specific modifiers

Hazard specific modifiers of 1 have been assumed, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity.

D4.4 EXPOSURE TO DUST

D4.4.1 Introduction

Exposure to dust could arise from many activities within the waste and recycling industry. Dust is present within most waste streams. Dust can also have many health and safety effects including both acute and chronic. Acute outcomes could include minor irritation, impacting eyes and cause sneezing or could trigger an asthma attack in a vulnerable person (work-related asthma). Chronic outcomes include occupational asthma caused by respiratory sensitisers within the dust or potentially cancer if carcinogens were present within the dust.

The risk from exposure to dust depends on many factors, including:

- The dust itself – for example, green waste contains microbes that form an aerosol when the waste is handled, although all waste types will produce aerosols that could potentially be a health and safety issue.
- Whether indoors or outdoors – the risk will generally be greater indoors than outdoors as the aerosols disperse less quickly and concentrations can build up; and
- The amount of material handled at any one time.

Where it is the micro-organisms within the dust that are the issue, these are not captured here but are captured under the microbiological hazard category.

D4.4.2 Component cross-reference

For the collection activities dust is generally not considered to be a major issue due to the activities being outdoors, thus reducing exposure to any dust as it easily disperses. In addition, even those areas where dust is more of an issue, the amount of material operatives are exposed to at any one time is small or the nature of the task means operatives are sufficiently far away (for example emptying Kerbsider hoppers or activating the compaction on an RCV) for dust not to be considered an issue. However, there still remain a number of activities where exposure to dust is more problematic and where there is a non-trivial level of risk as summarised below:

- ***High-rise bags collect*** – this activity involves tipping contents of bags into a slave sack and is generally carried out indoors. Therefore operatives are in reasonably close proximity to the dust and dispersion is slow.
- ***Reusable bags empty*** – emptying large bags of green waste into the rear of an RCV is assumed to expose an operative to a non-trivial concentration of dust, because of the close proximity even though this activity is carried out outdoors.
- ***Big wheeled bins (Euro and Palladin) empty*** – because of the amount of material in the bin this is assumed to give rise to sufficient levels of dust.
- ***Wheeled bins empty*** – generally this is thought not to be an issue, although it depends strongly on the contents of the bin, for example where residents have coal fires, coal dust in the waste was expressed as an issue at the industry workshop. Therefore, this activity has overall been judged to present a non-trivial level of risk.
- ***Slave receptacle collect*** – operatives will be in close proximity when contents are tipped into the slave receptacle.
- ***Emptying collection vehicle*** – tipping operations are liable to produce significant quantities of dust. The exposure to such dust will depend on where the operative operates the tipping mechanism from, i.e. whether outside the vehicle or not.

For post-collection activities dust has been assumed to be an issue wherever material is tipped, where it is moved vigorously or where it goes through a milling/grinding process. Within an MRF dust is a particular issue due to the dry nature of the material. Maintenance, cleaning and general housekeeping activities are also assumed to expose workers to dust. Most activities are therefore assumed to be affected. The main components, where the risk is judged as negligible, that have been excluded include:

- ***General vehicle movements*** – workers generally within vehicle and not exposed.
- ***Opening composting vessel doors*** – the activity does not generate dust and residual dust near this activity is assumed not to be an issue.
- ***Delivery of hazardous substances in bulk (incinerator)*** – material is blown into silos through pipes. This activity therefore does not expose operatives to dust.
- ***Landfill activities except tipping and compaction*** – these activities are predominantly in the open.

D4.4.3 Hazard ratings and justification

Tables D64 to D66 in Annex D3 list the probability and consequence ratings assumed for this hazard category.

As illustrated in the discussion above it is clear that there is a range of health outcomes from exposure to dust. However, for the purpose of this assessment it has been assumed that the most likely acute outcome is minor irritation leading to sneezing and minor eye problems. This has therefore been assessed as 1 throughout. In terms of chronic outcomes it has been assumed that if a chronic effect is to develop then its effect is likely to be long term, and could be irreversible, although some effects may be reversible. Therefore a consequence rating of 3.5 has been assigned in these cases, between the reversible and irreversible categories. Only one of the collection activities has a chronic effect been included, emptying collection vehicle; it has been assumed that the other activities give rise to an insignificant (although not zero) chronic risk because of being outdoors and exposed to relatively small quantities of dust at a time.

In terms of the probabilities assigned the general assumption has been that minor acute effects are relatively common whilst the chronic, relatively more serious effects, are rare. Therefore ratings in the region of 2 to 4 have generally been assigned to the acute outcomes and ratings of 1 to 1.5 to the chronic outcomes. This was supported by discussions at the industry workshops relating to knowledge of reported problems.

In terms of the acute probability ratings for the collection activities:

- ***High-rise bags collect*** – because of the close proximity of the operative to the source of the dust and the limited dispersion (indoors) this has been assessed as being fairly likely with the amount of material emptied into the slave sack increasing the amount of dust, and the likelihood of a health and safety effect. Therefore ratings of 3 and 4 have been assumed for low and high mass scenarios.
- ***Slave receptacle collect –*** this is analogous to the high-rise bags collect. However, in this case the activity is carried out outdoors, enabling the dust to disperse much more easily. Therefore lower probability ratings of 1 and 2 have been assumed for low and high mass scenarios.
- ***Reusable bags empty –*** when the bags are full a higher probability than for slave wheeled bins collect has been assumed because of the nature of the assumed waste

(green). With little material in the bags the issue is assumed to be negligible, hence the rare (1) rating.

- ***Big wheeled (Euro and Palladin) and wheeled bins (including slave) empty –*** a probability rating of 2 has been assumed as this operation can generate a reasonable amount of dust, but because the operation is carried out outdoors and operatives are generally a little distance away this leads to a judgement of the issue being relatively minor. The only exceptions are large wheeled bins and wheeled bins with little content due to the amount of material in them (rated higher and lower respectively). The content of bins (volume) is assumed to be irrelevant for big wheeled bins and slave bins as there is likely to be less variation in their volumes.
- ***Emptying collection vehicle*** – this is assumed to create a reasonable dust issue, especially if emptied indoors. An acute probability rating of 3 has therefore been assumed.

For the post-collection activities acute probability ratings have been assigned based on the following assumptions:

- Indoor activity whereby material is not moved around much, for example manual pre-sorting, or tipping operations outdoors – rating of 2;
- More rigorous movement of material or disturbing material from tipping or dropping waste or indoor maintenance, cleaning and housekeeping activities – rating of 3;
- At an MRF, in addition to the above, because of the dry nature of the material a rating of 3.5 has been assumed; and
- Significant dust creating activities from milling or grinding operations for example – rating of 4.

For the chronic outcomes the probability has been assessed as rare except for those activities that are significant dust producers, i.e. milling, grinding, screening, automatically sorting and picking lines at an MRF.

D4.4.4 Hazard specific modifiers

Hazard specific modifiers are generally 1, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity, with the exception of the following activities:

- ***Slave wheeled bin collect*** – 7 has been assumed as exposure to dust occurs for each receptacle emptied into the slave bin and not each time the slave bin is taken to the collection vehicle, which was assumed as 0.14 per household collection (Table D1). Therefore, 7 was the result of 1/0.14.
- ***Slave bag/box collect –*** 2 has been assumed as exposure to dust occurs for each receptacle emptied into the slave bag/box and not each time the slave container is taken to the collection vehicle, which was assumed as 0.5 per household collection (Table D1). Therefore, 2 was the result of 1/0.5.
- ***Manual sorting (MRF) –*** exposure to dust is going to occur fairly continuously as part of this activity and does not relate to any discrete frequency, such as the number of picking actions. However, as it is difficult to justify any other frequency, the same frequency is assumed and a hazard modification factor of 1 used.

D4.5 EXPOSURE TO ELECTRICITY

D4.5.1 Introduction

This hazard category captures any areas where operatives can be harmed through contact with electricity. Such contact has a high possibility of major injury or fatality.

D4.5.2 Component cross-reference

In terms of collection activities electricity is assumed to be an issue only with the following components:

- ***Assembly of collection crew at start of shift*** – vehicle checks may expose operatives to electricity.
- ***Kerbsider hopper empty*** – this depends on the design of the vehicle, but on some Kerbsiders emptying the hoppers is carried out by lifting these high above the vehicle and tipping them into the vehicle. Therefore any overhead power lines above the vehicle could give the operative a significant electric shock.

In terms of post-collection activities the most significant electricity hazard is encountered in the maintenance activities. For other activities it is assumed that the risk is relatively insignificant and has therefore been discounted. Some sites may have significant electrical hazards, although not directly related to the waste collection and processing. These have therefore been neglected as part of this assessment. An example of this is open-windrow composting, which given these sites are often on farmland, there may exist overhead power lines.

D4.5.3 Hazard ratings and justification

Tables D67 and D68 in Annex D3 list the probability and consequence ratings assumed for this hazard category for collection and post-collection activities respectively.

Consequences of exposure to electricity have been rated in the range 2 to 5 based on the likely nature of the electricity, for example its voltage. There is assumed to be no chronic effect. Contact with overhead power lines has been assessed as leading to a fatality (5), activities associated with maintenance have been assumed to expose a worker to voltages that generally would lead to major injury (4) and activities associated with general housekeeping have been assumed to lead to greater than 3 days absence, mainly based on the likely lower voltage.

In terms of probability it is assumed that electric shocks are rare, particularly contact with overhead power lines and electrical shocks during general housekeeping. Also, given that overhead power lines are much more likely in a rural environment, the rating for high housing density has been set to zero (low housing density is assumed to correlate to rural). It was judged that electrical shocks were most likely as part of maintenance activities, although these were again judged to be relatively unlikely and so were rated as 2.

D4.5.4 Hazard specific modifiers

Hazard specific modifiers are generally 1, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity, with the exception of the following activities:

- ***Kerbsider hopper empty*** – overhead power lines are assumed to exist for 1 in a 1000 empty operations. Therefore a hazard specific modifier of 0.001 has been assigned.

D4.6 INJURED BY MOVING MECHANISM

D4.6.1 Introduction

Moving mechanisms have the potential to harm in different ways:

- Entrapment/entanglement;
- Striking someone; and
- Crushing.

This hazard category is assumed to capture all issues related to items that move under external power. It does not include trapping fingers in doors or bin lids for example as these are captured elsewhere under the minor trapping hazard category.

Many activities in both collection and post-collection present a possibility of entrapment/entanglement due to moving parts. This includes bin lifting mechanisms, hopper emptying on Kerbsiders and compaction on collection vehicles, tipping operations, shovels on shovel loaders, forks on fork-lifts, other mobile plant with moving parts and various machinery used post-collection, such as automatic sorting, milling, conveyor belts etc. Therefore the potential for entanglement exists throughout the waste and recyclable management process.

Similarly, where there are parts moving under hydraulics, for example a bin lift on an RCV, there is the potential for accidents involving the mechanism either striking or crushing an operative.

D4.6.2 Component cross-reference

Activities associated with collection that involve moving machinery include the following and have therefore been included:

- ***Assembly of crew*** – vehicle checks are assumed to expose operatives to moving parts and potential injury;
- ***Emptying of wheeled bins*** – the bin lift mechanism on the back of an RCV is assumed to have the potential to trap, crush or entangle an operative;
- ***RCV compaction*** – there is the potential for injury due to the moving compaction plate within the rear of an RCV;
- ***Kerbsider hopper emptying*** – on those vehicles where hoppers are lifted and emptied into the body of the vehicle there is the potential for being struck by or trapped in the moving mechanism; and
- ***Emptying collection vehicle –*** the tipping operation or removal of stillages has the potential to create an entrapment or crushing injury.

For post-collection subsystems those activities where operatives are in close proximity to moving machinery have been assumed to have a non-trivial level of risk for this hazard category. This includes the following generic areas, unless operatives are unlikely to be in the vicinity of the moving machinery:

- Unloading collection vehicles;
- Areas where mobile lifting plant is used, e.g. in the handling of heavy waste, or fork-lift trucks;

- Operation of milling, grinding and baling machinery;
- Activities associated with conveyor belts, e.g. the picking line at an MRF; and
- Maintenance.

Activities involving shovel loaders have been neglected as it is assumed that no one is in the vicinity of the moving shovel.

D4.6.3 Hazard ratings and justification

Tables D69 and D70 in Annex D3 list the probability and consequence ratings assumed for this hazard category for collection and post-collection activities respectively.

Consequences due to accidents with large moving mechanisms were generally judged to be fairly severe, with anything having the potential to strike, crush or entangle an operative (for example through loose clothing being caught) assessed as potentially leading to a major injury (4), although a greater than 3 day absence (3) was judged most likely. Activities associated with maintenance were also assessed as most likely to lead to a greater than 3 day absence (3) because of the nature of the activity, although it is noted that this could be extremely variable. Other activities involving moving mechanisms were judged as having less chance of causing a severe accident, and therefore as leading to slightly lower consequences, between minor and a greater than 3 day absence (2.5). This includes activities such as vehicle checks (assembly of collection crew at start of shift). Finally, manual sorting at a picking line was judged to have the potential to cause a more minor injury (2).

In terms of probability it was judged that in most cases the probability of an accident given that an operative is exposed to moving mechanisms was rare (1). This is due to safe areas for operation of machinery, for example collection vehicles, and the fact that most machinery, e.g. screens, conveyor belts, baling machines etc, should be guarded. The only exceptions to this were vehicle checks, maintenance activities and manual sorting (MRF picking line) because of the closer proximity to the moving mechanism. It was judged that for vehicle checks and maintenance activities the probability rating was one step higher (2) and for manual sorting at an MRF picking line, one step higher again. In the latter case, the reasons were that nip points could exist on conveyor belts, which increase the risk of fingers or clothing getting caught, along with the fact that the belt is moving with no guarding.

D4.6.4 Hazard specific modifiers

Hazard specific modifiers of 1 have been assumed, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity.

D4.7 FALLING OBJECTS

D4.7.1 Introduction

This hazard captures all those scenarios where there is the potential for objects to fall and strike operatives. Because the outcome of such incidents is very dependent on the size and mass of the falling object, this category has been split into the following two sub-categories:

- falling bins
- falling objects (other)

The first category is fairly obvious and is only relevant for collection activities, whereas the second category captures all other falling objects including material falling out of bins during the emptying process and all falling objects in the post-collection stages.

Ejection of material is not included within this hazard category, and is included separately under ejection in Section D4.19.

D4.7.2 Component cross-reference

D4.7.2.1 Hit by falling objects (bins)

Falling bins generally only represent a significant hazard during collection activities and then only with those activities involved in emptying or to a lesser extent in collecting bins and taking them to the collection vehicle. The following components have therefore been assessed:

- ***Big wheeled bins (Euro and Palladin) collect*** – it has been assumed that there is the potential for the big bins to topple, particularly when pushed over kerbs or up hills (high environmental risk scenarios). The amount of material in the bin may also be a factor in increasing the likelihood of a bin toppling over (high mass scenarios).
- ***Wheeled bins collect (including slave bins)*** – as with the big bins, standard wheeled bins are judged to have the potential to topple over during the collection activity and strike an operative. Again, the environmental risk level and the mass of material in the bin will affect the likelihood of this.
- ***Big wheeled bins (Euro and Palladin) empty*** – it has been assumed that there is the potential for bins to break free from the lifting hoist during the emptying operation. This was also borne out in the discussions with representatives from industry at the industry workshops. The reasons for bins falling was stated to be damage to the bins or the lifting mechanism. However, in both cases good maintenance regimes were said to minimise the likelihood of this. One area of particular concern was emptying Palladin bins which were stated to be more likely to break free than other large bins, such as the Euro bins, because of problems with the clamps; however, these particular bins are in the process of being phased out.
- ***Wheeled bin empty (including slave bins)*** – as with the large wheeled bins, there is the potential for other wheeled bins to break from the lifting mechanism during the emptying operation. In addition, depending on the policy as regards whether bin lids should be open or closed there is the possibility of a bin lid interfering with the lifting mechanism and causing the bin to spring out.

The likelihood of a bin falling from the lifting mechanism could be increased if operatives ‘shake’ the bins to remove any lodged waste material. Green waste is a particular issue as this can often become lodged in wheeled bins.

D4.7.2.2 Hit by falling objects (other)

In terms of other falling objects (excluding ejection of material) this was assumed to be an issue for the following collection activities:

- ***Driving from location to location*** – a possibility of items being stored at head height in collection vehicles was identified. However discussions with industry yielded a varying picture from this not being an issue due to a mixture of their operational procedures not to store items in cabs and the design of modern vehicles having better storage, to it still being an issue, particularly on kerbside schemes, particularly where side-waste is collected. Therefore, on balance this is included although rated to give an average picture from across the industry; overall it is judged to be a minor issue.

- ***Big wheeled bins (Euro and Palladin) collect*** – collection of big bins will generally not lead to falling objects striking operatives. However, in certain circumstances this is possible, for example where bins are overloaded (high mass scenario) and where waste chutes feed waste into the bin. In this latter case, movement of the bin from the waste chute could lead to items within the chute falling free and hitting an operative. However, this is again only likely when the bin is full (high mass scenario).
- ***Stillage box sort and empty*** – when stillages are almost full, adding additional material to the stillage can cause material to move, fall and strike an operative.
- ***Emptying collection vehicle*** – the emptying operation is generally considered not to be an issue; however, occasionally waste material may become lodged and may have to be removed by the operatives causing it to fall and strike them. Falling objects as a hazard has therefore been included with this activity.

For the following collection activities, falling objects were initially considered to pose a hypothetical hazard, although they have since been ruled out following the industry workshops and sense checking of the assessments:

- ***Wheeled bin collect (standard)*** – although for an overloaded bin there is the potential for items to fall out and strike an operative this has been considered to present a negligible risk due to items most likely missing an operative; it only affects below waste height in any case (negligible consequences) and, generally, because overloaded bins may not be collected.
- ***Wheeled bin empty (standard, large and slave)*** – even if material could fall from the bin outside the RCV hopper area during the emptying activities (considered unlikely) it was judged to be unlikely that an operator would be struck because they would generally operate the lifting mechanism from a position of safety.
- ***Kerbsider hopper empty*** – this was initially considered to be an issue because of the height that material is lifted to be emptied into the body of a Kerbsider. However, discussion with industry and based on observations of this operation suggested that falling objects was not an issue. Occasionally paper may be blown in the wind, but this does not present a risk to operatives.

In terms of post-collection, the following activities were considered to have the potential for falling objects to strike operatives:

- ***Emptying collection vehicles*** – the type of vehicle will have a significant impact on the likelihood of an item falling and striking an operative. For example, loads may have shifted during transit and un-sheeting a vehicle or opening the back of a vehicle may lead to material falling out. Material striking an operative during the tipping operation was considered possible, although considered to be fairly rare given the position of operatives when tipping. However, some material may fall from an RCV after tipping has finished as discussed above. In addition, removing and emptying stillages, usually by fork-lift truck may present a falling object hazard either from the stillage itself or from the contents as they are tipped.
- ***Moving material using shovel loaders*** (including loading shredders, hoppers etc) – many activities post-collection involve moving material using shovel loaders. This will involve lifting material high and tipping in various locations. If no one is in the area of the tipping, other than the vehicle operator, then this may be considered to present no

risk. However, given that there is always this potential, these situations have been incorporated.

- ***Maintenance*** – maintenance and cleaning of machinery was considered, particularly by participants of the industry workshops, to present the greatest exposure to falling material, mainly through the close proximity to material being moved or processed.
- ***Activities associated with conveyor belts*** – due to the nature of conveyor belts, particularly at picking lines at MRFs there is always the potential for objects to fall off these and strike operatives.
- ***Moving and storing bales*** – movement of bales (by fork-lift truck), storing these too high and loading bales onto vehicles were all assumed to have the potential for bales to fall.
- ***Loading vehicles*** – similar to unloading material, any activity involving loading material was assumed to have the potential to lead to falling objects striking operatives. Obviously, there would be great variation in the level of risk from the different vehicles and practices.

Other activities were neglected on the basis that operatives would not be exposed to loose objects that are at height.

D4.7.3 Hazard ratings and justification

Tables D71 and D72 in Annex D3 list the probability and consequence ratings assumed for this hazard category for collection and post-collection activities respectively. Table D71 lists the ratings for both falling bins and falling objects (other).

D4.7.3.1 Falling object (bins)

Consequences due to a bin falling and hitting an operative have been assessed in the range of 1 to 4, i.e. negligible outcome to a major injury, depending on the size and weight of the bin (including its contents) and the distance it falls before striking an operative. This can be summarised as:

- ***Wheeled bins falling over on the ground*** – negligible to minor consequences (1 to 2) depending whether the bin has little material in it or is full (low and high mass scenarios).
- ***Large wheeled bin falling over at ground level*** – minor to between minor and greater than 3 day absence (2 to 2.5) depending whether the bin has little material or is full (low and high mass scenarios). Here it is assumed that the inherent weight of the bin and its size will lead to greater consequences than with a standard wheeled bin.
- ***Wheeled bin falling whilst being emptied*** – consequences of either a greater than 3 day absence or major injury have been assumed (3 to 4) depending on the amount of material in the bin.
- ***Large wheeled bin falling whilst being emptied*** – consequence of a major injury (4) have been assumed for all scenarios. It has been assumed that given the inherent weight of these bins that the amount of material in the bin is not going to significantly affect the consequences.

In terms of probability, it has been judged that bins falling off vehicles in the emptying process is fairly unlikely, even though it was acknowledged by industry that this does occur. However, this must be put into context with the number of bin lifts that are carried out and that those that have fallen off have generally not hit anyone due to operational procedure to be in a position of safety. A position of safety is less likely to be maintained for the wheeled bin empties due to the possibility of two bins being emptied at slightly different times by different operatives. Overall, probability has been assessed as in the range of 1 to 2. To summarise:

- ***Big bins empty*** – a probability of 1 or 1.5 has been assumed for Euro bins depending on the amount of material in the bin. For Palladins, a probability of 2 has been assumed due to the higher likelihood of these falling.
- ***Wheeled bins empty*** – a probability of 1 or 1.5 has again been assumed depending on the amount of material in the bin.
- ***Slave wheeled bin empty*** – the probability has been increased by half a category compared to wheeled bins to account for the fact that these bins are lifted and moved around more regularly and may therefore be subject to more damage. That is notwithstanding that the collection crew carries these bins and any damage is more likely to be noticed and the bins replaced.

D4.7.3.2 Falling object (other)

In terms of falling waste, this has been assumed to lead to fairly minor consequences (between 1 and 2), depending on the amount of material, the type, its mass and how far it falls. Where items have been lifted in the air, e.g. with a shovel loader, a consequence rating of 2 has been assumed, otherwise 1 has been assumed. The only exception to this has been for the following components:

- ***Handling of heavy/hazardous waste (transfer/bulking station)*** – because of the nature of the waste, i.e. potentially heavy, a higher consequence category has been assumed (3).
- ***Baling materials*** – as the mass of bales are generally around half a tonne, if a bale was to fall on someone then this could lead to major injury or even fatality. As an average outcome, a major injury has therefore been assumed (4).

As regards the probability that has been assigned in each case this ranges between 1 and 4 and is summarised below:

- ***Falling bales*** – it has been assumed that because of the potential consequences and from the workshop attendees' judgements, that rigorous controls are in place on the storage and movement of bales, this is a rare event (1).

For the following general activities it has been assumed that being hit by falling objects is still rare, although not quite as rare as with a falling bale. These have therefore been assessed as 1.5. This is partly because personnel would generally not be in the vicinity of the activity, although the potential exists.

- Unloading collection vehicles;
- Loading material onto vehicles, onto conveyors, into hoppers associated with various processes (automatic sorting, shredding, milling, grinding, screening etc); and
- Transferring material between locations.

For driving between locations it has been assumed that because of vehicle design and the operating procedures that were discussed at the workshops, being hit by a falling object in a cab is fairly unlikely although not rare. A rating of between 2 and 2.5 has therefore been assumed for low and high environmental risk scenarios (dependent on the nature of the roads). Similarly, driving on the landfill approach road has been assumed to be equivalent to the high environmental risk scenario for driving between locations.

The probability for falling objects from full stillages has been assumed to be vary between 2 and 3 depending whether sorting occurs at kerbside or on the vehicle. This is based primarily on judgements made at the industry workshops, but also taking into account that it is fairly likely that if stillages are full someone will be in an exposed position, but stillages will only be full for a small proportion of any round. Also, when sorting occurs on the vehicle it is assumed that it is less likely that someone will be in an exposed position, hence the lower rating.

For collection of large bins it has been assumed that when the bin is full (high mass scenario) it is possible that either material will dislodge from the top of the bin and hit an operative or excess material will fall from a waste chute, if backed up, even taking account of controls to minimise this. A rating of 3 has therefore been assigned for the high mass scenarios. The following activities were also assumed to have a similar probability of occurrence given exposure and were also rated at 3:

- ***Handling of heavy/hazardous waste (transfer/bulking station)*** – the nature of this task may mean that items fall during manoeuvring them and hit someone.
- ***Maintenance*** – the operative is assumed to be more likely in an exposed position, i.e. where falling objects may hit them.
- ***Manual sorting (MRF)*** – experience of some attendees at the industry workshop was that objects often fall onto the picking cabins.

D4.7.4 Hazard specific modifiers

Hazard specific modifiers are generally 1, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity, with the exception of the following activity:

- ***Slave wheeled bin collect (bins)*** – 7 has been assumed as exposure to a bin falling over occurs for each receptacle emptied into the slave bin and not each time the slave bin is taken to the collection vehicle, which was assumed as 0.14 per household collection (Table D1). Therefore, 7 was the result of 1/0.14.

D4.8 FALLING OVER (STANDING WHEN VEHICLE IN MOTION)

D4.8.1 Introduction

This hazard category relates to falling over due to standing whilst a vehicle is in motion. This is assumed to be only relevant for the collection activities as the only significant driver for this behaviour is to save time when arriving at the next collection point. Where standing leads to a fall from height this is captured under the fall from height hazard category and not here.

D4.8.2 Component cross-reference

The components where this hazard is assumed to be relevant are:

- ***Driving from location to location*** – operatives may be standing in the vehicle cab whilst the vehicle is still moving in preparation to jump out at the next collection point.
- ***Stillage box sort empty (Separate collect and sort)*** – where on operative remains on the body of a Stillage vehicle to sort dry recyclables there is a greater chance, even if

procedures do not allow it, of them remaining on the back of the vehicle whilst it moves to the next collection point. This is judged to be unlikely when the same operative collects and sorts compared to when there is a dedicated sorter.

D4.8.3 Hazard ratings and justification

Table D73 in Annex D3 lists the probability and consequence ratings assumed for this hazard category for collection activities. This was assumed to be irrelevant for post-collection activities.

In both cases it is judged that the probability of such an event, given that is assumed to be a prohibited activity, is rare, but increasing with the high environmental risk scenarios. Therefore a probability rating of between 1 and 2 has been assumed.

In terms of consequences, if such an accident occurred, the most likely outcome is assumed to be a minor acute injury (2), assuming the person does not fall from the vehicle, which is captured separately.

D4.8.4 Hazard specific modifiers

As the general procedure is not to stand whilst the vehicle is in motion a hazard modifier of 0.01 has been applied for all relevant components. This is based on assuming that this behaviour only occurs in 1 percent of cases.

D4.9 FALLS FROM HEIGHT

D4.9.1 Introduction

This hazard category captures all those scenarios where there is a potential for somebody to fall, including low falls from for example climbing in and out of a vehicle cab, falling down a flight of stairs, to greater falls from lorries during sheeting up or from machinery during maintenance activities. It essentially captures everything that does not occur at ground level. The scope of this hazard category is slightly wider than that covered by the Work at Height Regulations 2005 (Reference 46).

Falls predominantly on the level are captured separately under the slip and trip hazard category or falling over (standing when vehicle in motion) category. A fall has generally been taken to mean at least 2 steps, in that falling off a kerb is not treated as a fall, but a slip or trip. A degree of pragmatism has been applied to distinguish between a slip or trip and a fall.

There is a potential for falls to occur at all points in the collection and processing of waste and recyclables.

D4.9.2 Component cross-reference

D4.9.2.1 Collection

In collection the potential for falls is generally related to climbing in and out of vehicles, either cabs or the back of Stillage vehicles. However, for particular collection methods there are particular hazards that could lead to a fall, for example flights of stairs on a high-rise flat door-to-door collection or steps leading to a property on assisted collections. The areas where falls could occur and potential issues are summarised below.

For the following activities it is assumed that climbing in and out of the cab could lead to a fall. It is noted that the risk of a fall is dependent on vehicle type and design, and that some modern collection vehicles now have low entry cabs, which significantly minimises the risk of a fall. However, given the huge variation in vehicles, the average situation must be considered.

- Assembling of collection crew at start of shift and pre-round activities
- Getting in and out of cab
- Emptying collection vehicle

For the following activities falls from height is generally not an issue. However, where there is assisted collection and there are steps to negotiate there exists the potential to fall. The following have therefore been included:

- Disposable bags collect
- Reusable bags collect
- Food waste collect
- Kerbside box collect
- Wheeled bin collect

Stillage vehicles with steps to climb onto the body of the vehicle also provide an opportunity for a fall to occur during climbing onto or off the vehicle. This occurs with the following activities, where this type of vehicle is used:

- Reusable bags empty
- Food waste empty
- Stillage box sort empty (collect and sort)
- Stillage box sort empty (separate collect and sort)

The following two activities have the potential for falls as a result of specific issues:

- ***Driving from location to location*** – if operatives ride on the tailgate of a vehicle there is the possibility of a fall with serious consequences. However, it is noted that this practice is prohibited and rare, although the potential exists. In addition, with Stillage vehicles, particularly where operatives sort and empty receptacles on the vehicle, there may be an incentive to remain on the vehicle whilst it moves to the next collection point, even if prohibited. In this case the likelihood of a fall from a vehicle will depend on the vehicle, but also on whether constraints to prevent a fall are present and used.
- ***High-rise bags collect*** – where a door-to-door collection from flats is carried out stairs may be used to move from floor to floor if lifts do not exist, are out of order or are chosen not to be used.

D4.9.2.2 Post-collection

Post-collection all activities associated with vehicles have been assumed to present a risk of falls from height during entry or exit from the vehicle. Again, the likelihood of this is dependent on the vehicle design. There may be particular precursors that make a fall more likely, such as steps and boots contaminated with waste material.

Other activities involving working at height include:

- ***Vehicle reversing*** – it has been assumed that one of the vehicle occupants will leave the vehicle to guide it back and thus are exposed whilst leaving the cab.
- ***Emptying vehicle –*** where sites include a pit for tipping, as opposed to tipping onto the ground it has been assumed that there is an increased risk of a fall from height. A pit has been assumed for transfer/bulking stations, MBT plant and incinerators, based essentially on where residual waste is handled. Otherwise it has been assumed that the risk results from the climb in and out of the vehicle.
- ***Maintenance*** – there may be the potential for working on machinery at height. The likelihood of a fall will depend greatly on the access arrangements, whether permanent or temporary and any fall arrest controls in place.
- ***Loading vehicles*** – where lorries requiring sheeting up are utilised. The level of risk will depend on the method of sheeting, for example whether automatic or manual, whether gantries are present and if not the fall arrest controls in place.
- ***General housekeeping*** – it has been assumed that general housekeeping involves exposure to falls from height from use of step ladders and also where tipping pits exist.

D4.9.3 Hazard ratings and justification

Tables D74 and D75 in Annex D3 list the probability and consequence ratings assumed for this hazard category for collection and post-collection activities respectively.

In all cases consequences have been assessed on the basis of the height of the fall, what the ground is likely to be like and whether employees are likely to be carrying items that prevent them using hands and arms to protect other parts of the body. In most cases the most likely outcome of a fall has been assessed as between minor and a greater than 3 day absence (2.5). For the following scenarios a different consequence rating has been assessed:

- ***Driving from location to location*** – a fall from a moving vehicle has been assumed to lead to either a major injury or fatality depending on the road speed and traffic density (low and high environmental risk scenarios).
- ***High-rise bags collect*** – a fall on a flight of stairs has been assessed as leading to consequences between 3 and 4 depending on the amount being carried (low or high mass scenarios). It has been assumed that the more material that is carried the less likely it is to try and stop or reduce the impact of the fall. It has also been assumed that because of the distance involved, the consequences of such a fall are greater than a fall from a stationary vehicle.
- ***Unloading collection vehicle*** – where the vehicle tips into a pit, a fall into a pit has been assumed to lead to greater than 3 days absence (3), i.e. slightly higher than a fall from a stationary vehicle. Some mitigation has been assumed from cushioning of the fall by the waste material. The exact consequences will depend on the height of the pit. A pit has been assumed to exist for transfer/bulking stations, MBT plant and incinerators.
- ***Loading or unloading lorries*** – it has been assumed that sheeting or unsheeting of vehicles is carried out as part of these activities. Any fall from a vehicle whilst sheeting or unsheeting has been assessed as leading to a major injury (4) given the distance of the fall.
- ***General housekeeping*** – because the tasks and exposure to heights could vary immensely and that work may involve ladders and stepladders, falling from any one of which could lead to the full range of consequences, a mid point in the consequence scale has been assigned (3).

- ***Maintenance activities* –** maintenance activities, in line with general housekeeping are very variable and therefore the full range of consequences could arise following a fall. However, the nature of maintenance can mean that significant heights are involved. Therefore the consequences have been assessed as a major injury (4).
- ***Climbing in and out of vehicles at a landfill*** – because of the nature of the ground at a landfill, it has been assumed that any fall may lead to slightly greater consequences than a fall from a vehicle in any other circumstance. Therefore consequences of greater than 3 day absence have been assigned.

In terms of probability, falls have generally been assumed to be fairly rare per exposure compared to other hazards. This was supported by the attendees at the workshops whose experience indicated that falls were fairly rare. Therefore ratings in the range of 1 to 3 have been assigned for this hazard category, as summarised below:

- ***Climbing in and out of vehicles*** – the probability of a fall due to this activity has been assessed as either 1 or 1.5, i.e. rare. This is based on the discussions with industry and review of accident records, where provided. It has been assumed that a fall is more likely post-collection due to a mixture of contaminants on boots and steps and rushing.
- ***Falls from moving vehicle*** – as riding on a tailgate has been assumed to be extremely rare per driving activity, a rating of 1 has been assumed. In terms of falling from the back of a stillage whilst in motion, again it has been assumed that procedures would prohibit this activity, but that in practice it would occur. Therefore, taking that it is more likely to occur, but less likely to lead to a fall whilst doing it than from the tailgate, overall an unlikely (2) rating has been assigned.
- ***High-rise bags collect*** – as stairs are experienced in everyday life it has been assumed that falls are rare (1) to unlikely (2). However, the state of the stairs (environmental risk scenarios) – more trip hazards – and the amount of material being carried (receptacle mass scenarios) – cannot see steps – have been assumed to increase the likelihood of a fall.
- ***Collection of receptacle* –** falls have been assessed as possible but rare (1), increasing slightly (1.5) with high environmental risk, during assisted collections; this will vary immensely from property to property and will in many cases not present any risk from falling where steps do not exist, for example.
- ***Emptying receptacle on Stillage vehicle* –** where operatives have to climb onto vehicles to empty the receptacles there is a chance of falling down the steps. This has been judged to be more likely than from climbing in and out of a vehicle cab due to an increased presence of contamination on the steps, carrying receptacles whilst climbing and time pressure (from task and finish for example). Ratings in the range of 1.5 to 3 have therefore been assigned. The type of material has been assumed to affect the probability because of the effect of contamination on the steps. Therefore, emptying of food waste receptacles has been assessed as having a higher fall probability than emptying of reusable bags (assumed to contain dry recyclables). The amount of material in the receptacle has also been assumed to affect the ratings – high mass scenarios are assessed as higher than low mass scenarios. The difference in rating for the “Stillage box sort empty (separate collect and sort)” activity compared to the “Stillage box sort empty (collect and sort)” activity is because in the former case it is assumed that the sorter stays on the vehicle and boxes are passed up to them. Therefore, they would only potentially fall whilst moving off the vehicle to return to the cab. In which case they are assumed to not be carrying anything.

- ***Loading or unloading lorries –*** as discussed above, sheeting or unsheeting lorries is assumed to present a non-trivial risk. However, due to improvements in this area, such as gantries or automatic sheeting, it has been assumed that the probability is fairly unlikely although not rare and a rating of 2 has been assigned. Obviously the probability at a particular site will vary enormously dependent on the controls in place.
- ***General housekeeping –*** because most activities will not expose someone, the probability of a potential fall from height has been assessed as rare (1).
- ***Maintenance –*** compared with general housekeeping it is assumed, with the exception of landfill, that exposure to heights is much more likely, although better controls are likely to be used. Therefore on balance, the probability has been assessed as unlikely (2). For landfill, it has been assumed that the exposure to heights is less likely hence the rare (1) rating.

D4.9.4 Hazard specific modifiers

Hazard specific modifiers are generally 1, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity, with the exception of the following activities.

Collection systems:

- ***Assembling of collection crew at start of shift and pre-round activities*** – the number of climbs into the vehicle will be between 2 and 3 times the number of assemblies (depending on the number of crew members). A hazard modification factor of 2.5 has therefore been assumed.
- ***Driving from location to location (tailgate)*** – this is a prohibited and therefore rare activity. It has therefore been assumed to occur in 1 in a 10000 driving operations. Therefore a hazard specific modifier of 0.0001 has been assigned.
- ***Driving from location to location (within stillage)*** – vehicles moving whilst someone is on the working platform of a stillage vehicle has been assumed to occur in 1% of cases. Therefore a hazard modification factor of 0.01 has been assigned.
- ***High-rise bags collect*** – assuming between 2 and 3 sacks are carried by each operative (2.5 sacks per person on average) and 6 flats per sack an operative therefore goes down stairs once for every 15 flats collected from. This gives a hazard frequency modification factor of 1/15 (0.067).
- ***Receptacle collect*** – where assisted collection is relevant, i.e. kerbside collection, operatives may be exposed to steps within a property's boundary. If assisted collections are assumed to account for 10% of collections and 10% of these contain a hazard of falling then there is a 1% chance of leading to a hazard that can lead to a fall. The hazard modification factor in these cases is therefore assumed to be 0.01.
- ***Stillage box sort (separate collect and sort)*** – it is assumed that the sorter climbs onboard the Stillage vehicle once for every 20 houses collected from. This gives a modification factor of 1/20 (0.05).

Transfer/bulking station:

- ***Unloading collection vehicle (stillage***) – the component frequency factor, shown in Table D2, relates to the number of times the stillages are removed and emptied. However, the frequency of climbing out of a vehicle is going to depend on the number of overall Stillage vehicle empties. This can be calculated based on the values in Table D2 as 0.33/1.6 (0.2).

- ***Loading of material*** – it is assumed that the shovel loader operator climbs in and out of the vehicle for each lorry loaded. The derivation of the frequency modification factor for this activity, shown in Table D2, was based on a shovel loader with capacity 1 tonne loading a 30 tonne capacity vehicle. Therefore the hazard modification factor is 1/30 (0.033). This then also gives the correct frequency for the sheeting up operations.

MRF:

- ***Loading material onto conveyors, mechanical sorting and storage of recovered fractions (shovel loader)*** – it is assumed that the shovel loader operative is in his cab for a prolonged period of time, and loads an articulated lorry load of waste for each climb in and out of their cab. Therefore, the number of climbs relative to the number of shovel loads is again 1/30 (0.033).
- ***Loading lorries (shovel loader)*** – it is assumed that the shovel loader operator climbs in and out of the vehicle for each lorry loaded. The derivation of the frequency modification factor for this activity, shown in Table D3, was based on a shovel loader with capacity 1 tonne loading a 30 tonne capacity vehicle. Therefore the hazard modification factor is 1/30 (0.033). This then also gives the correct frequency for the sheeting up operations.

MBT, composting and incineration:

- ***Loading activities*** – the same hazard modification factors as at the MRF have been assumed.

D4.10 FIRE AND EXPLOSION

D4.10.1 Introduction

Fires and explosions are included where they are directly relevant to the activities. For example a fire in a building not due to the processing of waste and recyclables is not considered to be within scope. There may also be variations in particular systems where a fire and explosion risk is much greater that have not been adequately covered here.

D4.10.2 Component cross-reference

In terms of collection, the only fire risk considered, based on discussion at the industry workshops, is from fires that occur in the back of a collection vehicle due to contaminated waste. This has therefore been captured under the following activity although the fire could occur at any point:

- Driving from location to location

For post-collection systems the main areas assumed to present a fire and explosion risk include:

- ***Handling of heavy/hazardous waste (transfer/bulking station)*** – due to the nature of the materials being handled these could be prone to fire or explosion.
- ***Mechanical sorting (MRF and MBT)*** – paper in mechanical sorting machinery was raised as a particular issue at the industry workshop. This is likely to be more of an issue at an MRF than an MBT plant due to the dryer material.
- ***Delivery of hazardous substances in bulk (incinerator)*** – again due to the nature of the materials being handled they may present a fire or explosion risk, especially if mixed accidentally.

- ***Baling materials (MRF)*** – due to the nature of baling there may be a risk of a minor explosion due to compression of materials to form bales. Compression of plastic bottles may be a particular hazard.
- ***Maintenance (all subsystems)*** – maintenance activities may involve hot work that could start a fire, or could be in an area of methane gas, that could potentially ignite or explode.

Other activities were considered not to constitute a major fire and explosion risk as a result of direct processing of waste and recyclables.

D4.10.3 Hazard ratings and justification

Tables D76 and D77 in Annex D3 list the probability and consequence ratings assumed for this hazard category for collection and post-collection activities respectively.

For the fire in the back of a collection vehicle, this has been assumed to be a rare occurrence (probability rated as 1) leading to negligible consequences (1) based on the relatively few fires compared to the huge number of collections carried out each year, and the lack of any reported injuries following such fires.

For the relevant post-collection activities, all have been assessed as having a probability rating of between 1 and 2, i.e. rare to unlikely. Fires and explosions have been assumed to be more likely with maintenance activities (due to potential ignition sources as part of the work) and baling and have therefore been assessed at 2. Other activities have therefore been assessed as 1.

In terms of consequences for the relevant post-collection activities these have varied between 1 (negligible) and 3 (greater than 3 day absence).

A greater than 3 day absence (3) has been assumed to be the most likely outcome for handling of heavy/hazardous waste (transfer/bulking station) and delivery of hazardous substances in bulk (incinerator) because of the nature of the materials being handled and the close proximity of a worker to the source of the potential explosion.

An outcome of between negligible (1) and a greater than 3 day absence (3) has been assumed for maintenance activities. Where fires occur and explosions are unlikely the most common consequence is property damage and not personal injury, hence a rating of 1 has been assumed. However, where there is the possible presence of methane, for example composting and landfill, a higher consequence has been assumed due to the explosion risk. Composting has been rated as 3 and landfill as 2 because being generally outside is assumed to reduce the consequences, due to the proximity of the worker to the source of fire/explosion.

For baling a minor consequence (2) has been assumed as a result of a potential minor explosion in the baling process.

D4.10.4 Hazard specific modifiers

Hazard specific modifiers are generally 1, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity, with the exception of the following activities:

- ***Loading material onto conveyors and mechanical sorting (MRF)*** – the activity frequency relates to the loading frequency, but the hazard relates to the operation of the mechanical sorter. If 10 tonnes of material are assumed to be sorted per operation, then the hazard modification factor can be calculated as 1/10 (0.1), where 1 is the assumed shovel load in tonnes.

- ***Loading material into sorting drum (MBT)*** – making the same assumptions as for mechanical sorting a hazard modification factor of 0.1 is assumed.

D4.11 EXPOSURE TO SHARP OBJECTS LEADING TO CUTS

D4.11.1 Introduction

This hazard category captures all those hazards that may cut an operative, for example from handling waste material. Sharp objects are inherent in certain waste streams for example broken glass, serrated edges of tin cans and green waste, but are also often hidden unexpectedly in all waste streams, for example in the middle of food waste. Therefore any activity where an operative has contact with waste or recyclables there is the potential for cuts.

Cuts from sharp objects can also lead to other issues such as infection from biological agents, e.g. a puncture wound from a hypodermic needle as needles often carry other people's blood which can be contaminated with a number of viruses. However, these are not captured here but are captured separately under the microbiological hazard category.

D4.11.2 Component cross-reference

In terms of collection, handling sharp objects is potentially an issue with the following components:

- ***High-rise bags collect*** – operatives are assumed to physically handle dry recyclables while transferring material into slave sacks.
- ***Disposable bags collect and empty*** – these may contain a multitude of objects that have the potential to cut an operative. Sharp objects contained in the bags can easily protrude as the bag is lifted, carried or swung into a vehicle. In order to minimise the risk operatives should visually check the bag for obvious hazards, carry the bag away from the legs and not carry the bag over the shoulders. In areas where there is a particular problem, for example from drug abuse, operatives may be issued with ballistic trousers to minimise the risk of cuts to the legs as bags are carried.
- ***Reusable bags collect and empty*** – again any sharp objects may protrude from the bag and could cut an operative. The risk of cuts will depend on how the bag is carried and the PPE worn. Emptying reusable bags containing green waste is assumed to be an issue, as this material often has to be handled out of the receptacle and pushed into the back of an RCV (if collected in this way).
- ***Big wheeled bin (Euro and Palladin) collect*** – generally contact with sharp objects is considered to be unlikely. However, where there is waste on the ground (overflowing bins) there is the potential, depending on procedures, for operatives to handle this waste and therefore expose themselves to sharp objects.
- ***Slave receptacle collect*** – part of this activity involves operatives tipping boxes or emptying bags into the slave container. There is therefore the possibility of cuts from handling the material either from catching knuckles as the material is tipped or directly if they physically remove material from a bag/box.
- ***Wheeled bin collect*** – in line with big bins there is generally no risk of cuts from handling sharp objects. However, where bins are overloaded, and depending on

procedures/policy, operatives may remove excess waste from the bin before taking the bin to the collection vehicle. This activity therefore exposes operatives to a risk of cuts.

- ***Box sort and empty*** – operatives are at risk of cuts from physically handling material during the sorting phase. A particular issue raised at the industry workshop was that often paper is placed on top of boxes and operatives may place their hands under the paper to retrieve other materials (e.g. glass and cans). This may increase the risk of cuts because of not seeing the material deep in the box as the operative delves.

The remaining collection components have been neglected as it is assumed that it is extremely unlikely that operatives handle the waste and recyclables directly.

For post-collection it has been assumed that the following components present a risk of cuts from handling sharp objects:

- ***Handling of heavy/hazardous waste (transfer/bulking station)*** – the nature of the materials may mean the potential for cuts.
- ***Pre-sorting of materials (MRF, and composting)*** – any manual sorting of materials presents a risk of cuts, particularly when physically walking on the waste to pull out non-conformant material.
- ***Manual sorting (MRF) –*** again, manually sorting of material on a picking line exposes operatives to a risk of cuts.
- ***General housekeeping –*** as part of this activity, workers may have to handle many different materials, including waste and recyclables.
- ***Maintenance*** – this activity includes the unblocking of machinery and therefore exposes workers to waste and recyclables, including sharp objects.

For the other activities, such as loading and unloading, it has been assumed that contact with waste material is unlikely due to the use of mechanised emptying or loading. Where this is not the case, for example at a small site where a greater degree of manual handling may be prevalent, then the risk from this hazard would have to be included for these other activities.

D4.11.3 Hazard ratings and justification

Tables D78 and D79 in Annex D3 list the probability and consequence ratings assumed for this hazard category for collection and post-collection activities respectively.

The most likely consequences due to being cut from handling sharp objects have been assessed as acute only and requiring minor first aid treatment (rating of 2). This has been assumed for all activities.

In terms of probability (with the exception of handling disposable bags), this hazard has been assessed in the range of 1 to 3, i.e. rare to possible, depending on the nature of the material being handled, how often it is being handled each time the activity is carried out and the usual level of protection.

For the activities involving handling of dry recyclables these have been assessed in the range of 1.5 to 2 depending on the amount of material in the receptacle (low and high mass scenarios), i.e. more material equates to a higher likelihood of being cut. However, the probability has been assessed as fairly low due to wearing of gloves and the procedure of returning boxes containing broken glass. However, it was noted at the industry workshop that it was unlikely in reality that boxes containing broken glass would be returned without sorting and emptying. This applied to the following components:

- High-rise bags collect
- Slave receptacle collect
- Kerbsider box sort empty
- Stillage box sort empty (collect and sort)
- Stillage box sort empty (separate collect and sort)

Handling of disposable bags (black sacks) were assessed as having the greatest likelihood of cutting an operative due to the bags providing very little resistance to sharp objects protruding and the type of material contained within them (residual waste). However, due to procedures in how to carry bags and protection, i.e. ballistic trousers and gloves, they were assessed with a rating around 3, increasing slightly to 3.5 when full (high mass scenario). The reason for only a small increase is that operatives are assumed to carry more bags simultaneously when they contain less material. The majority of the risk was assumed to exist when carrying the bag from the property boundary to the vehicle, and not in placing the bag into the back of the vehicle, due to the proximity of the bag to the body in the former case compared to when placing it in the vehicle. In the latter case ratings of 1.5 and 2 have been assumed for the low and high mass scenarios respectively.

Handling of reusable bags are assumed to present less risk than with disposable bags as they are more resilient to puncture and also because they are assumed not to be used for residual waste, which is assumed to be intrinsically more hazardous. In addition, because of the controls in place, i.e. gloves, other clothing and methods for carrying the bags, it has been assessed that obtaining cuts from carrying such material is fairly rare, increasing with the amount of material in the bag (collect assessed as 1 and 1.5 for low and high mass scenarios respectively). In terms of emptying, because it is assumed that operatives may pull the material out of the bag and may push this into the collection vehicle, a higher rating has been assumed.

For wheeled bins (standard and large), the only risk is during collection, and then only when bins are overfull (high mass scenario). However, the probability of being injured has been assessed as being unlikely (2), even though the material is likely to be residual waste as operatives are able to see what they are handling, which should minimise the risk.

For post-collection activities, the probability ratings have been assessed as follows:

- ***General housekeeping*** – it has been assumed that because direct contact with sharp objects is unlikely, or where it occurs a good level of protection is used that a rare probability (1) has been assigned.
- ***Maintenance*** – for maintenance, because of the nature of the activity, particularly if unblocking machinery, a higher likelihood of contact with sharp objects has been assumed. Therefore an unlikely rating (2) has been assigned.
- ***Manual sorting*** – for manual sorting activities, both pre-sorting and on a picking line at an MRF, because of the direct contact with waste and recyclables, it is assumed that this leads to a higher likelihood of being cut from exposure to sharp objects. Therefore a rating of 3 has been assumed for pre-sorting and 3.5 for the picking line. The picking line probability is slightly higher to account for exposure being relative to a shift and not per item picked.

D4.11.4 Hazard specific modifiers

Hazard specific modifiers are generally 1, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity, with the exception of the following activities:

- ***Big wheeled bins (Euro and Palladin) collect*** – it has been assumed that material is handled in only 10% of collections. Therefore a hazard modification factor of 0.1 has been assigned.
- ***Slave wheeled bin collect*** – 7 has been assumed as contact with sharp objects occurs for each receptacle emptied into the slave bin and not each time the slave bin is taken to the collection vehicle, which was assumed as 0.14 per household collection (Table D1). Therefore, 7 was the result of 1/0.14.
- ***Slave bag/box collect –*** 2 has been assumed as contact with sharp objects occurs for each receptacle emptied into the slave bag/box and not each time the slave container is taken to the collection vehicle, which was assumed as 0.5 per household collection (Table D1). Therefore, 2 was the result of 1/0.5.
- ***Wheeled bins collect*** – it has been assumed that material is handled in only 10% of collections. Therefore a hazard modification factor of 0.1 has been assigned.

D4.12 EXPOSURE TO EXTREME TEMPERATURE AND SUNSHINE

D4.12.1 Introduction

This hazard category captures health and safety issues associated with extremes in temperature, both hot and cold. Heat stress is likely to be the greatest issue for collection activities as workers are generally outdoors and are involved in physically demanding work. However, prolonged periods in vehicles in hot weather may also be an issue, depending on the ventilation and design of the vehicle, as well as working indoors in hot weather.

Particular issues with the environment for refuse workers include:

- ***Heat stress*** – carrying out physically demanding work, such as collecting receptacles in hot conditions, can lead to heat stress, which may lead to symptoms such as an inability to concentrate, muscle cramps, heat rash, severe thirst, fainting, heat exhaustion or heat stroke (Reference 47). Wearing protective clothing in hot conditions can increase the risk of heat stress.
- ***Cold stress*** – working in cold conditions, particularly when associated with wet and windy conditions may also be a health and safety issue, which in severe cases could lead to hypothermia or frostbite. However, in most cases the risk is associated with other hazard categories, such as slips and trips as a result of wet or icy surfaces, dropping objects as a result of cold hands etc, as those exposed to the elements should have opportunity to shelter from the elements.
- ***Dehydration*** – this can be as a result of heat stress. In such circumstances it is recommended that workers regularly consume water, about 250 ml every 15 minutes (Reference 48). Indeed from discussion with industry, it appears that some organisations issue collection workers with bottled water on hot days.
- ***Sunburn*** – exposure to the sun whilst working outdoors can lead to short term acute effects such as sunburn, ranging from mild to severe, or longer term chronic effects, the most severe outcome being skin cancer.

Overall, the health and safety issues are focused on heat, although cold is implicitly captured.

D4.12.2 Component cross-reference

Temperature stress and sunburn are assumed to be relevant for all activities that occur outdoors, where there is sufficient exposure. Therefore, for collection activities this has been included for all activities with the exception of:

- ***Assembly of collection crew at start of shift*** – only outside for a short period of time. This has therefore been assumed to present a negligible level of risk.
- ***Getting in and out of cab*** – again as the duration of this activity is small the risk from heat or the sun has been assumed to be negligible.
- ***Emptying bins*** – for standard and large wheeled bins it is assumed that the duration of the task and the physical exertion are such that exposure to extreme temperature presents little direct risk.
- ***Operating vehicle machinery*** – the duration of this task is short and little physical exertion is required to complete it. The risk has therefore been assumed to be negligible.
- ***Emptying collection vehicle*** – as with operating vehicle machinery, the risk has been assumed to be negligible.

For post-collection activities, it has been assumed that heat stress is the main issue and not cold stress. This is generally where activities take place either outdoors or even indoors where the activity could be particularly strenuous or where the activity takes place in proximity to sources of heat, such as at an incinerator. Driving tasks post-collection have generally been ignored, with the exception of compaction on a landfill site, as it is assumed that operatives are not enclosed within a vehicle for prolonged periods, particularly outdoors where solar gain could be an issue. It has also been assumed, based on discussion at the industry workshops that modern vehicles will tend to have sufficient ventilation or cooling to minimise any risk and improve comfort. The areas where heat stress has been assumed to be an issue include the following based on the strenuous nature of the activities, exposure to heat and/or outdoor working:

- Handling of heavy/hazardous waste
- Maintenance
- Housekeeping

D4.12.3 Hazard ratings and justification

Tables D80 to D82 in Annex D3 list the probability and consequence ratings assumed for this hazard category.

For collection activities predominantly outside both acute and chronic consequences have been assessed. For these cases it has been assumed that the most likely acute outcome is a minor injury (from sunburn) or a minor health effect requiring treatment (hence a rating of 2). The most likely chronic effect has been assessed to be between long-term reversible and long term irreversible (hence a rating of 3.5) as a result of skin cancer. For the remaining collection activities the following have been assessed:

- ***Driving from location to location*** – this is assumed to be as a result of being in a cab for prolonged periods resulting in heat stress as a result of solar gain. This has been assessed as being a very minor issue, and improbable in modern vehicles, and negligible consequences have been assigned (rated as 1). It is noted that although improbable in most cases discussion with industry suggested that this could be a problem for some (older) vehicles. It has been assumed that chronic effects are not applicable.

- ***High-rise bags collect*** – as this activity is indoors, direct effects of the sun are irrelevant, i.e. sunburn or skin cancer; however, due to the strenuous nature of the activity in hot conditions, heat stress cannot be discounted. It has been assessed as leading to slightly higher consequences than being within a cab because of the nature of the activity, and has been rated at 1.5, i.e. a minor health effect, possibly requiring treatment. Again, it has been assumed that chronic effects are not applicable.

For post-collection activities, it has been assumed, with the exception of landfill that most of the affected activities occur indoors and therefore only acute effects as a result of heat/cold stress are relevant. For these cases, the consequences have been assessed consistent with the collection activity 'high-rise bags collect', and have been rated at 1.5. For the landfill activities, these consequences have been rated in line with those for outdoor collection activities.

In terms of probability, ratings between 1 and 2.5 have been assigned based on the following:

- Heat stress as a result of being in vehicles for prolonged periods of time has been assessed as rare (1) for collection vehicles and slightly higher for compaction vehicles on a landfill (1.5) based on ventilation and cooling available, particularly in modern vehicles. Compaction has been assumed to be more of an issue due to prolonged periods in unsheltered space.
- Chronic effects such as skin cancer have been assessed as rare (1).
- For activities that take place predominantly outdoors, such as collection, and maintenance and housekeeping at a landfill site the acute probability has been assessed as between unlikely and possible, i.e. 2.5. The basis of this was that although sunburn was considered to be a fairly likely outcome, this is only the case at certain times of a year. Also, given controls such as clothing, hats, sunscreen and water to counteract heat stress, on balance over a year, this rating has been assigned.
- For strenuous activities indoors, particularly in hot weather where heat stress has been assessed as the most likely outcome, it was considered to be a fairly rare event although more likely than from spending prolonged periods in a vehicle. Therefore a rating between rare and unlikely (1.5) has been assigned.

D4.12.4 Hazard specific modifiers

Hazard specific modifiers of 1 have been assumed, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity.

D4.13 HIGH-PRESSURE HOSE

D4.13.1 Introduction

This hazard category captures hazards associated with high pressure piping/hoses and includes the following:

- Use of high pressure water hoses – the pressure of the water is assumed to be sufficiently high to cause harm directly or force other objects to hit the worker; and
- Failure of high-pressure hoses on vehicles, i.e. hydraulic systems – this could lead to oil being sprayed out or a hose moving and hitting the operative.

D4.13.2 Component cross-reference

The following activities have been considered as exposing workers to high-pressure hoses:

- ***Assembling of collection crew at start of shift*** – vehicle checks may place operatives in close proximity to high-pressure hoses.
- ***Operating collection vehicle machinery*** – this includes emptying bins, RCV compaction, emptying Kerbsider hoppers or emptying collection vehicles. In all cases it is assumed that these operations are powered by hydraulics and the operative is in close proximity to the hydraulic piping.
- ***General housekeeping*** – it is assumed that high-pressure hoses are used as part of this activity, with the exception of landfill which has been excluded.
- ***Maintenance*** – maintenance of machinery containing hydraulics is assumed to be fairly likely, therefore many maintenance activities may place someone in close proximity to hydraulic piping.

D4.13.3 Hazard ratings and justification

Tables D83 and D84 in Annex D3 list the probability and consequence ratings assumed for this hazard category for collection and post-collection activities respectively.

In all cases, it has been assumed that the most likely injury due to an incident with a high-pressure hose would be acute and minor, possibly requiring first aid treatment. Therefore an acute rating of 2 has been assigned.

In terms of probability, ratings of between 1 and 2 have been assigned, depending on whether exposure occurs due to an activity or whether something must fail first:

- ***Operation of machinery*** – it has been assumed that injury as a result of failure of the hydraulics is extremely rare, hence a rating of 1.
- ***Maintenance*** **–** because of the nature of this activity and the potential to be working on hydraulic systems, failure of such systems has been assessed as more likely than from operating machinery. Therefore a higher probability has been assumed and a rating of 2 assigned.
- ***General housekeeping*** **–** operation of high-pressure water hoses exposes operatives to high-pressure water as part of the task. However, because of a lack of evidence of injuries in this area a rare probability has been assigned (1).

D4.13.4 Hazard specific modifiers

Hazard specific modifiers of 1 have been assumed, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity.

D4.14 HOT PIPE WORK AND STEAM

D4.14.1 Introduction

This hazard category relates to injury that may occur due to contact with hot pipe work or steam. Only pipe work associated with processing of waste and recyclables is considered to be within scope. In addition, issues associated with plant connected to the process but on the periphery, such as power generation, have been excluded.

D4.14.2 Component cross-reference

The only systems and activities where this may generally be an issue is considered to be incineration. However, it is noted that this may be an issue at a particular plant for different systems and should in those cases be taken into account. Activities at incineration plants where contact with steam and hot pipe work is most likely, and have therefore been assessed, includes:

- maintenance; and
- general housekeeping.

D4.14.3 Hazard ratings and justification

Table D85 in Annex D3 lists the probability and consequence ratings assumed for this hazard category for post-collection activities. This was assumed to be irrelevant for collection activities.

Contact with hot steam or pipe work has been assessed as most likely to lead to minor burns or scalds; therefore, a rating of 2 has been assigned. In terms of probability, this has been assumed to be fairly unlikely although, because of the nature of maintenance and general housekeeping and the presence of hot pipe work, not rare. Therefore a rating between rare and unlikely has been assigned (1.5).

D4.14.4 Hazard specific modifiers

Hazard specific modifiers of 1 have been assumed, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity.

D4.15 INSECTS AND VERMIN BITES

D4.15.1 Introduction

This hazard category captures issues associated with insect bites, such as flies and wasps, but also bites from vermin, such as from rats. Contraction of a disease as a result of a bite, for example Weil’s disease from a rat bite, is not captured here, but is included under the microbiological hazard category. Only acute effects of such a bite are captured here, such as a cut. Bites from other animals, such as domestic animals, are also not captured here, and are considered under the other animal hazard category.

Generally insects are considered to be the most likely problem and a direct bite from a rat or similar animal is considered extremely unlikely. This was also supported by participants at the industry workshop. Insects are generally more of a nuisance than a health and safety issue, although a minor sting can require treatment or in the worst case a wasp sting could lead to anaphylactic shock and even death in rare cases in a susceptible individual. The time of year, time of day, waste stream, amount of material and length of time between collections are big factors in whether insects pose a non-trivial health and safety issue. In terms of the assessment, an average has been assumed over the working day across a year. Also, typical collection frequencies have been assumed, ranging between weekly and biweekly.

D4.15.2 Component cross-reference

In terms of collection, insects, in particular, are assumed to potentially be an issue at any point where waste or recyclables are handled or where operators are in close proximity to the waste on the collection vehicle. This therefore captures most activities with the exception of:

- Assembling of collection crew at start of shift;
- Driving from location to location;
- Getting in and out of cab; and
- Walking to and from collection point.

Post-collection, it is assumed that insects are an issue where operatives are in close proximity to waste and recyclables and are not in the confines of vehicles. Therefore, the following activities have been included:

- ***Unloading vehicles*** – it is assumed that operatives generally empty collection vehicle from outside the vehicle and not within the cab.
- ***Handling of heavy or hazardous waste (transfer/bulking station)*** – it is assumed that this is done manually or where mechanically that the mobile plant offers no protection from insects.
- ***Manual sorting (including pre-sorting)*** – in close proximity to the waste.
- ***Inserting temperature probes*** – again, assumed to be in close proximity to the waste.
- ***Monitoring composting process*** – this is assumed to be carried out manually by physically sampling or measuring and therefore leads to someone being in close proximity to the waste. Where this activity is carried out remotely and automatically and involves monitoring via some computer system, this hazard for this activity should be discounted.
- ***General housekeeping*** – it has been assumed that as part of this activity an operative would be in close proximity to the waste.
- ***Maintenance*** – again it has been assumed that the activity would bring someone in close proximity to the waste.

Loading activities have been discounted due to the assumption that shovel loaders are used and operatives are within the confines of the vehicle cab.

D4.15.3 Hazard ratings and justification

Tables D86 and D87 in Annex D3 list the probability and consequence ratings assumed for this hazard category for collection and post-collection activities respectively.

In all cases it has been assumed that the most likely outcome would be very minor and would result from a bite or sting from an insect. Reactions to such a bite or sting and bites from vermin have been considered to be extremely rare. Therefore consequences have been rated as minor injury (acute safety) – 1.

The probability of a bite has been assessed as between rare and unlikely (1 to 2) dependent on a number of factors, including the amount of material (low or high mass scenarios), the type of waste and the proximity to the waste. Generally, however, this issue is considered to be relatively minor and more of a nuisance than a health and safety issue. This view was also supported by participants at the industry workshop. Notwithstanding this, it has been included in the assessment as the potential for a serious outcome exists, particularly in susceptible people.

- ***Collection of receptacles*** – for closed receptacles, i.e. wheeled bins and bags, and collection indoors (high-rise flats), the probability has been assessed as rare (1). For open receptacles it has been assumed that the probability increases slightly with the amount of waste (high mass scenarios); hence these activities have been assessed as either 1 or 1.5.

- ***Emptying receptacles*** – because of the proximity to a greater amount of waste that may attract insects these activities have generally been assessed as slightly higher than rare (1.5) irrespective of the precise scenario. The only exception is for 'high-rise slave sacks empty', which has been assessed as rare because of the waste type.
- ***Emptying collection vehicle*** – because of the volume of waste and a static location it has been assumed that insects are more likely to be present. Therefore, a slightly higher probability has been assigned (unlikely – 2).
- ***Manual pre-sorting (including visual inspection)*** – as part of this activity is assumed to involve walking on the waste pile, due to the volume of waste and proximity to it an unlikely rating (2) has been assigned.
- ***Manual sorting (MRF)*** – as this involves dry recyclables and takes place indoors, a slightly lower rating has been assigned, between rare and unlikely (1.5).
- ***Maintenance and housekeeping*** – with the exception of landfill, these activities are assumed not to involve work always in close proximity to large volumes of waste. Therefore, it has been assumed that insect or vermin bites as part of these activities are rare events (hence rated as 1).

D4.15.4 Hazard specific modifiers

Hazard specific modifiers of 1 have been assumed, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity.

D4.16 MANUAL HANDLING

D4.16.1 Introduction

This hazard category refers to the human effort of transporting and supporting a load including lifting, putting down, pushing, pulling, carrying or moving as defined by the manual handling regulations (Reference 49). Injuries sustained from handling can lead to either acute or chronic ill health due to a musculoskeletal disorder (MSD) such as back or shoulder pain, or a direct injury such as a cut from a sharp edge. For the purposes of this hazard rating, manual handling injuries refers only to those that lead to a MSD. Injury from handling of sharp objects is covered separately under the 'handling sharp objects' hazard category. It should be noted that this hazard refers to any MSD injury and is not limited to the back so therefore covers upper and lower limb disorders.

It is assumed that all operatives will have received some manual handling training. It is further assumed that the receptacles handled during collection are in good condition and the MRF sorting station incorporates good ergonomic design principles as outlined in HSE guidance (Reference 50).

D4.16.2 Component cross-reference

This hazard category is included across all systems, as there will invariably be some form of handling that occurs for example during maintenance activities, litter picking or sheeting a lorry. The most frequent handling activities occur mainly during collection and at the materials recycling facility.

The reasoning behind the inclusion of this hazard category for specific components is summarised below.

D4.16.2.1 Collection

Exposure to this hazard is considered in the following components:

- ***High-rise bags collect*** – this is taken to be from the point where material is first placed into the bag, walking between locations carrying the bag, and then returning to the vehicle with a full sack.
- ***Disposable bags pull out*** – this requires an operative to lift and carry a bag/bags to a central point for collection. However, this activity is not captured separately as it is assumed that the risk from this is implicitly captured under “Disposable bags collect”.
- ***Disposable bags collect*** – this generally involves stooping to lift a bag or bags from the kerbside or the central collection point and carrying them to the collection vehicle.
- ***Reusable bags collect*** – it was pointed out at the workshops that the types and size of reusable bags vary. For example the sack observed during data collection was made of white nylon with one handle at each side, and a handle strap on the base. The ratings are assumed to cover a range of reusable bags.
- ***Big wheeled bins (Euro and Palladin) collect*** – an operative is required to push and pull the large Euro style wheeled bins or Palladins from the collection point to the vehicle.
- ***Food waste collect*** – an operative will pick up the food waste bin from the presentation point and carry it to the collection vehicle.
- ***Kerbside box collect*** – an operative will pick up the kerbside box from the presentation point and carry it to the vehicle. (In separate collect and sort, an operative will lift the box onto the vehicle).
- ***Slave receptacle collect*** – operatives will push/pull a wheeled bin, or carry a slave bag or box, to go from one presentation point to another and empty the contents from a receptacle into the slave container. This combines a push/pull or carry task with a lifting task.
- ***Wheeled bin collect*** – operatives will push and pull wheeled bins from the presentation point to the collection vehicle.
- ***Disposable bags empty*** – this activity generally involves extending the upper limbs away from the body to lift and throw a bag into the rear of the collection vehicle. The throwing action may also lead to some trunk twisting.
- ***Reusable bags empty*** – this activity generally involves extending the upper limbs away from the body to lift and throw a bag into the rear of the collection vehicle. The throwing action may also lead to some trunk twisting. The bags are shaken to fully empty them and are then retrieved.
- ***Big wheeled bins (Euro and Palladin) empty*** – the large ‘Euro’ or Palladin style bins are manoeuvred onto the vehicle’s bin lift mechanism.
- ***Food waste empty*** – an operative will lift and shake the food waste bin to empty into a vehicle container.
- ***High-rise slave sacks*** – the sack needs to be lifted/thrown to empty the contents into the collection vehicle. The bags are shaken to assist emptying and then retrieved.

- ***Wheeled bins empty*** (including slave bin) – the wheeled bins are manoeuvred onto the vehicle's bin lift mechanism.
- ***Kerbsider box sort empty*** – this involves hand sorting into hoppers at the side of the vehicle and additional carrying of the box along the hoppers.
- ***Stillage box sort empty (collect and sort)*** – this involves hand sorting into stillages either from outside the vehicle or within the vehicle body. This is likely to require additional lifting and carrying as they move around the vehicle, including going up and down steps.
- ***Stillage box sort empty (separate collect and sort)*** – a single operative will remain within the vehicle and be passed a kerbside box to empty. This involves lifting of the box and sorting the contents.

For the following components it is assumed that there is no manual handling:

- Assembling of collection crew at start of shift;
- Driving from location to location;
- Getting and out of the cab;
- Walking between collection points;
- Operating vehicle machinery; and
- Emptying collection vehicle – Stillage vehicle, Kerbsider, and RCV.

D4.16.2.2 Post-collection

For post-collection activities it is assumed that wherever general housekeeping and maintenance activities occur this will expose workers to manual handling for example litter picking, handling of machine parts and cleaning fluids. At the MRF and composting sites it also assumed that on occasions pre-sorting of materials would be required to remove unwanted items such as computers or animal waste. At the incineration plant the unloading of hazardous waste substances involves the handling of large, heavy pipes. At the MBT and in-vessel composting sites the inserting of temperature probes exposes workers to manual handling risks. It is assumed that all of these handling activities are relatively infrequent.

The areas where there is a greater risk of a manual handling injury include:

- ***Manual sorting at the MRF*** – workers stand/sit at conveyor belts and sort through the material. This involves frequent handling that exposes the musculoskeletal tissue, particularly of the upper limb, to low-magnitude forces. Factors that will affect the risk of injury include the hours spent working without a sufficient rest break, the conveyor belt design and the frequency of handling.
- ***Manual movement of biscuit bales*** – in addition to large bales, some plants produce small bales that are manually transferred from the baler onto a pallet. This requires the bales to be lifted and carried. It is assumed that to transfer the bales onto a pallet they are handled near to floor level up to roughly waist height. In this case there is a significant manual handling hazard. The manual handling rating for baling is only relevant for biscuit bales and should be discounted for large bales.
- ***Screening of material and bagging finished product*** – the bagging of the screened material involves a worker capturing the material in a bag as it exits the screener and

then loading it onto a lorry. It is assumed this activity occurs on a frequent basis with the handling of loads up to 25kg.

The activities listed at composting sites reflect those at relatively large processing sites with a high degree of automation. It is understood that a greater number of handling activities occur at smaller sites. For the purposes of this project, the focus is on the larger processing sites.

It is assumed that manual handling is not a hazard for the remaining post-collection activities, because of the assumed use of mobile plant, e.g. shovel loaders, including:

- Loading and unloading of materials from vehicles into shredders, screeners, conveyors, millers etc;
- Loading of material onto windrows;
- Turning of windrows;
- Monitoring compost process;
- Taking finished product to stockpiles; and
- Opening and closing of in-vessel doors.

D4.16.3 Hazard ratings and justification

Tables D88 to D90 in Annex D3 list the probability and consequence ratings assumed for this hazard category.

D4.16.3.1 Hazard ratings and justification – collection

To determine the manual handling hazard ratings, an iterative process has been adopted. Initial ratings were developed from a group rating session that involved people from the project and HSL manual handling experts. The ratings developed from the initial group rating session were based upon the following assumptions:

- An increased environmental risk can lead to a greater chance of injury, but the consequence is the same. This is to reflect that walking over uneven terrain may increase the chance of the body becoming out of balance and thus increasing the load on the muscles and spine to regain balance. The environmental risk is likely to influence the risk of an acute injury more than a chronic as it relates to accidental injury.
- In high housing density areas there is a greater probability of injury and potentially more severe consequences. This is to reflect the greater intensity of the work in higher density areas with correspondingly more time spent handling. A continual, constant work rate whilst handling will fatigue the muscles thus reducing the bodies tolerance level to a given load.
- Where the mass is high there is a greater probability of injury and a more severe consequence compared to the low mass estimates. This is to reflect that the greater the load, the greater the risk of injury and potentially the greater the consequences.

The initial ratings were then separately sense checked by the manual handling experts by cross comparing the different systems against disposable bags. The collection and emptying components were compared separately. In addition some similar components such as large wheeled bins and Palladins were also compared with each other to ensure the ratings reflected the assumptions. This process resulted in changes to some of the group rated scores.

The relevant assumptions upon which the sense checking is based are detailed below.

Project team ratings

Disposable bags (collect and empty): the collection of bags generally involves stooping to lift bags from the floor and carry them to the vehicle. This primarily involves greater forces being regularly placed on the back, particularly at the point of lifting. The bags can also be held away from the body when carrying to reduce contact with the legs. Holding bags away from the body means that the weight of the bags is taken solely through the arms and shoulders. Therefore, when collecting a high mass from high housing density areas the risk of injury is considered to be probable. In low housing density areas and low mass the risk is considered to be unlikely.

The emptying of bags involves a short impulse action to throw the bags into the rear of the vehicle, over the height of the rave bar. This action may involve some twisting of the back and lifting above shoulder height. When working in high housing density areas and emptying a high mass the risk of injury is therefore considered to be probable.

The consequence of an acute injury for both collection and emptying is considered to be relatively low. This is because minor aches and pains are likely to be the most common injury and it is assumed that workers will generally feel able to continue to do their job. Where there is a lengthy absence this is taken to be a chronic case and is more likely to be short or long term reversible ill health.

Reusable bags (collect and empty): there is a greater probability of an acute or chronic injury during emptying reusable bags compared to disposable bags as the arm is generally lifted higher (i.e. load is held further away from the body), individual bag weights are likely to be higher so increasing the force required to throw them into the RCV, and the bag has to be shaken/retrieved. It has been assumed the severity of the consequence would be similar to that of the disposable bags.

The acute and chronic risk for collection of reusable bags is approximately the same as for disposable bags. During collection, the reusable bags tended to be dragged rather than lifted. Due to the size of the bags, there appeared to be less need to stoop to reach them, which could reduce the risk of injury. However, the individual bag weights are likely to be greater so the overall risk is assumed to be similar to disposable bags.

Sacks – high-rise bags (collect and empty): the probability of an acute or chronic injury during emptying is considered to be the same as that of reusable bags, which reflects the need to keep the upper limbs elevated when retrieving the bags and the range of awkward shapes/sizes of the reusable bags. The severity of the consequence is assumed to be similar to that of the disposable bags.

The probability of an acute or chronic injury during collection is considered to be higher than for reusable and disposable bags due to the need to handle in more confined areas, and up and down stairs. The severity of the consequence is assumed to be similar to that of the disposable bags.

Big wheeled bins – collect and empty (Euro bins not Palladins): there is a greater probability of an acute injury when collecting in high environmental risk areas compared to disposable bags, although the consequence is considered to be the same. Handling over a poor surface increases the force required to manoeuvre the bin. It could also lead to more instances where sudden action is required to maintain control of the bin where unpredictable stresses can be imposed on the body. Therefore, it is assumed there is a greater probability of an acute injury. The chronic injury risk rate is considered to be the same as for disposable bags in high environmental risk areas.

In low environmental risk areas, compared to bag handling the probability of an acute or chronic injury during collection and the severity of the consequence is considered to be less. This is because the level of force required to push and pull a given weight is less than what is required to lift and carry.

The acute and chronic probability and consequence ratings for emptying are similar to disposable bags. This is because the manoeuvres required to position the large and potentially very heavy bin onto the lifting mechanism could generate quite large forces within the back.

Palladin bins – collect and empty: these types of bins generally have small wheels in relation to the size of the container. This can make them more difficult to handle, particularly over rough surfaces. Therefore, the principles that apply to big wheeled bin handling also apply to the Palladins for collection and emptying. In both low and high environmental risk areas the risk of an acute injury and the consequence has been rated higher than for handling Euro bins. The risk of a chronic injury and the consequence have also been rated higher than for handling Euro bins.

Wheeled bins – collect and empty: the probability of an acute or chronic injury during collection in high environmental risk areas is similar to that of disposable bag collection. It is assumed that when handling over poor surfaces, up and down kerbs and so on, to maintain control of the bin, unpredictable stresses could be imposed on the body. In low environmental risk areas it is assumed the probability of an acute injury is lower as less force is required to handle the bin than to lift and carry bags.

The probability of an acute or chronic injury during emptying is assumed to be lower than for disposable bags. This is because the force required to manoeuvre the bins is assumed to be less than for throwing bags. There would also be less twisting involved than for throwing.

Slave wheeled bins – collect and empty: there is a greater probability of an acute or chronic injury during collection, compared to wheeled bins, because another receptacle is lifted and emptied into the slave bin. The risk of injury is therefore considered to be similar to that of handling bags. The acute and chronic consequence is considered to be similar to disposable bags.

The emptying of the slave bin is assumed to have the same degree of risk and consequence severity as a wheeled bin.

Kerbside box – collect: there is a lower risk of an acute or chronic injury during collection compared to disposable bags. This is based on the assumption that symmetrical loading of the body presents a lower risk of injury than asymmetrical loading. Therefore, this applies to where good handling technique is adopted and both hands are used to carry one box at a time. The box is also generally held against the body, thereby transmitting more of the weight directly to the trunk, increasing the control over the load, and reducing the load on the arms and shoulders. The acute consequence is considered to be similar to the disposable bags ratings. The chronic consequence for high housing density and high mass is considered to be lower than the disposable bags ratings but all other consequence ratings are considered to be the same.

Kerbside box: Kerbsider vehicle – empty: there is a lower risk of an acute or chronic injury during emptying a kerbside box at a Kerbsider vehicle compared to disposable bags or wheeled bins. Any MSD injury is more likely to be to the wrists or hands, and could lead to similar ill health consequences as the handling of wheeled bins.

Kerbside box: Stillage vehicle (worker dedicated to sorting) – empty: the risk of an acute or chronic injury is considered to be similar to that of disposable bags because of the frequent lifting of a full box in a confined space, and the need to potentially sort to shoulder height and above. The consequence of injury is also considered to be similar to that of disposable bags.

Kerbside box: Stillage vehicle (collection and sorting combined) – empty: in this system it is assumed that some hand sorting occurs, thereby gradually reducing the weight of the box as the collectors work around the vehicle. However, due to the need to sort to shoulder height and above, to work in confined spaces, and to negotiate steps whilst handling the risk is considered to be greater than when using the Kerbsider type vehicle.

Overall it is considered that the risk of either a chronic or acute injury is similar to that of wheeled bins although the types of injury that occur may be different. It is assumed that the severity of the consequence will also be similar to that of wheeled bins.

Food waste – collect and empty: the acute and chronic risk ratings for collection are considered to be similar to the kerbside box collect. Although the receptacle for food waste collection would lead to an asymmetrical lift, generally the loads experienced would be lighter than the disposable bags because only one would be carried at a time. The container could also be easily carried in front of the body.

The acute and chronic risk ratings for emptying are considered to be less than for disposable bags but not as low as the Kerbsider empty ratings. This is because the container was carried up steps to be emptied. The rating is considered to be less than disposable bags, however, because generally both hands are used to empty the contents, and no throwing is required.

Workshop rating comparison

The expert rating scores were compared with those obtained at the workshops. Due to the complexity of the ratings, it was not possible to obtain a complete range of scores. Therefore in most instances the scores obtained at the workshops were taken to represent an average of all the possible scores. The workshop ratings and justification for the final scores is discussed below.

Disposable bags collect: attendees at the workshop rated the acute and chronic probability as a 1 to 3, and the consequence as a 2 to 3. It was felt these ratings would change with the housing density and mass. The acute probability ratings given by the project team for collection ranged between 1.5 and 4, and the acute consequence ratings ranged from between 2 and 2.5. In this case the project team probability ratings would seem a little high compared to the workshop ratings. The high probability rating was given to reflect the increased likelihood of an injury when collecting in high density areas and handling a high mass, both are known risk factors that will increase the risk of injury. To reflect the opinion given at the workshops the highest acute probability rating was reduced to 3.5.

The chronic probability ratings given by the project team ranged from 1 to 3 and the consequence ranged from 2 to 3.5. These figures are in line with those given at the workshop.

Reusable bags collect: attendees at the workshop rated the acute and chronic probability to be a 1 to 2, and the consequence to be a 2 to 3. It was felt that in high housing density areas these ratings would increase to 3.5, as operatives could be more likely to pick up more than one bag at a time. The project team acute and chronic probability ratings were between 1 to 3.5 and 1 to 3 respectively. The consequence acute and chronic ratings were 1 to 2.5 and 2 to 3.5 respectively. The ratings given at the workshop seem to reflect the opinion of the project team.

Reusable and disposable bags (including high-rise slave sacks) empty: the workshops rated the acute and chronic probability as a 2 to 4, and the consequence as a 2 to 3. It was felt that having to throw the bags over rave rails and shaking them increased the risk of injury, as did working in high housing density areas. This reflects the assumptions of the project team. The acute and chronic probability ratings given by the project team were 1.5 to 4.5, and 1 to 4 respectively. The acute and chronic consequence ratings from the workshop were between 1 to 2.5 and 2 to 3 respectively. Again, these ratings seem to reflect those of the project team.

Note, ratings were not given for the collection of high-rise slave sacks, due to a lack of experience of this at the workshops.

Big wheeled bins (Euro and Palladin) – collect and empty: the project team rated the acute probability of Euro bins from 1 to 4 and for Palladins as 1.5 to 4.5. The chronic probability ratings for Euro bins are 1 to 3 and for Palladins they are 1.5 to 4. The workshop rated the low mass acute and chronic ratings as a 2 and from their experience the risk of injury increased with high environmental risk. The higher probability ratings given by the project team reflect this opinion. For the low mass ratings the probability has been increased to 1.5 for Euro bins and 2 for Palladins to better reflect the workshop opinion.

The project team acute consequence ratings for Euro bins are 1 to 2.5 and for Palladins 1.5 to 3. The chronic consequence ratings for Euro bins are 2 to 3.5 and for Palladins they are 2 to 4. The workshop rated the high mass/high environmental acute and chronic probability risk as a 4. The project team acute rating is less than the chronic rating to reflect that if a lengthy absence from work is required then the MSD injury is more likely to be chronic. In this case the ratings have not been altered.

Wheeled bins – collect: the workshops rated the acute and chronic probability ratings for low and high housing density areas as a 2, and where there is a high mass it was felt this should be a 3. The project team acute and chronic probability ratings are 1 to 3 and 1 to 2 respectively. The workshop ratings reflect the project team opinion for the acute risk but not the chronic. To raise it to 3 would give this the same risk of injury as handling disposable bags. It is considered that this would be too high and does not represent the greater risk expected from handling bags. It was therefore decided to leave the highest chronic probability rating as a 2.

The workshops rated the acute consequence ratings for low and high housing density areas as a 2 and the chronic as a 3. In high mass areas it was felt the acute rating should be 3 and the chronic a 4. The project team acute consequence ratings are 1 to 2 and the chronic 2 to 2.5. These ratings are therefore similar to those given by the project team but with the exception of the high mass chronic rating. It is considered that to increase this to a 4 gives it a disproportionate most likely consequence of injury compared to the handling of big wheeled bins, which has been rated as 3.5. It was therefore decided to leave the highest chronic consequence rating as 2.5.

Slave wheeled bins – collect: the workshop attendees felt that the slave bin method of collection posed the same risks of injury as wheeled bins. However, the project team believe there is an increased likelihood that an injury could occur as this method would require a worker to lift and empty a receptacle into the bin as well as pushing and pulling the bin to each presentation point.

Wheeled bins – empty: the workshop ratings for emptying of bins were considered to be the same as for collection. This included the high mass/high housing density probability score of 3 and chronic consequence score of 4. Again, this is in discord with the high mass/high housing density ratings given by the project team, which for the chronic probability and consequence rating it was a 2. To better reflect the workshop probability and consequence rating the figure has been changed to 2.5 for both criteria. However, the chronic consequence has not been made any higher for the reason outlined under the wheeled bin collection.

Kerbside box – collect: at one of the two collection workshops there were opposing opinions to what the ratings for kerbside collection should be. One proposal was that all acute and chronic probability ratings should be a 1 to 2, the opposing opinion was that where there is a high mass it should be 3 to 4. At the second workshop the consensus was that where there is a high mass the rating should be 3.5. The project team gave a high mass/high housing density rating of 3. Given the project teams justifications for the ratings as discussed previously, and some joint consensus from the workshops, it was felt that the high end rating should remain as 3.

The acute and chronic consequence rating proposed at the workshop was a 2 to 3. The project team rated these as between 1 (2 for chronic) to 3. The workshop ratings reflect those of the project team.

Kerbside box: Kerbsider vehicle – empty: the project team gave acute and chronic probability and consequence ratings of between 1 to 2 for sorting and emptying kerbside boxes into a Kerbsider type vehicle. This reflects the opinion at the workshop where it was suggested the probability rating should be a 1 and the consequence 2 to 3.

Kerbside box: Stillage vehicle – empty: the project team rated the acute and chronic probability between 1 and 3 for the collect and sort system and between 1 and 3.5 for the separate collect and sort system. The workshops rated the probability between 2 to 3.5. It was felt there was a higher risk of injury for the separate collect and sort system. This reflects the opinions of the project team.

The project team rated the acute and chronic consequence between 1 (2 for chronic) and 3 for both types of Stillage vehicle. The workshops rated these as 2 to 3, which reflects the opinions of the project team.

D4.16.3.2 Hazard ratings and justification – post-collection

For the post-collection low frequency handling activities i.e. general housekeeping, maintenance, delivery of hazardous substances, pre-sorting of materials and inserting temperature probes the acute and chronic probabilities have been assigned based on the following logic:

- Low frequency activities are less likely to cause injury;
- The loads handled are likely to be very variable but some are assumed to be over 25kg so presenting a greater risk of injury;
- With infrequent handling the workers may have a reduced physical capacity for handling heavy loads and therefore may be more at risk of an injury; and
- Because the handling activities are generally low frequency it is assumed there is less chance of cumulative damage through overuse so therefore the risk of a chronic outcome is considered to be low.

The acute probability ratings for low frequency activities range from between 2 to 3.5 with highest probability rating being for maintenance activities. It is assumed that for maintenance activities workers are more likely to have to work in confined spaces and are therefore at greater risk of an injury. The workshops rated the acute probabilities from between 2 to 3, which are in line with the project team ratings with the exception of maintenance. To reflect the opinions given at the workshops the final rating was reduced to 3.

The chronic project probability ratings range from 1 to 2 whilst the workshops range from 1 to 3. Given the assumptions stated above, it was decided not to adjust the chronic ratings to those suggested at the workshops.

The acute and consequence ratings of both the project team and workshops range from 1 to 2 and the chronic ratings were assessed as 2.

Those activities that involve a higher frequency of handling are discussed below in more detail:

- ***Manual sorting*** – the project team gave an acute probability rating of 4 with a consequence of 2. The workshop gave an acute probability rating of 3 and consequence of 3. It was felt that the static nature of this task is likely to lead to a relatively high risk of musculoskeletal problems that may be more easily recovered from and so would not require time off work. Therefore, in this case the ratings were not altered to reflect those given at the workshop. The chronic probability and consequence rating given were respectively 2 and 3 by the project team and a 3 and 3 by the workshop. The ratings reflect the assumption that a chronic injury would be unlikely but should one occur then it would be quite severe.
- ***Moving of biscuit bales*** – it is assumed that the biscuit bales weigh about 8.5kg and are lowered onto a pallet. Handling close to floor level can increase the risk of injury. Therefore the acute probability rating given was 3 and the chronic 1.5. The workshop ratings reflect this opinion with ratings of 3 and 1 respectively. The severity of consequence of this activity was considered to be low with a rating of 2. Again this was in line with the opinion at the workshop.
- ***Bagging compost*** – it is assumed that 25kg bags are used to bag the compost and the frequency can be variable. The acute and chronic probability has been rated as a 3, the same as given at the workshop, which reflects the heavy load handling. It was felt that any absence related to an injury is more likely to be related to a chronic problem, hence an acute consequence of 2 and a chronic consequence of 3.

D4.16.4 Hazard specific modifiers

Hazard specific modifiers are generally 1, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity, with the exception of the following activities:

- ***Slave receptacle collect*** – the manual handling frequency occurs at the frequency that the household containers are emptied into the slave receptacle. Therefore modification factors of 7 and 2 are required for slave bins and slave box/bags respectively as before.
- ***Screening of material and bagging finished product*** – as the frequency of this task relates to loading by shovel loader, a modification factor is required to change this to per bag. Assuming each bag weighs 25 kg then a modification factor of 1/0.025 (40) is required, where 1 is the shovel capacity in tonnes and 0.025 is the weight of a bag in tonnes.

D4.17 EXPOSURE TO METHANE GAS

D4.17.1 Introduction

Methane gas is produced as a natural by-product from bacterial decomposition of waste. It is flammable and explosive when mixed with air in certain concentrations and is also an asphyxiant. However, it is only its toxic properties that are considered here. Fire and explosion as a result of the ignition of methane is captured separately under the fire and explosion hazard category. In terms of waste and recycling, methane is produced as part of composting and also at landfill sites. It is therefore only considered as an issue for the following subsystems:

- Composting (open windrow and in-vessel);
- MBT plant; and
- Landfill.

D4.17.2 Component cross-reference

For the three systems where exposure to methane has been assessed as an issue, it is only maintenance where it is assumed to pose a non-trivial level of risk (neglecting fire and explosion, which is considered elsewhere) to workers due to the nature of these activities, including the possibility of working in confined spaces.

D4.17.3 Hazard ratings and justification

Table D91 in Annex D3 lists the probability and consequence ratings assumed for this hazard category.

Harm from exposure to methane has been assessed as a low frequency relatively high consequence type of event. Consequences have been assumed to be a greater then 3 day absence, and probability has been assessed as rare. This is based on methane being an odourless gas and also on the possibility of lone working during maintenance activities.

D4.17.4 Hazard specific modifiers

Hazard specific modifiers of 1 have been assumed, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity.

D4.18 MICROBIOLOGICAL

D4.18.1 Introduction

This hazard category captures all those scenarios where there is the potential for contact with microbiological organisms that have the potential to cause harm.

These organisms may include:

- ***Penicillium*** – a common mould everywhere. This can trigger allergy if inhaled in large numbers.
- ***Cladosporium*** – a common mould everywhere. As above.
- ***Aspergillus***, including, ***aspergillus fumigatus*** – a common mould everywhere, which grows on rotting vegetation. In particular this may be present in large numbers in compost and can trigger allergy or in some rare circumstances infection if inhaled in large numbers.
- ***Escherichia coli (E coli)*** – food-poisoning bacteria usually associated with faecal contamination.
- ***Salmonella*** – as above, food poisoning bacteria usually associated with faecal contamination.
- ***Clostridium tetani*** – the bacteria that cause tetanus. This may be present in any soil and cause infections through cuts.
- ***Leptospira*** – bacteria that cause Weil’s disease. They grow in rats and may cause an infection through cuts or damaged skin in humans in contact with contaminated rat urine.
- ***Pasteurella multocida*** – bacteria present in animal saliva. This can cause infection through dog bites.
- ***Toxoplasma and Toxocara*** – parasites that may be present in dog and cat faeces and cause infection through hand to mouth contamination.
- ***Zoonoses*** – this can cause infection, which is associated with animal detritus in waste.
- ***Blood borne viruses*** – viruses such as Hepatitis and HIV could be present as a result of clinical waste or contaminated needles from drug users.

Illness/injury received from chemical agents are ignored here as they are captured under the chemical hazard category (Section D4.2).

As part of the collection and processing of waste and recyclables operatives may come into contact with materials that have the potential to cause harm from directly handling the waste and recyclables. Waste material naturally has micro-organisms in it and some processes such as composting rely on large numbers of micro-organisms being present. Collecting and handling waste can create bioaerosols (micro-organisms suspended with dust in the air). There is a potential for inhalation exposure to dusts containing allergenic micro-organisms and proteinaceous material, infection by ingestion following hand to mouth cross-contamination and infection via percutaneous (skin) injury.

D4.18.2 Component cross-reference

This hazard category is considered to be an issue mainly where operatives directly handle waste and recyclables, or may be in contact with bacteria and micro-organisms as part of the activity, for example maintenance (machinery and vehicle), cleaning and housekeeping.

The reasoning behind inclusion of this hazard category for specific components is summarised in the following subsections.

D4.18.2.1 Collection

For the following components it is assumed that there is no contact with waste stream, bacteria or other micro-organisms. This hazard category is therefore neglected for the following components:

- ***Assembling of collection crew at start of shift*** – no contact with waste stream or other microbiological hazards.
- ***Driving from location to location*** – no contact with waste stream or other microbiological hazards.
- ***Getting in and out of cab*** – no contact with waste stream or other microbiological hazards.
- ***Kerbsider hopper empty*** – assumed to be sufficiently far away and in the open such that any aerosols produced as the hoppers are emptied into the vehicle body cause a negligible exposure to the operative.

Exposure to this hazard is considered in the following activities:

- ***High-rise bags collect*** – possible contact with micro-organisms while emptying materials into the slave sack. This activity involves tipping contents of bags into a slave sack and is generally carried out indoors or on enclosed balconies. Therefore operatives are in reasonably close proximity to micro-organisms and dispersion is slow. It is assumed to present a negligible level of risk due to material being dry recyclables. However, as the household receptacle is emptied into the sack there is contact with the waste and possibility of cuts and virus/infection.
- ***Disposable bags collect*** – slight possibility of contact with micro-organisms if bags split, although thought to be fairly unlikely. Mainly an issue through cuts/needle stick injuries as opposed to inhalation.
- ***Reusable bags collect*** – depending on the material being collected there may be a chance of exposure to micro-organisms if bags split, although fairly unlikely. Generally garden waste is collected. Assumed negligible exposure in the fetching of waste as not generally handling the waste.
- ***Big-wheeled bins collect*** – unless these bins are overflowing it is considered very unlikely that operatives would come into contact with micro-organisms. However, for overflowing bins the hazard is included for this activity. As this is an open-air activity it is not assumed to be much of a respiratory issue. There could be an issue with vermin in the vicinity of the bin, however.
- ***Food waste collect*** – unless the food waste bins are overflowing it is considered very unlikely that operatives would come into contact with micro-organisms. However, for overflowing bins the hazard is included for this activity. Organic material such as food waste is capable of microbiological deterioration and poses a hazard.

- ***Kerbside box collect*** – unless the kerbside box is overflowing, there is generally no contact with the material in the boxes during this activity. However for overflowing boxes the hazard is included for this activity. Requirements for manual handling and the typical nature of the material (e.g. cans/glass) can lead to infection via cuts and grazes. Assumed to be minimal risk as materials likely to be dry recyclables rather than residual waste.
- ***Slave receptacle collect*** – unless these receptacles are overflowing it is considered very unlikely that operatives would come into contact with micro-organisms. However, for overflowing receptacles the hazard is included for this activity. Overall, it is assumed to present a minimal risk as materials are likely to be dry recyclables. The greatest exposure comes from emptying household receptacles into the slave containers.
- ***Wheeled bin collect*** – unless these bins are overflowing it is considered very unlikely that operatives would come into contact with micro-organisms. However, for overflowing bins the hazard is included for this activity.
- ***Disposable bags empty*** – slight possibility of contact with micro-organisms if bags split, although thought to be fairly unlikely (compaction captured separately). Potential for cuts and infection as per collecting bags. Some inhalation hazard through disturbing waste in hopper as bag thrown in although this is assumed to be small due to activity being conducted in the open air, small exposure time and material generally in bags.
- ***Reusable bags empty*** – because operatives may have to physically shake these bags empty, and may push the waste material into the back of the collection vehicle there is the possibility of longer exposure contact with micro-organisms. These may enter the lungs, as a result of opening bags and leaning over them whilst shaking to empty. Minimal risk also of cross contamination or percutaneous infection via cuts and grazes.
- ***Big wheeled bins (Euro and Palladin) empty*** – not handling the waste directly, but may be some respiratory hazard due to the close proximity to tipping waste when operating vehicle machinery, e.g. bin lift mechanisms, which could cause a possible exposure. Emptying big wheeled bins is likely to generate more dust containing bio aerosols than emptying normal wheeled bins because of the greater amount of material in the bin.
- ***Food waste empty*** – organic material such as food waste is capable of microbiological deterioration and poses a hazard. Operatives may come into contact with micro-organisms as this activity involves tipping contents of food waste containers into stillages. Therefore operatives are in reasonably close proximity to material and there is a possibility of exposure.
- ***High-rise slave sacks empty*** – operatives will be in close proximity when sacks are being emptied. Because they may have to physically shake these bags empty, and may push the material into the back of the collection vehicle there is the possibility of contact with micro-organisms. These may enter the lungs, as a result of opening bags and leaning over them whilst shaking to empty. Chance also of cross contamination or percutaneous infection via cuts and grazes. Assumed minimal risk however because of typical nature of the material – dry recyclables.
- ***Wheeled bins empty*** – generally this is thought not to be a major issue, due to the minimal contact with the waste stream. However, close proximity to tipping waste when operating vehicle machinery, e.g. bin lift mechanisms, cause a possibility of exposure to micro-organisms.
- ***Kerbsider box sort and empty*** – the operative is in direct contact with recyclables during the sorting and emptying operation, which could be contaminated with micro-organisms; however, the risk is assumed to be minimal. Requirements for manual

handling/sorting and the typical nature of the material (e.g. cans/glass) can lead to infection via cuts and grazes.

- ***Stillage box sort and empty (collect and sort)*** – as above.
- ***Stillage box sort and empty (separate collect and sort)*** – the operative responsible for sorting in this activity is in direct contact with recyclables during the sorting operation, which could be contaminated with micro-organisms, although assumed minimal due to the nature of the material. Requirements for manual handling/sorting and the typical nature of the material (e.g. cans/glass) can lead to infection via cuts and grazes. It is assumed that the risk to the operative only collecting the stillage box is negligible, unless, as previously stated, the box is overflowing.
- ***Slave wheeled bin empty*** – as for wheeled bins empty.
- ***Walking to and from collection point*** – no contact with waste stream, but risk of contact with uncontrolled dogs and subsequent infection from possible dog bite.
- ***RCV compaction*** – compression during the compaction on an RCV could expose operatives to bioaerosols. Operatives are also likely to be standing in close proximity when operating compaction mechanisms, increasing the risk of exposure.
- ***Emptying collection vehicle*** – this is dependent on the vehicle, the waste type and where emptied. However, a generic assumption is that inhalation hazard is the main issue; tipping from vehicles and use of compaction vehicles in tipping halls and at landfill will create aerosols. Large numbers of vehicles congregating to empty waste may be done in enclosed facilities e.g. tipping halls increase risk of exposure. Greatest risk is to operatives outside vehicles operating vehicle machinery. Inhalation hazard is the greatest issue; however, operative may have to touch waste if it falls into the wrong place.

D4.18.2.2 Post-collection

For the post-collection systems it is also assumed that this hazard category is only an issue where operatives are in direct contact with the waste stream, from for example manual sorting or handling the waste or from maintenance, cleaning and housekeeping activities. Most activities are therefore assumed to be affected. For the other activities it is assumed that exposure to microbiological hazards is extremely unlikely and this has therefore been neglected for the following components:

- ***Inward vehicle movements (all post-collection systems, including driving on access road (landfill))*** – workers are generally within vehicles, no contact with waste stream and therefore not exposed.

Exposure to this hazard is considered in the following groups of activities:

- ***Composting*** – composting processes purposefully select degradable waste and increases microbial activity within it. Co-composting with wastewater or sewage sludge can increase possible exposure to faecal bacteria; composting of animal by-products can increase possible exposure to food poisoning bacteria. Activities such as manual pre-sorting require direct contact with waste. Vehicles used to churn up waste, e.g. when turning windrows, creates aerosols. However, this risk is assumed to be balanced by operatives being inside cab, windows closed and air conditioning being used. It is still assumed to present a non-trivial inhalation hazard, however.
- ***Emptying collection vehicle*** – this hazard is incorporated for this activity due to the rigorous movement of material or disturbing material from tipping or dropping waste.

Tipping from vehicles and use of compaction vehicles in tipping halls and at landfill will create aerosols. Large numbers of vehicles congregating to tip waste may be done in enclosed facilities e.g. tipping halls, increasing exposure possibility. Risk is assumed to be balanced by operatives being inside cab, windows closed and air conditioning if used. It is still assumed to present a non-trivial inhalation hazard, however.

- ***Manual handling activities*** – requirements for manual handling of waste/containers can lead to cuts and grazes. Large amounts of manual sorting e.g. at MRFs may create aerosols and is judged to be a possible inhalation hazard due to moving material, even though likely to be dry recyclables. Risk of exposure also via percutaneous injury or cross contamination. Activity may be outdoors; therefore inhalation hazard may be less of an issue, but in close proximity to the waste and handling waste therefore cuts and possibility of infected cuts may be an issue.
- ***Mechanical handling*** – refers to the mechanical handling of waste such as loading compactors or conveyor belts. Shredding, turning and screening, a necessary part of the composting process, generates aerosols. It is assumed that the risk is balanced by operatives being inside a vehicle cab, windows closed and air conditioning if used. However, there may be contamination inside cab. The need to monitor post-collection processes (e.g. checking leachate levels, compost temperatures) also may lead to exposure to micro-organisms.
- ***Maintenance/housekeeping*** – operatives conducting maintenance activities could be in close proximity to the waste and aerosols. Activities such as sweeping/cleaning up during housekeeping may generate aerosols containing micro-organisms. May also use a high-pressure hose that could increase respiratory hazard due to production of aerosols. There is also risk of exposure due to possible working in confined spaces and handling machinery parts that may have contaminated material upon them. Risk also from Weil’s disease due to possible exposure to vermin.

D4.18.3 Hazard ratings and justification

Tables D92 to D94 in Annex D3 list the probability and consequence ratings assumed for this hazard category. These were assessed through discussion with experts at HSL and within the industry at the industry workshops.

For the acute and chronic outcomes probability was generally assessed based on exposure, for example how long exposed, operative’s proximity to the waste and the environment. E.g. for outdoors activities it is assumed that exposure by inhalation is much reduced. Probability was also assumed to depend on the types of waste being collected e.g. mixed general waste as opposed to dry recyclables or garden waste. Mass of bag/bin was assumed to be irrelevant and would balance itself out, as operatives would handle more bags/bins at a time if lighter. Overall probability was generally assessed between 1 and 2 (for both acute and chronic consequences) depending on the above factors.

In terms of the variations from these probability ratings for the collections activities:

- ***Disposable bags collect*** – probability was rated as 3 (possible) for an acute consequence. This was mainly assumed an issue through cuts/needle stick injuries as opposed to inhalation; chronic was therefore weighted a little lower at 2 (unlikely).
- ***Emptying collection vehicle*** – probability was rated as 2 (unlikely) for an acute consequence and 3 (possible) for a chronic consequence. It is acknowledged that this is dependent on the vehicle, the waste type and where emptied; however, a generic

assessment was carried out here. Inhalation hazard was assumed the main issue (bioaerosols) hence the higher chronic rating due to prolonged exposure.

As for collection, for post-collection, probability was generally assessed based on exposure. E.g. outdoors activities means exposure by inhalation is much reduced. Probability was also assumed to depend on the types of waste. E.g. mixed general waste at an MBT was assumed a greater hazard than garden/food at in-vessel, which in turn was assumed a greater hazard than purely garden waste at windrow. Being inside a vehicle for some activities was also assumed to provide some protection due to vehicle air conditioning, although the interiors of vehicles were assumed contaminated. Vehicle design and whether windows are up or down was also assumed to affect probability. Overall, probability was assessed between 1 and 2.5 (for both acute and chronic consequences) depending on the above factors.

In the following components a higher probability rating has been assumed:

- ***Manual sorting*** – this was assessed as a probability of 3 (possible) for acute consequences due to prolonged physical contact with waste, producing a chance of an acute effect from infected cuts etc. This was also judged to be a 2.5 (possible) chronic inhalation hazard due to moving material, even though likely to be dry recyclables.

- ***General housekeeping/maintenance*** – this was assessed as slightly higher probability of 3 (possible) for acute and chronic consequences at incinerators and transfer/bulking stations as opposed to MRFs and landfill. It was assessed that the waste streams dealt with at these plants is likely to pose a greater microbiological hazard and there is a risk of cuts/scratches being sustained when conducting cleaning and maintenance.

- ***Unloading collection vehicle*** – as above, probability assessed at 3 for transfer and incinerators due to the nature of the waste stream. There may be a build up of bioaerosols as typically tipping halls are inside. Operative generally has to go outside vehicle to operate machinery. Inhalation hazard is therefore assessed as the greatest issue. However, may also have to touch waste if it falls into wrong place.

In terms of consequences for collection and post-collection it has been assumed that both acute and chronic effects may occur from contact with micro-organisms. In acute cases the consequences have been assessed in the 1 to 3 range; minor health effect to minor illness >3 days e.g. infected cut, gastrointestinal infection. A chronic outcome may be possible from for example, allergenic respiratory conditions from long-term exposure. These have been judged as ranging from short term reversible to long term reversible. It is noted that the chronic outcome is unlikely for accidental exposure to micro-organisms, and is more likely for activities where exposure occurs routinely, for example when carrying out compaction, manual sorting, maintenance, cleaning and housekeeping activities.

D4.18.4 Hazard specific modifiers

Hazard specific modifiers are generally 1, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity, with the exception of the following activities:

- ***Slave wheeled bin collect*** – 7 has been assumed as exposure to micro-organisms occurs for each receptacle emptied into the slave bin and not each time the slave bin is taken to the collection vehicle, which was assumed as 0.14 per household collection (Table D1). Therefore, 7 was the result of 1/0.14.

- ***Slave bag/box collect –*** 2 has been assumed as exposure to micro-organisms occurs for each receptacle emptied into the slave bag/box and not each time the slave container is taken to the collection vehicle, which was assumed as 0.5 per household collection (Table D1). Therefore, 2 was the result of 1/0.5.

- ***Loading activities*** – post-collection loading/unloading activities are assumed to create an exposure to micro-organisms for each load of material transferred, e.g. a shovel load. Therefore the component frequency modification factors are assumed to be valid and hazard modification factors of 1 have been assigned.

D4.19 EJECTION OF MATERIAL

D4.19.1 Introduction

This hazard category captures those events where material is ejected and may strike an operative. This may occur as a result of emptying receptacles and some material 'bouncing' out, or from operation of compaction on an RCV for example. This has been captured separately to falling objects (see Section D4.7) as the consequences of ejection can be very different due to the energy and direction.

D4.19.2 Component cross-reference

Emptying of boxes/bags into slave receptacles was considered not to be an issue due to the proximity of the container being tipped to the slave receptacle. Similarly, emptying wheeled bins was considered to pose an insignificant risk due to the design of RCVs generally in use, for example rave heights and use of curtains. In terms of collection, the activities that were assessed as presenting a non-trivial ejection hazard included:

- ***Kerbsider box sort and empty*** – generally it was considered through discussion with attendees at the industry workshop that when procedures are followed there is a trivial level of risk from emptying boxes at Kerbsiders. However, where operatives throw objects, particularly glass, into the hoppers, there is the potential for shards of glass to be ejected. This may be done to save moving along the vehicle or to make more room in the hopper. Therefore, although likely to be a prohibited activity there is the potential for it to occur and it has been included.
- ***Stillage box sort and empty*** – the main issue considered here is with emptying through flaps into the stillage from the kerbside. Experience of some at the workshops was, depending on the size of the opening, for material to be ejected back after hitting other material in the stillage. This was said to be a particular problem with glass and shards of glass being ejected. In terms of managing the risk, some were said to be reducing the size of the openings in order to reduce the likelihood of any ejected material leaving the stillage and hitting an operative. Where material is sorted and emptied onboard the vehicle, it is judged that the risk from ejection is likely to be less as operatives, particularly their faces, are further away. This is the case with 'stillage box sort empty (Separate collect and sort)'.
- ***RCV compaction*** – operating the compaction on an RCV may lead to ejection of material as the compaction plate squashes the material. However, design of vehicles, including rave height and use of curtains, and operating the compaction from a position of safety (side and not rear of vehicle) should minimise the risk from ejection, although because of variations in vehicles and variation in operating practices, it cannot be ruled out.

Post-collection, ejection was assessed as much less of an issue, due to many activities being carried out mechanically with operatives generally not being in a position of danger. However, the following were considered to present a non-trivial level of risk due to the nature of the operations:

- Baling materials
- Shredding/milling materials

D4.19.3 Hazard ratings and justification

Tables D95 and D96 in Annex D3 list the probability and consequence ratings assumed for this hazard category for collection and post-collection activities respectively.

In all cases consequences have been assessed as minor requiring first aid treatment, as a result of cuts. However, in the worst case injury to the eyes could occur.

In terms of probability, as discussed above, in most cases ejection of material striking an operative is a relatively rare event, with the exception of stillage sort from the kerbside. Therefore, most activities have been assessed as unlikely or rare (between 1 and 2).

- ***Kerbsider box sort and empty*** – following standard procedures would make ejection very unlikely with this collection method. Therefore, on balance, a rare probability has been assigned.
- ***Stillage box sort and empty*** – where sorted from within the vehicle, an operative being hit by ejected material has been assumed to be very unlikely, due to the reasons outlined above, and has, therefore, been assessed as rare (1). Where sorted from the kerbside, from discussion with industry there appeared to be a particular issue with ejection, depending on vehicle design. This has therefore been assessed in the rare to unlikely (1 to 2) range depending on the amount of material being sorted (low and high mass scenarios). The range of vehicle designs was taken into account in coming to this assessment of the average situation.
- ***RCV compaction*** – because of vehicle design and operating procedures on where to stand, being hit by ejected material was considered unlikely although more likely than when sorting at a Kerbsider. Therefore, overall this activity has been assessed as unlikely (2).
- ***Baling, shredding and milling*** – as operatives are generally not assumed to be in a position of danger, this has been assessed as a relatively rare event although, again, more likely than being hit by ejected material at a Kerbsider. Therefore this activity has been assessed at 2.

D4.19.4 Hazard specific modifiers

Hazard specific modifiers of 1 have been assumed, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity.

D4.20 EXPOSURE TO NOISE

D4.20.1 Introduction

Noise can be an issue throughout the collection and processing of waste and recyclables. This includes from operation of machinery both during collection and post-collection, sorting and tipping specific materials such as glass and tin and general vehicle engine noise. A particular problematic source of noise is the collection and sorting of glass and tin.

Exposure to noise can lead to hearing loss, which can be temporary or permanent. The hearing loss may be sudden if the noise is loud enough or more likely would be gradual over time, i.e. a chronic effect. In addition to hearing loss, exposure to noise can lead to other conditions such as developing tinnitus (ringing, buzzing or humming) in the ears.

In addition to direct health effects from noise, noise is also a significant precursor to other hazardous events, due to audibility problems. For example, a lack of awareness of moving vehicles leading to being struck by a vehicle. These issues are not captured under this hazard, however, and are implicit in other relevant hazard categories.

The Noise at Work Regulations 2005 (Reference 51) set two action levels and a limit based on daily or weekly averages and peak sound pressure. It is the average daily or weekly exposure that is likely to be an issue in the activities considered here.

D4.20.2 Component cross-reference

Noise was considered to be a direct health and safety issue for the following activities:

- ***Assembling of collection crew at start of shift*** – vehicle noise in the depot.
- ***Slave wheeled bin collect*** – tipping of dry recyclables onto dry recyclables within the slave container was judged to be a potential issue, especially if the dry recyclables consisted of mainly glass and tin.
- ***Big wheeled bins (Euro and Palladin) empty*** – operation of the lifting mechanism.
- ***Wheeled bins empty*** – operation of the lifting mechanism.
- ***Box sort and empty (Kerbsider and Stillage vehicle)*** – sorting or tipping glass or tin onto glass or tin is a major source of noise. The amount of noise generated will depend on the method of emptying, e.g. bottle at a time or tipping and whether the hopper is lined. This is described further in Reference 52.
- ***Slave wheeled bin empty*** – operation of lifting mechanism and tipping of dry recyclables. The latter will be a particular noise concern if the material is predominantly glass and tin.
- ***RCV compaction*** – operation of compaction mechanism. Again, the noise level could be exacerbated if the material was predominantly glass and tin.
- ***Kerbsider hopper empty*** – noise will be dominated by tipping of glass and tin onto glass and tin respectively.
- ***Emptying collection vehicle*** – operation of vehicle tipping mechanism will be a potential source of noise. However, this will be dominated by tipping of the contents if mainly glass and tin. There may also be other general noise where tipped, from other vehicles and even machinery dependent on where the material is taken.

The other collection activities were not assessed as it was judged that any noise exposure was negligible compared to the other activities.

In terms of post-collection activities, the level of noise will vary from site to site and will depend heavily on whether activities are carried out indoors or outdoors. Noise has therefore been rated for those activities which are inherently noisy or which are carried out within the same building as other noisy activities. This is summarised below:

- ***Transfer/bulking stations*** – it is assumed that there is little machinery noise, other than from vehicles. The main source of noise would be tipping glass or tin onto glass or tin. For other materials the level of noise would be dominated by vehicle noise and would be an issue only for those exposed for the majority of the working day. Therefore, it has been assumed that only unloading, loading, housekeeping and maintenance are affected.
- ***MRF*** – more machinery noise is assumed for an MRF, but material being tipped at the start of the process will be mixed dry recyclables, which pose less risk than just glass. Most activities are assumed to be affected within an MRF.
- ***MBT*** – noise was assumed to be an issue as with an MRF, except the material type, being residual waste, means the noise will be dominated by machinery and vehicles and not tipping of glass and metal.
- ***Composting*** – noise assumed to dominated by machinery and vehicle noise. For in-vessel composting noise was assumed to be more of an issue as activities were assumed to be carried out predominantly indoors.
- ***Incineration*** – due to the nature of the waste (residual), noise was not assumed to be a major issue when tipping, other than from vehicle noise. Therefore, the only tasks judged to pose a threat from noise were those where workers were exposed for long periods, maintenance and housekeeping.
- ***Landfill*** – noise is assumed not to be a major issue, with the exception of compaction where an operative is exposed for long periods of time.

D4.20.3 Hazard ratings and justification

Tables D97 to D99 in Annex D3 list the probability and consequence ratings assumed for this hazard category.

Acute effects were judged to be rare in that noise levels would not be high enough to cause a perforated ear drum from one exposure. The only effect judged to be possible was tinnitus, but this was thought to be rare, hence assessed as 1. Consequences for this were judged to be in the range of a minor to moderate health effect, rated as 2 to 3, although assessed as 2 for the most likely.

Chronic effects were assessed as being more likely. Therefore probably was rated between 2 and 3 for those exposed all day or where tipping glass onto glass occurs regularly. For those only exposed during dropping waste/recyclables off (unloading activities) the probability was assessed as rare – rating of 1. Consequences have been assessed generally as a short term to long term reversible effect, i.e. a rating of 2.5. The only exceptions were for those activities where the operatives are only exposed for short periods (unloading collection vehicle), where a consequence rating of 2 has been assumed, and where tipping of glass (or tin) onto glass (or tin) occurs, where a rating of between 3 (long term reversible effect) and 4 (permanent hearing loss) has been assumed.

D4.20.4 Hazard specific modifiers

Hazard specific modifiers are generally 1, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity, with the exception of the following activities:

- ***Slave wheeled bin collect*** – 7 has been assumed as exposure to noise occurs for each receptacle emptied into the slave bin and not each time the slave bin is taken to the collection vehicle, which was assumed as 0.14 per household collection (Table D1). Therefore, 7 was the result of 1/0.14.

- ***Slave bag/box collect* –** 2 has been assumed as exposure to noise occurs for each receptacle emptied into the slave bag/box and not each time the slave container is taken to the collection vehicle, which was assumed as 0.5 per household collection (Table D1). Therefore, 2 was the result of 1/0.5.

D4.21 OTHER ANIMALS

D4.21.1 Introduction

This hazard category captures bites from animals, predominantly domestic animals, e.g. dogs. Bites from insects and vermin are captured separately under the insects and vermin hazard category. It is the acute safety effects of a bite that are assessed under this hazard category. Any infection as a result of a bite is captured under the microbiological hazard category.

Animals, particularly dogs, are assumed to be an issue as part of collection of waste and recyclables. In some demographic areas there may be more of a problem with loose animals than others. However, the risk is increased as part of assisted delivery where workers must go onto a property or where collection is from the rear of properties, for example from alleyways at the rear of dense terracing.

D4.21.2 Component cross-reference

All activities where an operative is on a street are assumed to expose them to potential bites from animals. Therefore, the only activities not assessed include:

- Assembly of collection crew;
- Driving from location to location;
- Getting in and out of cab; and
- Emptying collection vehicle.

This hazard category has been assumed to present a negligible risk for post-collection subsystems.

D4.21.3 Hazard ratings and justification

Table D100 in Annex D3 lists the probability and consequence ratings assumed for this hazard category.

In terms of consequence it is assumed that following a bite, even a minor bite, that first aid treatment would be given, for example a tetanus injection. Therefore, the most likely consequence has been assessed as minor (2).

In terms of probability, it has been assessed that generally bites from animals are fairly rare when compared to the number of collections made, but as discussed above may increase in certain circumstances. Therefore ratings have been generally assessed as rare (1), but with the following activities posing a slightly higher risk, which have been assessed as unlikely (2):

- High-rise bags collect – close proximity to households.

- Collection at single holdings (low density scenarios) – more likely to enter property, but will depend on contract. For collection of disposable bags, a slightly lower probability has been assumed (1.5) as there is no need to re-enter the property boundary to return the receptacle; the animal only has one opportunity to bite.

D4.21.4 Hazard specific modifiers

Hazard specific modifiers are generally 1, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity, with the exception of the following activities:

- ***Slave wheeled bin collect*** – 7 has been assumed as exposure to animals occurs for each receptacle emptied into the slave bin and not each time the slave bin is taken to the collection vehicle, which was assumed as 0.14 per household collection (Table D1). Therefore, 7 was the result of 1/0.14.
- ***Slave bag/box collect*** **–** 2 has been assumed as exposure to animals occurs for each receptacle emptied into the slave bag/box and not each time the slave container is taken to the collection vehicle, which was assumed as 0.5 per household collection (Table D1). Therefore, 2 was the result of 1/0.5.
- ***Stillage box sort (separate collect and sort)*** – it is assumed that the sorter is only exposed when they climb out of the vehicle. It is assumed they climb from the Stillage vehicle once for every 20 houses collected from. This gives a modification factor of 1/20 (0.05).

D4.22 SLIPS AND TRIPS

D4.22.1 Introduction

This hazard category is included across all systems as there is an ever-present risk of slipping and tripping whenever we propel ourselves over a surface.

Illness/injury received from falls not at ground level are ignored here as they are captured under the fall from height hazard category (Section D4.9).

As part of the collection and processing of waste and recyclables operatives may encounter numerous scenarios that have the potential to cause a slip/trip incident. Collection workers walk around 6 ¼ miles (10 km) per day. That is over 10000 steps, which means over 10000 opportunities for a slip or trip. Common causes of slip incidents in collection work are slippery surfaces due to ice, snow, mud, grass and wetness, uneven ground, kerbs and holes. Workers (both collection workers tipping material and site workers) are exposed to a range of slip and trip risks at waste management sites. Common causes of slip incidents are stray items of waste/recyclable/compostable material, wetness, dust and mud. Common causes of trip incidents are stray items of waste/recyclable/compostable material, uneven ground in tipping areas and obstacles.

D4.22.2 Component cross-reference

This hazard category is considered to be an issue across all systems. The reasoning behind inclusion of this hazard category for specific components is summarised in the following subsections.

D4.22.2.1 Collection

For the following collection components it is assumed that there is no risk of a slip/trip incident. This hazard category is therefore neglected for the following components:

- ***Driving from location to location*** – operatives seated in vehicle, and therefore assumed no slip/trip hazard.
- ***Operating vehicle machinery*** – operatives stationary whilst doing this task, and therefore assumed there is no slip/trip hazard.

The reasoning behind the inclusion of this hazard category for specific components is summarised below.

Exposure to this hazard is in considered in the following components:

- ***Assembling of collection crew at start of shift*** – collection crew walk around depot to prepare for start of shift.
- ***Getting in and out of cab*** – there is a risk of slipping on the steps used to get in and out of the cab, or on the ground before or after entry/exit to/from the cab.
- ***All collection of receptacle activities*** – the crews will negotiate a number of different floor surfaces and slip and trip hazards.
- ***All emptying activities*** – although there is less movement involved during emptying, there will still remain a risk of slipping or tripping.
- ***Walking between collection and presentation points*** – collection workers can walk around 6 ¼ miles per day. That equates to over 10,000 steps, which means 10,000 opportunities for a slip or trip.
- ***RCV compaction*** – the worker is generally immobile during this task; however, there is still a chance that they could slip, dependent upon the condition of the floor surface.
- ***Stillage vehicle empty*** – a crew member will walk around the vehicle; therefore there is a risk of slipping/tripping on stray items of waste on tipping hall/yard floor or uneven surfaces.
- ***Emptying collection vehicle (RCV and Kerbsider)*** – a crew member will walk around the vehicle to activate the control mechanisms to empty the vehicle; therefore there is a risk of slipping/tripping on stray items of waste on tipping hall/yard floor or uneven surfaces.

D4.22.2.2 Post-collection

Exposure to this hazard is in considered in the following components:

- ***Inward vehicle movements*** – when a banksmen is present then this hazard is appropriate.
- ***Unloading vehicle*** – a crew member will walk around the vehicle to activate the control mechanisms to empty the vehicle. There is a risk of a slip/trip on stray items of waste on tipping hall/yard or uneven surfaces.
- ***Pre-sorting materials*** – workers may walk over the material to be sorted to pull out any unwanted items.

- ***Manual sorting*** – although workers will generally be stationery to do this task, this hazard would still be present as workers may be standing at the side of the conveyor belt. Could slip on stray items of waste that have fallen off the belt.
- ***Manual movement of bales*** – workers will need to walk between the baler and the storage point so they will be exposed to this hazard.
- ***Inserting temperature probes*** – to insert the probes will require a worker to walk either on the roof of the vessel or over the material to be composted.
- ***Screening material and bagging finished product*** – bagging of the screened material involves a worker capturing material in a bag as it exits the machine and then loading it onto a lorry. Exposure to this hazard is a result of standing and walking around.
- ***Monitoring compost process*** – to check on the composting process, there will be a need to walk around the site.
- ***Delivery of hazardous substances in bulk (incinerator)*** – pipes have to be connected from the tanker to the silo so the worker will have to walk between these two points.
- ***Loading lorries*** – a worker may be involved in assisting with the reversing and loading of a vehicle to transfer the material off site.
- ***General housekeeping*** – workers will walk around the site, potentially over wet surfaces, so they will be exposed to this hazard. Potential hazard from stray waste, dust or spilt cleaning fluids.
- ***Maintenance*** – working in and around machinery presents both a slip and trip hazard. Possibility of tripping over cables/hoses.

D4.22.3 Hazard ratings and justification

Tables D101 and D102 in Annex D3 list the probability and consequence ratings assumed for this hazard category for collection and post-collection activities respectively. These were assessed through discussion with pedestrian safety experts at HSL and within the waste management industry at the industry workshops.

In terms of consequences it has been assumed that the main outcome is an acute effect from exposure to slip/trip hazards. This hazard is assessed as being more likely than falls and is assumed to be a fairly probable event given the nature of the environment encountered by operatives (both collection and post-collection). Probability was generally assessed as dependent on the activity and the nature of the slip and trip hazards. Probability was also assumed to depend on the environmental risk e.g. permanent obstacles such as kerbstones, steps, stairs and walls and the types of terrain being walked upon by operatives. Weather conditions such as rain, ice and snow were also assumed to influence probability. The mass of receptacle was also assumed to be relevant and would influence the probability of a slip/trip. E.g. it was assumed that operatives were more likely to suffer a slip/trip if handling heaving receptacles. Post-collection it is assumed that probability is increased by contamination on the floor/ground, e.g. stray items of waste, recyclable or compostable material, rainwater, mud, oil, grease, or dust. By-products from treatment and processing such as condensation, water, leachate and ash are also assumed to increase the probability. Overall, for collection and post-collection probability was assessed between 1 and 4 (rare to probable), with the most common rating being 3.

In terms of the variations for probability ratings for the activities, higher probabilities were assumed for:

- ***High-rise/reusable/disposable bags collect –*** higher probabilities of 4 were assumed for these tasks when conducted in situations of high environmental risk and if the mass of the bags is high. It is generally assumed that operatives are more likely to slip/trip when carrying bags as opposed to pulling/pushing bins as carrying items can obstruct the view of where they are walking and decrease the chance of recovering from a loss of balance.
- ***Maintenance/housekeeping –*** higher probabilities of 4 and were assumed for maintenance and cleaning tasks at post-collection sites as it is assumed that housekeeping at many sites requires carrying items and the use of pressure hoses etc, posing a trip hazard from cables, leads and pipes.
- ***Composting*** – practices such as manual pre-sort and inserting temperature probes require operatives to walk on compostable material, which introduces a risk of tripping or slipping on uneven surfaces or items such as plastic bags.

In terms of consequences for both collection and post-collection it has been assumed that only acute effects would occur from slip and trip hazards. Consequences have been assumed to be fairly minor in the 1.5 to 2 range; slight, minor injury with no absence to requires minor first aid treatment, e.g. a lower limb sprain/strain.

D4.22.4 Hazard specific modifiers

Hazard specific modifiers are generally 1, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity, with the exception of the following activities:

- ***Assembling of collection crew at start of shift*** – the number staff movements will be between 2 and 3 times the number of assemblies (depending on the number of crew members). A hazard modification factor of 2.5 has therefore been assumed.
- ***Slave wheeled bin collect*** – 7 has been assumed as the risk of slips and trips occurs for each receptacle fetched and emptied into the slave bin and not each time the slave bin is taken to the collection vehicle, which was assumed as 0.14 per household collection (Table D1). Therefore, 7 was the result of 1/0.14.
- ***Slave bag/box collect –*** 2 has been assumed as the risk of slips and trips occurs for each receptacle fetched and emptied into the slave bag/box and not each time the slave container is taken to the collection vehicle, which was assumed as 0.5 per household collection (Table D1). Therefore, 2 was the result of 1/0.5.
- ***Loading vehicle (artic)*** – assuming the shovel loader operative climbs in and out of their vehicle for each lorry loaded, the relative frequency of exposure to this hazard compared to the unloading frequency is 1/30 (0.033), taking the values from the derivation of the modification factors shown in Table D3.
- ***Manual sorting (MRF)*** – it is assumed that operatives are exposed to slip and trip hazards each time they move away from the picking line. If housekeeping occurs once per day and the modification factor is 0.0025 (Table D3) and movements from the picking line occur at an assumed 4 times per day the assumed hazard modification factors can be calculated as 0.0025 x 4 / 2 (0.005) where 2 is the component frequency modification factor.

D4.23 STRESS

D4.23.1 Introduction

This hazard captures all those scenarios where there is the potential for operatives to experience psychological stress. Stress has been defined by HSE as: ‘The adverse reaction people have to excessive pressure or other types of demands placed on them’. Work-related stress is an important issue within the waste management industry. It has the potential to affect the health and safety of industry workers if not properly managed and controlled.

Work-related stress produces a range of symptoms and negative outcomes for both individuals and organisations. For the individual, symptoms can include coronary heart disease, mental illness, and poor health behaviours such as drinking, smoking and a lack of exercise. Stress can also lead to accidents, and careless or unsafe behaviours at work. For the organisation, symptoms can include high labour turnover, high sickness absence rates, industrial relations difficulties, and high rates of absenteeism.

Psychological stress can be subject to individual differences. What one individual experiences as stressful, another may not. As part of the collection and processing of waste and recyclables operatives may come into contact with numerous situations that have the potential to cause psychological stress for the individual.

D4.23.2 Component cross-reference

This hazard category is considered to be an issue where tasks are mundane or boring (i.e. very repetitive), or where there are production pressures such as maintenance. It is considered particularly applicable to tasks that place demands on the operative either due to workload, work patterns or the work environment.

The reasoning behind inclusion of this hazard category for specific components is summarised in the following subsections.

D4.23.2.1 Collection

The typical organisation of collection activities can place demands on operatives due to fast-paced, physically demanding tasks, which may be boring and repetitive. Task and finish work practices, for example, are likely to encourage rushing/time saving activities that can lead to stress in some individuals. In addition, exposure to members of the public can lead to stressful situations for operatives. Employees whose job requires them to deal with the public can suffer stress as a consequence of being at risk from verbal abuse and occasionally physical violence.

Given the above points, this hazard category is therefore included for all collection components with the exception of climbing in and out of vehicles and emptying the collection vehicle.

D4.23.2.2 Post-collection

For the post-collection systems it is assumed that this hazard category is only an issue where operatives are conducting boring, repetitive and monotonous tasks, which provide a lack of opportunity for changing work tasks or where tasks are conducted under production pressure. For the other activities it is assumed that psychological stress is extremely unlikely and this hazard has therefore been neglected.

Exposure to this hazard is considered in the following groups of activities:

- ***Loading (e.g. onto lorries, conveyors, shredders etc)*** – this is considered to be potentially stressful due to the repetitive, monotonous nature of the task. Operatives are confined to vehicle cabs operating mobile plant e.g. shovel loaders, for long periods of time. No opportunity to vary task.
- ***Removal of by-products*** – as above.
- ***Manual sorting/ pre-sorting*** – extensive periods of time spent manually sorting waste streams can be potentially stressful due to the monotonous nature of task and the lack of mental stimulation and opportunity to vary tasks. Operatives are also in potentially uncomfortable working positions; this is assumed to be a potential stressor.
- ***Maintenance*** – this is assumed to be a stressor due to production pressures; operatives may have to conduct tasks within limited time periods (to minimise disruption and down time to plant). Additionally, maintenance necessary during periods of breakdown can be perceived as a stressful situation. Housekeeping tasks on landfill sites, such as litter picking, are also considered stressful, as this is a repetitive, boring, and solitary task providing no opportunity for mental stimulation.
- ***Turning windrows*** – this task provides little mental stimulation, long hours spent in vehicle cabs and a lack of opportunity for different work tasks and is therefore assumed a potential stressor.
- ***Driving of compaction vehicles (landfill)*** – as above.

D4.23.3 Hazard ratings and justification

Tables D103 and D104 in Annex D3 list the probability and consequence ratings assumed for this hazard category for collection and post-collection activities respectively. An important caveat is the need to be careful when allocating a rating to this hazard given individual differences in personality. It must be recognised that what may be perceived as a stressful situation for one individual may be negligible for another. This point was discussed and acknowledged at the industry workshops.

As illustrated in the discussion above it is clear that there are individual differences to perception of stress. However, for the purpose of this assessment an average approach has been taken. In terms of the probability ratings for collection, task and finish, pressure from colleagues, violence/assault, boredom and traffic conditions are assumed to be the main stressors. Ratings assigned were typically between rare and unlikely (1-2), with the only exception being for the task of driving from location to location. A probability rating of 3 (Possible) was assigned for this task. Stress was considered more likely for this task because task and finish and traffic conditions were considered to be important stressors. High housing density typically was assigned a probability rating of 2 as compared to 1 for low housing density. The rationale being that the higher the housing density the greater volume of waste which will require faster paced work; which is also more mundane and repetitive for the operative. Additionally, higher density provides a greater likelihood for potential stressors from greater contact with members of the public.

In terms of consequences assigned for collection the general assumption has been that the most likely consequences are a chronic short-term reversible effect (rating of 2). This was supported by discussions at the industry workshops relating to knowledge of reported problems.

Ratings for post-collection activities were considered to be applicable across all the subsystems. Production pressure has been assumed to be an important stressor; hence tasks such as maintenance have been assessed with a probability rating of 2. Other tasks which are solitary, repetitive and mundane (e.g. loading, manual sorting, turning windrows) have been assessed between 1 and 1.5 depending on the assumed strength of this stressor. In terms of consequences assigned for post-collection, as for collection, the general assumption has been that the most likely consequences are a chronic short-term reversible effect (consequence rating of 2).

D4.23.4 Hazard specific modifiers

Hazard specific modifiers of 1 have been assumed, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity.

D4.24 MINOR TRAPPING

D4.24.1 Introduction

This hazard category captures those relatively minor events, in terms of consequence, where some extremity of the body is trapped or crushed. This does not include issues associated with moving (powered) machinery, which are assessed under the moving mechanism hazard category. The main hazards captured here include closing doors on vehicles, flaps on Stillage vehicles and bin lids. Therefore, generally, this hazard category captures the high frequency low consequence type of events.

D4.24.2 Component cross-reference

All activities involving entering or leaving vehicles are captured here, as there is the potential for hands or fingers to be crushed in closing doors. For activities post-collection involving vehicles, it is assumed that an operative will enter and leave the vehicle as part of the activity. Other activities where minor crushing or trapping may occur include:

- ***Wheeled bins collect and empty (including slave bins)*** – bin lids may fall onto fingers.
- ***Box sort and empty*** – crushing of fingers between vehicle side and box or stillage flaps closing on hands.

D4.24.3 Hazard ratings and justification

Tables D105 and D106 in Annex D3 list the probability and consequence ratings assumed for this hazard category for collection and post-collection activities respectively.

In the majority of cases the most likely consequences are assumed to be negligible as a result of bruising and have therefore been assessed as 1. The only exception has been for the ‘handling of heavy/hazardous waste’ component (transfer/bulking station), which because of the nature of the material being handled – heavy – it has been assumed that this is more likely to lead to more severe consequences.

In terms of probability, a range of probabilities from 2 (unlikely) to 4 (probable) have been assigned. This is based on the following assumptions:

- ***Vehicle doors*** – extremities being crushed in vehicle doors or limbs being hit by vehicle doors has been assessed as being a reasonably likely event, increasing when outdoors due to the effects of wind. Therefore ratings of 3 or 4 have been assigned dependent on whether predominantly outdoors or not.
- ***Bin lids*** – hands becoming caught in falling bin lids has been assumed to be more likely with standard wheeled bins than large bins such as the Euro bins. Additionally this

situation is assumed, per exposure, to occur less frequently than being caught by a vehicle door. Therefore ratings of 2 and 3 have been assigned for activities involving large and standard bins respectively.

- ***Boxes*** – trapping fingers between a vehicle and a box or flaps falling on hands with Stillage vehicles have been assumed to be a fairly likely event and has been assessed as occurring more frequently than with wheeled bin lids. Therefore a rating of 4 has been assigned.
- ***Maintenance*** – because of the nature of this activity, which may involve handling and manoeuvring heavy and awkward objects, it has been considered that the probability of trapping fingers or dropping objects on toes is quite likely. Therefore a rating of 4 has been assigned.
- ***General housekeeping*** – this activity has been assessed as unlikely to lead to a minor trapping type of accident and a rating of 2 has been assigned.

D4.24.4 Hazard specific modifiers

Hazard specific modifiers are generally 1, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity, with the exception of the following activities.

Transfer/bulking station:

- ***Unloading collection vehicle (stillage***) – the component frequency factor, shown in Table D2, relates to the number of times the stillages are removed and emptied. However, the frequency of minor trapping (climbing out of a vehicle) is going to depend on the number of overall Stillage vehicle empties. This can be calculated based on the values in Table D2 as 0.33/1.6 (0.2).
- ***Loading of material*** – it is assumed that the shovel loader operator climbs in and out of the vehicle for each lorry loaded. The derivation of the frequency modification factor for this activity, shown in Table D2, was based on a shovel loader with capacity 1 tonne loading a 30 tonne capacity vehicle. Therefore the hazard modification factor is 1/30 (0.033).

MRF:

- ***Loading material onto conveyors, mechanical sorting and storage of recovered fractions (shovel loader)*** – it is assumed that the shovel loader operative is in his cab for a prolonged period of time, and loads an articulated lorry load of waste for each climb in and out of their cab. Therefore, the number of climbs relative to the number of shovel loads is again 1/30 (0.033).
- ***Loading of articulated lorries (shovel loader)*** – it is assumed that the shovel loader operator climbs in and out of the vehicle for each lorry loaded. The derivation of the frequency modification factor for this activity, shown in Table D3, was based on a shovel loader with capacity 1 tonne loading a 30 tonne capacity vehicle. Therefore the hazard modification factor is 1/30 (0.033). This then also gives the correct frequency for the sheeting up operations.

MBT, composting and incineration:

- ***Loading activities*** – the same hazard modification factors as at the MRF have been assumed.

D4.25 VEHICLE TIPPING OVER

D4.25.1 Introduction

This hazard category captures those events resulting in a vehicle tipping over. This could be as a result of driving a vehicle, including mobile plant, too fast, driving over a void on a landfill site, reversing over the edge of a pit, at a transfer/bulking station for example, or from lifting of objects in an unsafe way with mobile plant. It is therefore relevant for some components both during and post-collection.

D4.25.2 Component cross-reference

In terms of collection components, a vehicle tipping over is only relevant for the following components:

- ***Driving from location to location*** – driving too fast, pulling a vehicle onto a verge or driving fast round bends to arrange material in a stillage all have the potential to lead to a vehicle tipping over.
- ***Emptying collection vehicle*** – it is assumed that it is possible for a vehicle to tip over wherever emptying into a pit occurs, due to reversing too far back and through any barriers. Discussion with participants at the workshops indicated that although unlikely there have been occurrences of this.

In terms of post-collection systems, for the following types of component a non-negligible level of risk has been assessed:

- ***Collection vehicle movements*** – wherever a system utilises a pit for tipping into there exists the potential for a vehicle to go over into the pit.
- ***Unloading collection vehicle*** – where material is tipped, failure of the hydraulic rams may have the potential to lead to a vehicle tipping over. Where mobile plant is used to empty a vehicle, for example fork-lift trucks to remove stillages, there is the potential for the mobile plant to tip over.
- ***Handling of heavy/hazardous waste (transfer)*** – use of mobile plant to move heavy items.
- ***Loading of material*** – wherever material is being loaded using either fork-lifts or shovel loaders there exists the potential for these to tip over, either as a result of lifting loads high, style of driving whilst moving the load or due to driving on waste mounds.
- ***Turning of windrows*** – the nature of the ground may give rise to the vehicle being used to turn the windrows tipping over.
- ***Vehicle movements on a landfill site*** – because of the nature of a landfill site, any vehicles on the landfill may tip over because of uneven ground or hidden voids. This includes collection vehicle movements, tipping and driving of compaction vehicles. Driving on the access road is also included as a vehicle tipping over may occur as a result of excess speed.

D4.25.3 Hazard ratings and justification

Tables D107 and D108 in Annex D3 list the probability and consequence ratings assumed for this hazard category for collection and post-collection activities respectively.

For collection activities, it has been assumed that a vehicle tipping over is a fairly rare event, given the low number of incidents discussed at the workshops relative to the large number of vehicle movements and tipping operations. Therefore probability has been rated as 1 for emptying vehicles and 1.5 for driving from location to location. It has been assumed that a vehicle tipping over on the road due to poor driving is slightly more likely than during the emptying operation, but is still relatively rare. In terms of consequences for these events a vehicle tipping over whilst driving has been assessed as leading to between a greater than 3 day absence and a major injury due to the potential speeds involved in leading to such an incident. For emptying a vehicle, tipping over is assumed to occur at a low speed and, therefore, a lower consequence has been assessed. However, where falling into a pit is involved, the distance involved could result in fairly severe injuries, even with the operatives within the confines of their cab. On balance the consequences for this component have therefore been assessed as a greater than 3 day absence (rating of 3).

For post-collection activities tipping of a vehicle has been assumed to be a relatively rare event, and the probability has generally been assessed in the 1 to 2 range. Tipping of a vehicle during unloading collection vehicles and inward movement of collection vehicles has been assumed to be rare. The probability has been assessed as being higher (rated as 2) where mobile plant are used to move material, or where shovel loaders are used. For shovel loaders it is assumed that they may drive up the side of the material during the activity thereby increasing the chance of tipping over. Activities involving windrows have been assessed as between the two. The only activities assessed as having a slightly higher probability of a vehicle tipping are on a landfill site, where the vehicles are on the landfill, due to the nature of the ground and the possibility of voids. These components have been assessed as having a probability rating of 2.5.

In terms of consequence for the post-collection components, a rating of 2 (minor injury) has been generally assessed, as in most cases the people at risk are likely to be within the confines of the vehicle and tipping is likely to occur at low speed. Where a vehicle tips onto someone, the consequences will be much more severe, although it has been assumed that this is a less likely outcome. Higher consequences have been assumed where the vehicle occupant(s) has less protection, for example a fork-lift truck operator, or where the vehicle tips over the edge into a pit, for example during the emptying operation. In these circumstances a consequence rating of 3 has been assigned.

D4.25.4 Hazard specific modifiers

Hazard specific modifiers of 1 have been assumed, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity.

D4.26 VIBRATION

D4.26.1 Introduction

This hazard category is concerned with the health effects as a result of being exposed to vibration. Vibration is categorised as hand-arm vibration (Reference 53) and whole-body vibration (Reference 54). Regular exposure to hand-arm vibration can cause a range of conditions which includes vibration white finger and carpal tunnel syndrome. Whole-body vibration, which is as a result of vibration being transmitted through a vehicle seat or feet, can cause back-pain or make an existing back condition worse. Hand-arm vibration generally comes from the use of hand-held power tools. Drivers of some mobile plant, including fork-lift trucks, shovel loaders and tractors, or where collection vehicles are driven regularly for most of the day have the potential to be exposed to whole body vibration. It is whole-body vibration that is considered to be an issue for the activities considered within scope. Hand-arm vibration has been assumed to present a negligible risk, although it may be an issue for some maintenance or construction activities that are outside of scope.

D4.26.2 Component cross-reference

Vibration has been assumed to be an issue for all vehicle movements. The design of the vehicle and seating and ground conditions are all big factors in whole-body vibration.

In terms of collection systems, vibration has been assessed as a problem only for driving from location to location. However, it is recognised that with well maintained vehicles on reasonable road surfaces the level of risk is likely to be small.

For post-collection systems, whole-body vibration has been assumed to be an issue for operators of mobile plant or vehicles where exposure occurs for long periods of time. Therefore all loading or unloading activities have been assessed as having a non-trivial level of risk. Movement of vehicles into and out of a facility have been ignored as any exposure to these drivers or occupants is likely to be negligible compared with driving outside of the facility, for example as part of a collection round.

D4.26.3 Hazard ratings and justification

Tables D109 and D110 in Annex D3 list the probability and consequence ratings assumed for this hazard category for collection and post-collection activities respectively.

In terms of consequence, the resultant harm from exposure to whole body vibration has been assessed as a chronic effect. It is unlikely that any single exposure to whole-body vibration will cause a problem. However, prolonged exposure has the potential to cause back pain in particular. Whole-body vibration can also aggravate an existing back condition. Therefore, the most likely outcome has been assessed as between a short-term and long-term reversible effect, i.e. a rating of 2.5.

In terms of probability, a chronic outcome as a result of whole-body vibration has been assessed as between rare and possible (rating of 1 to 3) depending on the type of vehicle, the duration of exposure to vibration and the ground conditions.

- ***Driving from location to location (collection)*** – road vehicles on reasonable surfaces are likely to pose a low level of risk. Therefore, the probability has been assessed as rare (1), and increasing slightly with high environmental risk (1.5) as a result of more jarring due to poor road surfaces.
- ***Driving mobile plant*** – the exposure to whole-body vibration has been assumed to be higher for mobile plant, partly due to their design, but mainly due to the nature of the surfaces they operate over. However, the probability has still been assessed as fairly low and an unlikely rating has been assigned (2).
- ***Driving on access road (landfill)*** – it has been assumed that driving on landfill roads will give rise to a larger whole-body vibration exposure than public roads. However, as exposure is only occasional, probability has been assessed as slightly higher than rare (1.5).
- ***Driving compaction vehicles (landfill)*** – this activity has been assumed to give rise to the greatest whole-body vibration exposure due to the nature of the surface over which the vehicle is operated. Therefore as operatives will also be exposed to the vibration for

prolonged periods, a higher probability rating than for the other activities has been assigned (3).

D4.26.4 Hazard specific modifiers

Hazard specific modifiers are generally 1, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity, with the exception of the following activities.

Transfer/bulking station:

- ***Unloading collection vehicle (stillage***) – the component frequency factor, shown in Table D2, relates to the number of times the stillages are removed and emptied. However, the frequency of exposure to vibration is going to depend on the number of overall Stillage vehicle empties. This can be calculated based on the values in Table D2 as 0.33/1.6 (0.2).
- ***Loading of material*** – it is assumed that the shovel loader is operated for the duration that it takes to load each lorry. The derivation of the frequency modification factor for this activity, shown in Table D2, was based on a shovel loader with capacity 1 tonne loading a 30 tonne capacity vehicle. Therefore the hazard modification factor is 1/30 (0.033).

MRF:

- ***Loading material onto conveyors, mechanical sorting and storage of recovered fractions (shovel loader)*** – it is assumed that the shovel loader operative is in his cab for a prolonged period of time. Therefore, exposure to vibration relative to the number of shovel loads is again 1/30 (0.033).
- ***Loading of articulated lorries (shovel loader)*** – it is assumed that the shovel loader operative is exposed to vibration for the duration that it takes to load each lorry. The derivation of the frequency modification factor for this activity, shown in Table D3, was based on a shovel loader with capacity 1 tonne loading a 30 tonne capacity vehicle. Therefore the hazard modification factor is 1/30 (0.033).

MBT, composting and incineration:

- ***Loading activities*** – the same hazard modification factors as at the MRF have been assumed.

D4.27 VIOLENCE

D4.27.1 Introduction

HSE defines workplace violence as (Reference 55) “any incident in which a person is abused, threatened or assaulted in circumstances relating to their work”. Within this both verbal abuse or threats as well as physical attacks are included. However, this hazard category is not as wide as the HSE definition, and only captures injury as a result of physical violence between members of the public and collection workers and also between workers. It is physical violence that is captured here. Any verbal assault is likely to be a stressor and is therefore implicitly captured under the stress hazard category.

The most likely areas for violence are between members of the public and collection workers. This could be as a result of ‘road rage’, e.g. from collection vehicles obstructing roads or moving slowly, or could be triggered by noise early in the morning or refusing to collect certain items for example. In addition, violence could also occur between workers. This is most likely where the different subsystems come together, for example a collection vehicle tipping at a processing site when crew members are in a hurry to tip and leave, potentially as a result of a task and finish system. Violence is also possible between workers at any stage for a wide range of reasons, mostly not connected with the job, however. Only violence triggered by specific activities have been considered to be within scope.

D4.27.2 Component cross-reference

In terms of collection systems, anywhere where an operative has the potential to be in contact with members of the public, for the reasons summarised above, has been included. That includes all components except the following:

- ***Assembly of collection crew at start of round*** – although violence between workers is possible, this has been assumed to be trivial in relation to the work activity and has therefore been discounted.
- ***Getting in and out of cab –*** the activity is assumed not to be a precursor to violence.

Also included is “emptying collection vehicle”, which although not involving members of the public may lead to violence between workers as a result of different pressures, collection operative on task and finish, and processing site operative. This has also been assessed as non-trivial for the emptying collection vehicle components in each post-collection system. The risk from violence for other post-collection activities has been assessed as negligible.

D4.27.3 Hazard ratings and justification

Tables D111 and D112 in Annex D3 list the probability and consequence ratings assumed for this hazard category for collection and post-collection activities respectively.

In terms of consequences physical workplace violence can result in a wide range of outcomes from minor injury through to disability or even death. In terms of the most likely outcome a minor injury requiring minor first aid treatment has been assumed in all cases, i.e. a rating of 2.

In terms of probability physical violence was assessed as being fairly rare although increasing in certain circumstances, for example with proximity to households and demographics. Overall, probabilities in the range of 1 to 2 were assigned. For collection the highest probability is assumed when closest to properties, i.e. during collection of the receptacle, and only in certain demographics. For example, high-density housing has been assumed to have a higher probability than low-density housing. Those situations have been rated as 2 compared with 1 for the other components. For high-rise collect and big-wheeled bins collect, low-density housing is assumed to be irrelevant and has therefore been assessed as for high-density. Activities at the vehicle, e.g. emptying receptacles or operating vehicle machinery have been assessed as rare (rating of 1) irrelevant of housing density.

Other components include:

- ***Driving from location to location*** – road rage has been assumed to be fairly likely to lead to abuse, although in most cases this is assumed to be verbal abuse. However, physical violence was thought to be as likely here as in collection from the highest-risk areas and has therefore been assessed as unlikely (rating of 2).

- ***Emptying collection vehicle*** – violence between workers during the emptying of collection vehicles has been assessed as rare, based on discussion with workshop participants.

D4.27.4 Hazard specific modifiers

Hazard specific modifiers are generally 1, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity, with the exception of the following activities:

- ***Slave wheeled bin collect*** – 7 has been assumed as exposure to violence is assumed to occur for each receptacle emptied into the slave bin and not each time the slave bin is taken to the collection vehicle, which was assumed as 0.14 per household collection (Table D1). Therefore, 7 was the result of 1/0.14.
- ***Slave bag/box collect –*** 2 has been assumed as exposure to violence is assumed to occur for each receptacle emptied into the slave bag/box and not each time the slave container is taken to the collection vehicle, which was assumed as 0.5 per household collection (Table D1). Therefore, 2 was the result of 1/0.5.
- ***Stillage box sort (separate collect and sort)*** – it is assumed that the sorter is only exposed when they climb out of the vehicle. It is assumed they climb from the Stillage vehicle once for every 20 houses collected from. This gives a modification factor of 1/20 (0.05).
- ***Unloading collection vehicle (stillage)*** – the component frequency factor, shown in Table D2, relates to the number of times the stillages are removed and emptied. However, the frequency of violence is going to depend on the number of overall Stillage vehicle empties. This can be calculated based on the values in Table D2 as 0.33/1.6 (0.2).

D4.28 WORKPLACE TRANSPORT

D4.28.1 Introduction

Workplace transport accidents are one of the most common causes of fatalities in the waste management industry. Workplace transport is taken here to be wider than HSE’s standard workplace transport definition as it includes workers being hit by private vehicles on public roads. The following are therefore included:

- Collection operative being hit by a moving collection vehicle whilst collecting on public roads;
- Collection operative being hit by a private vehicle, whilst crossing a road for example, during collection activities;
- Workers being hit by moving vehicles within sites, including at all post-collection systems considered within scope.

This hazard category therefore captures all circumstances where a worker is hit by a moving vehicle, no matter where they are, as part of the activities considered within scope.

Reversing activities during collection are particularly problematic as the environment in which the movement is being carried out is hard to control, due to street geography, street furniture, other vehicles, pedestrians and weather.

The following guidance produced jointly by HSE and WISH contains further issues and guidance in relation to workplace transport:

- Waste and recycling vehicles in street collection – Reference 56; and
- Safe transport in waste management and recycling facilities – Reference 57.

The likelihood of a workplace transport accident will be dependent on many factors, but the following environmental factors can be critical:

- Time of year – the amount of light;
- Weather – visibility as a result of fog, rain, steam etc; and
- Noise – audibility problems can be a major issue, particularly during noisy activities such as sorting glass and whilst wearing ear protection.

D4.28.2 Component cross-reference

D4.28.2.1 Collection components

In terms of collection activities, being hit by a vehicle has been assessed as an issue for the following activities:

- ***Assembly of collection crew at start of shift*** – at the start of a shift it is assumed that there will be many different vehicle movements within the depot, from which the collection crew will be exposed. The level of risk will be dependent on the design of the yard, for example pedestrian and vehicle segregation and the existence of traffic flow systems and lighting levels. At certain times of the year, this activity is likely to be carried out in darkness, therefore the adequacy of artificial lighting will also affect the level of risk.
- ***Driving from location to location*** – where a vehicle is reversing banksmen may be used who are assumed to be exposed to the moving collection vehicle as well as other road traffic.
- ***Getting in and out of cab*** – generally it has been assumed that collection crew will not be exposed to other vehicles as they exit a cab due to alighting at the kerbside. However, where the driver also assists with collections, they are likely to exit the vehicle at the roadside thereby exposing themselves to moving vehicles. This activity has therefore been included, but at a lower exposure frequency.
- ***Receptacle collect (except high-rise flats and big bins)*** – it has been assumed that for some collections operatives will collect receptacles from the opposite side of the road to the collection vehicle and will therefore have to negotiate traffic. Good practice is that collections are carried out on the same side as the vehicle only except in exceptional or low risk situations. However, notwithstanding this it is assumed that there are still a non-trivial number of collections where traffic is negotiated.
- ***Big wheeled bins (Euro and Palladin) collect*** – collections will generally not have to negotiate roads, although the collection operatives may still be exposed to traffic in the areas in front of flats.
- ***Slave receptacle collect*** – it has been assumed that operatives are occasionally exposed to road traffic.
- ***Receptacle empty*** – where emptying into an RCV an operative may be exposed to vehicles hitting him from behind or from the RCV reversing or rolling back. Stillage

vehicles are assumed to present less risk when recyclables are sorted from the kerbside. However, where Stillage vehicles have steps on both sides, and the vehicle is alighted from the roadside exposure to road traffic occurs.

- ***Walking to and from collection point*** – it is assumed that roads are crossed as part of this activity.
- ***Emptying collection vehicle*** – one of the collection crew are assumed to be exposed from being on the ground as the vehicle is reversed ready for tipping, as a banksman.

For the following components there is no significant exposure to moving vehicles:

- ***High-rise bags collect*** – collection within the confines of flats therefore no exposure to moving vehicles.
- ***Kerbsider box sort empty*** – it is assumed that sorting always occurs at the kerbside.
- ***RCV compaction*** – it is assumed that compaction is operated from the kerbside or from within the vehicle cab.
- ***Kerbsider hopper empty*** – it is assumed that the hoppers are emptied by operating buttons from the kerbside.

D4.28.2.2 Post-collection components

Post-collection virtually all activities are assumed to involve exposure to moving vehicles or moving mobile plant. Therefore the workplace transport hazard category has been assessed for most components. This is summarised below:

- ***Inward vehicle movements*** – a banksman is assumed to be used or other pedestrians on-site could be exposed.
- ***Unloading vehicle*** – unloading assumed to be carried out from outside vehicle, which exposes this operative to other moving vehicles.
- ***Manual pre-sorting waste*** – it has been assumed that vehicle movements occur in the vicinity of this activity.
- ***General loading operations (by shovel loader) –*** other workers are assumed to be exposed to the shovel loader’s movements.
- ***Handling heavy or hazardous waste (transfer)*** – workers exposed to other vehicle movements during this activity.
- ***General housekeeping –*** workers assumed to be carrying out housekeeping activities in locations where vehicle movements occur.

The level of risk from workplace transport related hazards has been assumed to be negligible for the following components:

- ***Manual sorting (MRF)*** – workers on picking lines are assumed not to be exposed to vehicle or mobile plant movements.
- ***Turning windrows*** – it is assumed that there are no pedestrians around the windrows.
- ***Inserting temperature probes*** – it has been assumed that workers are not exposed to vehicle movements during this activity.

- ***Removal of large items of waste from feed chute (incinerator)*** – it has been assumed that this is carried out using a purpose built grab crane that does not expose workers to vehicle movements.
- ***Maintenance*** – maintenance of fixed plant has been assumed to be generally away from vehicle movements.

D4.28.3 Hazard ratings and justification

Tables D113 and D114 in Annex D3 list the probability and consequence ratings assumed for this hazard category for collection and post-collection activities respectively.

D4.28.3.1 Collection components

For collection components the consequences from being hit by a vehicle have been assessed as leading to a major injury. The speed of the collision, the size of vehicle involved will have an impact on the level of consequences. However, major injury was judged to be a reasonable outcome by the project team and the industry workshop participants, especially given that fatality following such an incident is not rare.

In terms of probability, given the number of vehicle movements compared to accidents it was assessed that such an incident per exposure was fairly rare, and ratings of between rare (1) and unlikely (2) were assigned. The following assumptions were made:

- Where relevant a higher probability was assigned for high environmental risk scenarios (road speed and type) compared to low environmental risk scenarios.
- Activities at the rear of vehicles, for example emptying receptacles into the rear of RCVs were assumed to present a slightly higher probability than low environmental risk scenarios where crossing of the road occurs. There are issues with other vehicles running into the rear and also the collection vehicle reversing.
- Activities relating to flats have been assessed as rare as there is generally less traffic movement for the operatives to interface with.
- Emptying onboard Stillage vehicles (including food waste) have been assessed as slightly higher than low environmental risk scenarios where crossing of the road occurs due to the presence of steps on both side of the vehicle, which may lead to operatives leaving by the roadside.
- Emptying collection vehicles has been assessed as a rating of 2 due to the presence of reversing vehicles in confined spaces.

D4.28.3.2 Post-collection components

In terms of consequence, in all cases except for compaction vehicles on landfill sites, a consequence of major injury has been assigned for the most likely outcome, to account for the probable range of injuries from moderate to fatality. For compaction vehicles, fatality has been assumed because of the size of these.

In terms of probability again it has been assessed, that given the number of vehicle movements compared with the small number of accidents, as a relatively rare event. Ratings of between 1 and 2 have therefore been assigned, with most components the probability assessed as rare (1). The only exceptions are:

- ***Reversing of collection vehicles*** – it has been assumed that there is an increased likelihood of someone being in the proximity of the reversing vehicle.
- ***General housekeeping*** – the activity has been assumed to involve being anywhere on a site where there are lots of vehicle or mobile plant movements.
- ***Pre-sorting/visual inspection of waste* –** it has been assumed that this may occur at the same time as when shovel loaders are operating nearby.

D4.28.4 Hazard specific modifiers

Hazard specific modifiers are generally 1, i.e. exposure to the hazard category occurs at the same frequency as exposure to the activity, with the exception of the following activities.

- ***Getting in and out of cab*** – it has been assumed that the driver will exit onto the road in 1% of collections. A hazard frequency modifier of 0.01 has therefore been assumed.
- ***Collection of receptacles*** – it has been assumed that roads are crossed in 1% of collections; that is the collection vehicle is on the opposite side of the road to the households. A hazard frequency modifier of 0.01 has therefore been assumed.
- ***Stillage box sort (separate collect and sort)*** – it is assumed that the sorter is only exposed when they climb out of the vehicle. It is assumed they climb from the Stillage vehicle once for every 20 houses collected from. This gives a modification factor of 1/20 (0.05).

D5 SUMMARY

This appendix has described the assumptions made in deriving all the hard-wired factors that are used by the Risk Comparator Tool. It is important to recognise, however, that these assumptions may not be valid in all circumstances. It is therefore recommended that the default values are used for a base case assessment, but that these are modified with more appropriate values where necessary.

It is stressed that the hazard ratings contained within this appendix have been derived by expert judgement and so will have inherent uncertainty. Accident data was investigated to support the assessments, although it was found that it was not sufficiently detailed to map onto the component and hazard breakdown as adopted here. Where improvements in accident data classification occur from across the industry, this should be used in the future to update the judgments made.

Notwithstanding the above, a multistage approach was taken in the derivation of the frequency modification factors and hazard ratings. Given that there was reasonable agreement between ratings derived by the project team and by participants at the industry workshops, this gives some confidence in the overall robustness of the data.

D6 ANNEX D1 – HAZARD TABLES

D6.1 COLLECTION ACTIVITIES

Table D25 Assembling of collection crew at start of shift

Hazards/Risks	*Range of consequences/harm outcomes*	*Assumptions/other information*
Workplace Transport • Reversing activity • Non-segregation of pedestrians and vehicles • Large number of vehicular manoeuvres • Large numbers of operative movements • Collection vehicle striking operatives	Most likely outcome – major injury [crushing] *Most severe outcome – single fatality [crushing]*	Reversing operations have 'blind spots' covered by CCTV, but operations are contingent on driver using this / it is in working order Constraints of yard layout - limited space for manoeuvres, one-way system may impact on operations Multiple vehicles stored in same yard increase amount of workplace transport activity Where operatives operating job and finish system, will tend to rush to leave yard Workers are issued and are wearing appropriate PPE (particularly high-visibility jackets) Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) Ice on windscreen / mirrors affects visibility Inexperienced drivers / unfamiliarity with vehicle
Slips and Trips • Uneven surfaces in yards • Maintenance / cleaning of yard surfaces	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	Operatives running to access cab and leave yard (if operating job and finish system tend to hurry) Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility)

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Falls On climbing into cab	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	Limited access to cab (e.g. vehicles parked close together) may restrict use of proper access technique Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility)
Stress	Most likely outcome – no absence [acute stress / headaches / high blood pressure] Most severe outcome [chronic ill-health]	Job and finish system in operation Peer pressure from other crew members to rush to leave yard to begin round

Table D26 Driving from location to location

Hazards/Risks	*Range of consequences/harm outcomes*	*Assumptions/other information*
Workplace transport • Collision with other road users [road traffic accident]	Most likely outcome – minor injury [cuts / bruises, whiplash, shock] *Most severe outcome – single fatality [crushing, internal injuries]*	Light levels vary according to time of day / year (early in morning / during winter), degree to which artificial lighting is available (heavy shadows might impact on visibility), and weather conditions Potential driver distractions – mobile phone, alcohol in blood levels Fatigue / sleep deprivation– e.g. early start following weekend Driving experience and familiarity with collection vehicle Time of day influences level of traffic flow on streets Degree of harm potentially affected by the wearing of seat belts / standing up in the cab whilst vehicle is in motion Inexperienced drivers / unfamiliarity with vehicle Reversing operations into a main road and in areas with limited space Use of banksmen can help to guide reversing vehicle Banksman activity exposes these operatives to risk of being hit by either the collection vehicle or another road user. Reversing operations have ‘blind spots’ covered by CCTV, but operations are contingent on driver using this / it is in working order The vehicle may be required to suddenly change direction thus potentially destabilising operatives standing up in cab and causing them to fall Ability to maintain balance may be affected by the number of handholds available Risk compounded by the use of an inexperienced driver / unfamiliar with the vehicle
Workplace Transport • Reversing	Most likely outcome – major injury [crushing] *Most severe outcome – single fatality [crushing]*	
Workplace Transport • Standing up in cab whilst vehicle is moving	Most likely outcome – minor injury no absence [bruising] Most severe outcome – major injury [fracture]	

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Workplace Transport • Vehicle tipping over	Most likely outcome – major injury [crushing] *Most severe outcome – single fatality [crushing]*	Tipping could be caused by driving too fast around corners High winds may affect the stability of a high sided vehicle Crew members are advised not to ride on the outside of the vehicle
Workplace Transport • Riding on footplate	Most likely outcome – minor injury [cuts / bruises, sprains] *Most severe outcome – single fatality [crushing / falling underneath the vehicle]*	
Heat stress	Most likely outcome – no absence [minor dehydration] Most severe outcome – minor absence [dehydration / unconsciousness]	Due to long periods spent in cab without appropriate ventilation / consumption of water Due to performance of strenuous work activities without appropriate ventilation / consumption of water
Stress	Most likely outcome – no absence [acute stress / headaches / high blood pressure] Most severe outcome [chronic ill-health]	Difficult driving conditions influence stress levels (e.g. high traffic density, difficult access, road rage from other road users) Peer pressure to drive in a risky manner from other crew members – compounded by job and finish system Self-imposed time-pressures
Vibration • From time spent in vehicle whilst in motion	Most likely outcome – no absence *Most severe outcome – major injury [MSD injury]*	Vibration from driving over potholes / uneven road surfaces manifests in MSD issues relating primarily to handling activities conducted during normal course of day

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Struck by falling object • Contents of cab falling and hitting crew member or driver	Most likely outcome – no absence *Most severe outcome – minor injury [cuts / bruising]*	Various work clothes, crew members lunch etc. may be stored loose in the cab

Table D27 Access and egress to vehicle cab

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Workplace transport • Egress into road [struck by other road users / own collection vehicle]	Most likely outcome – major injury [crushing] *Most severe outcome – single fatality [crushing]*	Only potential for this risk if exiting onto roadside, as opposed to kerbside Light levels vary according to time of day / year (early in morning / during winter), degree to which artificial lighting is available (heavy shadows might impact on visibility), and weather conditions Time of day influences level of traffic flow on streets
Workplace transport • Struck by door	Most likely outcome – no absence *Most severe outcome – minor injury [cuts / bruising]*	High winds could result in door being banged against the body Poor access technique – not holding onto the door
Falls • From steps / cab	*From stationary vehicle* – Most likely outcome – minor injury [cuts / bruises] Most severe outcome – major injury [fracture] *From moving vehicle* – Most likely outcome – minor injury [cuts / bruises] *Most severe outcome – single fatality [crushing]*	Light levels vary according to time of day / year (early in morning / during winter), degree to which artificial lighting is available (heavy shadows might impact on visibility), and weather conditions Contaminants (e.g. oil) on steps, or ice in poor weather Greater risk during egress (less control / visibility) Poor technique – e.g. jumping out of cab instead of descending backwards Material on the sole of the boot which could reduce the grip between boot and step Operatives may be rushing e.g. if operating job and finish system

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Slips and Trips • Contaminated or uneven surfaces	Most likely outcome – no absence / minor injury [cuts / bruises] *Most severe outcome – major injury [fracture]*	Light levels vary according to time of day / year (early in morning / during winter), degree to which artificial lighting is available (heavy shadows might impact on visibility), and weather conditions Vehicle steps and interior may / may not be slip resistant Slipping on the floor surface of the cab or step during ingress/egress Operatives may be rushing e.g. if operating job and finish system Contaminants (e.g. oil) in cab, or ice in poor weather

Table D28 Handling receptacle from presentation point to collection vehicle and returning receptacle

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Workplace transport • Large number of vehicular manoeuvres, both collection vehicle and other road users • Working in close proximity to reversing collection vehicles	Collection vehicle striking operatives – Most likely outcome – major injury [*crushing]* Most severe outcome – single fatality [crushing] Other road traffic vehicle striking operatives – *Most likely outcome – major injury [crushing]* *Most severe outcome – single fatality [crushing]*	Collecting from both sides of road in same pass (i.e. crossing road to access bags/bins/boxes) influences level of risk Time of day influences level of traffic flow on streets Collection may occur in conditions of limited access Light levels vary according to time of day / year (early in morning / during winter), degree to which artificial lighting is available (heavy shadows might impact on visibility), and weather conditions Workers are issued and are wearing appropriate PPE (particularly high-visibility jackets) Where operatives operating job and finish system, will tend to rush during round Larger bins are normally kept in internal bin stores, as opposed to at kerbside [big bins]
Falls on Stairs • High-rise bags collect	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	Variation in type and condition of stair. If lift not functioning, will only collect from 5 storeys and under. Slave sacks can be carried at the side of the body so the operative is able to see where they are placing their feet Operatives hurrying whilst carrying the sacks if operating job and finish system Light levels vary according to time of day / year (early in morning / during winter), degree to which artificial lighting is available (heavy shadows might impact on visibility), and weather conditions

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Slips and Trips • Uneven surfaces / slopes / kerbs in collection area	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	Bags can be carried at the side of the body so the operative is able to see where they are placing their feet Operatives hurrying whilst carrying the bags if operating job and finish system Light levels vary according to time of day / year (early in morning / during winter), degree to which artificial lighting is available (heavy shadows might impact on visibility), and weather conditions Wheeled bins: • Moving large bins reduces visibility as operatives can't see feet [big bins] • Control may be difficult given the large size and weights of the bins, uneven distribution of contents, and also the poor quality of wheels on older bins [big bins] Food waste/boxes: • Lifting / carrying box may obscure visibility, particularly of operative's feet • Carrying heavy boxes / multiple boxes may be difficult to control
Lone Working* • Going on ahead of the collection vehicle to centrally locate the bags • *Generally only occurs during disposable bag collections	Most likely outcome – no absence Most severe outcome –	Operatives may go on ahead of vehicle to position bags in a central location to make it easier and quicker to load bags into the back of the RCV Operatives may collect on their own from different levels in block of flats. Operatives may go on ahead of vehicle to position slave sacks in a central location to make it easier and quicker to empty sacks into the back of the RCV
Lifting / carrying [bags/food/boxes] • Bags from presentation point to	Most likely outcome – minor injury no absence [strain / sprain]	Load weight – the weight of the bags will vary with type and amount of material collected. Items such as paper or grass cuttings will generally weigh more than cans or plastics

Hazards/Risks	*Range of consequences/harm outcomes*	*Assumptions/other information*
central location and to the vehicle • Boxes from presentation point to vehicle • Lifting of containers into wheeled slave bin	*Most severe outcome – major injury [severe strain / sprain]*	generally weigh more than cans or plastics. Dragging of bags requires less force than lifting Operatives will pick up more than one bag/box at a time, thus increasing the overall load Handhold on the load –the bags may or may not have handholds. The suitability of the handholds for assisting manual handling will vary Frequency of lifting and carrying is affected by set-out rate, number of bags required to collect and whether the bags are transferred from the presentation point to a central location before being emptied The bags may split when handled Food waste: • Handhold on the load – a good handhold improves the grip on the load and reduces the grip strength required and is less fatiguing • Frequency of lifting and carrying is affected by set-out rate, number of containers required to collect • Load weight – the weight of the boxes will vary with type and amount of material collected. Boxes (including into slave bins): • Load weight – the weight of the container is altered by the type of material collected and the amount of material placed into the container by the resident • Operatives will lift and carry more than one box at a time, thus increasing the overall load • Handhold on the load – a good handhold improves the grip on the load and reduces the grip strength required and is less fatiguing· • Frequency of lifting and carrying is affected by set-out rate, number of containers required to collect · • Damage to the box may result in the load becoming unstable

Hazards/Risks	*Range of consequences/harm outcomes*	*Assumptions/other information*
		Slave bin: • If one person is both pushing / pulling and lifting / carrying the combined risk may be greater than performing one task on its own. Compared to a separate box and bin scheme, a large proportion of time is spent walking from one point to another unloaded. This would not be the case if one person were performing this task component on their own
Lifting / carrying /emptying [flats] • Emptying contents of presented receptacles into slave sacks. • Slave sacks from presentation point to central location and then to the slave bin or collection vehicle	Most likely outcome – minor injury no absence [strain / sprain] *Most severe outcome – major injury [severe strain / sprain]*	Material on doorstep may be presented in box, reusable sack or single use sack. Emptying contents into slave sack will require lifting, and inversion of receptacle using either one or both hands. Load weight – the weight of the slave sacks will vary with type and amount of material collected. Items such as paper will generally weigh more than cans or plastics. Dragging of sacks requires less force than lifting Operatives will pick up more than one slave sack at a time, thus increasing the overall load. Dependent upon the load weight may carry slave sack over the shoulder. Handhold on the load –the sack may or may not have handholds. The suitability of the handholds for assisting manual handling will vary Frequency of lifting and carrying is affected by set-out rate, volume of recyclables required to collect and whether the slave sacks are transferred from the presentation point to a central location before being emptied into a slave bin or directly into vehicle.
Pushing / pulling [big bins]	Most likely outcome – minor injury no absence [strains / sprains]	Large capacity of bins, thus heavy when full / overloaded

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
• Of receptacles uneven surfaces / slopes / kerbs / steps • Loss of control of load • Crushing between bins and vehicle • Crushing between bins and walls	[strains / sprains] *Most severe outcome – major injury [crushing]*	Single operative moving bin is more strenuous than when performed with 2 operatives Operatives may not be able to see kerbs / slopes due to reduced visibility resulting from large size of bin Control may be difficult given the large size and weights of the bins, uneven distribution of contents, and also the poor quality of wheels on older bins Manoeuvring bins over uneven surfaces, slopes and kerbs will increase the force required to move the bin The design of the wheels and height of the handle on the bins can affect the forces required to move it Rain may make it more difficult to grip handles. Cold weather reduces dexterity thus ability to grip Wheeled bins: • Compounded by overloaded bins • Load weight – the weight of the container will vary with how full it is. [– the weight of the container is altered by the type of material collected and the amount of material placed into the container by the resident.] • Larger force values occur during the tilting phase • Operatives may not be able to see kerbs / slopes due to reduced visibility resulting from large size of bin • Control may be difficult given the large size and weights of the bins • Manoeuvring bins over uneven surfaces, slopes and kerbs will increase the force required to move the bin • The design of the wheels and height of the handle on the bins can affect the forces required to move it • Rain may make it more difficult to grip handles. Cold weather reduces dexterity thus ability to grip

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
		- Operatives may move two bins at the same time - Operative controls weight and contents of slave bin
Handling sharp objects - Contents spilling out of the bag / piercing through bag - Handling excess waste which has fallen from bag - Needlestick injury - Sharp objects outside of bin - Removing non-recyclable contents from box [boxes] - Removing excess waste from top of bin Contents spilling out of the presentation receptacle / piercing through [flats]	Most likely outcome – minor injury no absence [cuts] *Most severe outcome – major injury [cuts]*	Residents placing inappropriately wrapped material into the bags [bags] Residents placing inappropriate material into the receptacles [slave sacks and boxes] Operatives should wear gloves when performing this task Big bins: - When attempting to, dislodge waste stuck inside the waste chute that has backed up when falling into an already full bin - In removing excess waste from top of bin - In placing waste items left on ground into bins Wheeled bins: - In removing excess waste from top of bin - In placing waste items left on ground into bins - Limited direct handling of material
Microbiological hazards	Most likely outcome – minor injury no absence *Most severe outcome – major injury*	
Chemical hazards - Exposure to chemicals inappropriately discarded in receptacle	Most likely outcome – minor injury no absence *Most severe outcome – major injury*	Residents placing inappropriate material into the receptacles Operatives should wear gloves when performing this task

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Noise [slave bins] • Emptying of glass into wheelie bin: glass on glass	Most likely outcome – minor injury no absence [temporary hearing loss] *Most severe outcome – major injury [complete deafness]*	Provision of ear defenders for operatives
Struck by falling objects [big bins] Hit by falling waste items from open top of bin	*Most likely outcome – no absence minor injury [cuts / bruises]* *Most severe outcome – minor injury [cuts / bruises]*	When attempting to dislodge waste stuck inside the waste chute, that has backed up When manoeuvring overloaded bins
Fatigue • Muscular fatigue • Mental fatigue	Most likely outcome –no absence / minor injury [sprains] *Most severe outcome – major injury [MSD]*	Repetitious handling of heavy loads Few / no breaks taken from collection activities during course of shift Running between receptacles/ collection points due to job and finish system Long collection rounds e.g. after Christmas / bank holidays
Violence • From members of the public		During very early morning collection rounds / due to collection vehicle blocking road
Stress	Most likely outcome – no absence [acute stress / headaches / high blood pressure] Most severe outcome [chronic ill-health]	Job and finish system in operation Peer pressure from other crew members to rush to complete round
Pets/insects	Most likely outcome – minor injury no absence [bite/scratch/sting] *Most severe outcome – major injury [bacterial infection/ severe trauma*]	Risk of injury from uncontrolled domestic animals (dogs) Rural areas – greater risk from wild animals (foxes) Seasonal variation – greater risk of insect bite/sting during summer

Table D29 Emptying contents of receptacle into collection vehicle

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Workplace transport • Large number of vehicular manoeuvres, both collection vehicle and other road users • Vehicle reversing whilst operative still emptying • Vehicle moving when operatives are emptying receptacles [food] • Vehicle moving with operatives still in body of vehicle [stillage]	Collection vehicle striking operatives – Most likely outcome – major injury [*crushing]* Most severe outcome – single fatality [crushing] Other road traffic vehicle striking operatives – *Most likely outcome – major injury [crushing]* *Most severe outcome – single fatality [crushing]* Food: • Most likely outcome – minor injury [bruising] • Most severe outcome – major injury [fracture] Stillage • Standing inside vehicle whilst in motion: • Most likely outcome – minor injury [bruising] • Most severe outcome – major injury [fracture]	Collecting from both sides of road in same pass (i.e. crossing road to access bins) influences level of risk Time of day influences level of traffic flow on streets Collection may occur in conditions of limited access Light levels vary according to time of day / year (early in morning / during winter), degree to which artificial lighting is available (heavy shadows might impact on visibility), and weather conditions Workers are issued and are wearing appropriate PPE (particularly high-visibility jackets) Where operatives operating job and finish system, will tend to rush during round Due to loading / driving responsibilities, driver's situational awareness of position of other operatives may be limited Potential for an operative to be struck from behind by other road users Potential for driver of RCV to not be aware of an operative standing behind the vehicle

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Slips and trips • On contaminated surfaces • On steps to vehicle body [food/stillage] • Falling off kerb edge [kerbside sort] • On contaminated surfaces around vehicle	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	Generic: • Operatives hurrying due to operating job and finish system • Light levels vary according to time of day / year (early in morning / during winter), degree to which artificial lighting is available (heavy shadows might impact on visibility), and weather conditions Bags: • Swinging of bag may obscure operatives visibility of floor surface e.g. if icy Boxes/food bins: • Visibility may be limited (operatives cannot see feet)· • Control may be difficult if handling heavy box / boxes· • Vehicle steps and interior may / may not be slip resistant • Steps may not be appropriately designed for purpose or adequate handrails fitted. Handrails may not be used if carrying multiple boxes • Attention will be given to the sorting of the contents and not to the positioning of the feet [kerbside sort]

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Pushing / pulling • Of receptacles uneven surfaces • Loss of control of load • Crushing between bins and vehicle	Most likely outcome – minor injury no absence [strains / sprains] *Most severe outcome – major injury [crushing]*	• Large capacity of bins, thus heavy when full / overloaded • Single operative moving bin is more strenuous than when performed with 2 operatives • Control may be difficult given the large size and weights of the bins, uneven distribution of contents, and also the poor quality of wheels on older bins • The design of the wheels and height of the handle on the bins can affect the forces required to move it • Rain may make it more difficult to grip handles. Cold weather reduces dexterity thus ability to grip • The bin has to be lined up with the hoist mechanism – a precision operation can increase the stress on the muscles
Lifting / throwing • Throwing disposable bags/contents of slave sacks into the rear of the vehicle • Throwing and then emptying contents of bag into the rear of the vehicle • Emptying contents of slave sacks into slave bins	Most likely outcome – minor injury no absence [sprains/strains] *Most severe outcome – major injury [severe strain / sprain]*	The height by which the bags/sacks have to be lifted is determined by the height of the 'rave' bar and the height of the handhold. The higher handhold the higher the hand and the load has to be lifted To swing the bags into the rear of the vehicle requires less force than compared to lifting but there are rapid changes in posture involving twisting of the trunk On some reusable bags a handle is located on the bottom of the bag to assist with emptying and retrieval Operatives have to shake the reusable bags/slave sacks to release the contents placing additional stress on the upper limbs Variations depending upon whether slave sacks are emptied into slave bins or directly into vehicle.

Hazards/Risks	*Range of consequences/harm outcomes*	*Assumptions/other information*
Lifting / carrying / emptying • Box lifted and carried into body of vehicle • Boxes lifted above shoulder height to empty into hopper above wheel [Kerbsider] • Boxes supported against side of vehicle during sorting [Kerbsider]	Most likely outcome – minor injury no absence [strain / sprain] *Most severe outcome – major injury [serious strain / sprain]*	• Workplace constraints – the vehicle design will influence the posture adopted during sorting, for e.g. lifting above head height • Raising and inverting the box at shoulder height or above can place strain on the upper body, even when handling light loads • Holding box at arms length away from the body (to prevent contact with food waste) can place strain on upper body Kerbsider/stillage: • Operatives may need to support weight of box between own body and vehicle whilst sorting and emptying contents • Load weight – the weight of the container is altered by the type of material collected and the amount of material placed into the container by the resident· • Operatives will lift and carry more than one box at a time, thus increasing the overall load • Handhold on the load – a good handhold improves the grip on the load and reduces the grip strength required and is less fatiguing· • Frequency of lifting and carrying is affected by set-out rate, number of containers required to collect • Damage to the box may result in the load becoming unstable
Handling sharp objects • Contents spilling out of the bag / piercing through bag/sack • Handling excess waste which has fallen from bag/sack • Pushing material down in the back of RCV • Sorting contents of box (especially tins / glass) • Needlestick injury	Most likely outcome – minor injury no absence [cuts] *Most severe outcome – major injury [cuts]*	Residents placing inappropriately wrapped material into the receptacles Operatives should wear gloves when performing this task Operatives will push material down in the back of the RCV using their hands Residents placing inappropriate materials into the boxes

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Falls [food/stillage] • Climbing into / out of vehicle body	Most likely outcome – minor injury / no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	• Visibility may be limited (operatives cannot see feet) • Control may be difficult if handling heavy box (es) • Operatives may be rushing e.g. if operating job and finish system • Light levels vary according to time of day / year (early in morning / during winter), degree to which artificial lighting is available (heavy shadows might impact on visibility), and weather conditions
Entrapment • Pushing down material in the back of the RCV	Most likely outcome – minor injury [bruising] *Most severe outcome – major injury [crushing]*	Hands/arm becoming trapped and/or crushed by moving machinery in the back of vehicle from pushing down material
Noise • Emptying of glass into hopper (for glass only collection) [RCV] • Emptying glass / tins into hoppers [Kerbsider] • Emptying glass / tins into stillages	Most likely outcome – minor injury no absence [temporary hearing loss] *Most severe outcome – major injury [complete deafness]*	Provision of ear defenders for operatives Throwing glass / tins into hoppers creates greater noise (is louder when are emptying into stillages from height) [Kerbsider] In vehicle sorting of glass and tins within an enclosed space (body of vehicle), refraction of sound waves off vehicle Throwing glass / tins into stillages creates greater noise (is louder when are emptying into stillages from height)
Microbiological hazards	Most likely outcome – minor injury no absence *Most severe outcome – major injury*	
Chemical hazards • Exposure to chemicals inappropriately discarded in receptacle	Most likely outcome – minor injury no absence *Most severe outcome – major injury*	Residents placing inappropriately wrapped material into the receptacles Operatives should wear gloves when performing this task· Operatives will push material down in the back of the RCV using their hands

Hazards/Risks	*Range of consequences/harm outcomes*	*Assumptions/other information*
Struck by falling objects - Hit by falling bins - Hit by bin being lowered whilst attached to hoist - Hit by falling waste from bin - Raising boxes above shoulder height to empty contents - Mechanical emptying of hoppers· - Struck by lowering hopper - Stillage bars / flaps not appropriately fixed	Most likely outcome – minor injury no absence [cuts / bruises] (but depends on the object – a falling bin may lead to more severe injuries) *Most severe outcome – single fatality [crushing/head injury]*	- Operatives have to stand clear of the bin when it is raised - At the top most point the hoist / mechanism shakes the bin to remove the contents - Open bins (e.g. Palladins) raised above head height - Bin lid opens when inverted above head height Kerbsider/stillage: - The wind will affect the likelihood of material falling out of the box - Operatives have to stand clear of the hoppers when emptying - Bars / flaps may strike operatives if not fixed on appropriately
Entrapment in machinery [bins] - In hoist - Attempting to manually compact waste in hopper - Retrieving receptacles fallen into hopper	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [crushing]*	- Entrapment between lifting mechanism and RCV, particularly ‘side holding bars’ used for emptying Palladin bins - Operatives supposed to stand clear of machinery in action and not attempt to manually intervene - Violation of safe working practices - Sufficient safe systems of work required - It is possible for the wheelie bin to become jammed on the mechanism in an upright position. To free the bin operatives may be required to reach up and pull on it
Fatigue - Muscular fatigue - Mental fatigue	Most likely outcome –no absence / minor injury [sprains] *Most severe outcome – major injury [MSD]*	Repetitious handling of heavy loads Few / no breaks taken from collection activities during course of shift Running between receptacles due to job and finish system Long collection rounds e.g. after Christmas / bank holidays
Violence - From members of the public		During very early morning collection rounds / due to collection vehicle blocking road

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Stress	Chronic ill-health	Job and finish system in operation Peer pressure from other crew members to rush to complete round
Pets/insects	Most likely outcome – minor injury no absence [bite/scratch/sting] *Most severe outcome – major injury [bacterial infection/ severe trauma*]	Risk of injury from uncontrolled domestic animals (dogs) Rural areas – greater risk from wild animals (foxes) Seasonal variation – greater risk of insect bite/sting during summer

Table D30 Walking from one collection point to another

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Workplace transport • Large number of vehicular manoeuvres, (both collection vehicle and other road users) • Large numbers of operative movements • Collection/other vehicle striking operatives • Reversing activity	Collection vehicle striking operatives – Most likely outcome – major injury [crushing] *Most severe outcome – single fatality* [crushing] Other road traffic vehicle striking operatives – Most likely outcome – major injury [crushing] Most severe outcome – single fatality [crushing]	Collecting from both sides of road in same pass (i.e. crossing road to access waste) influences level of risk Collection often occurs during busy periods on the roads (e.g. rush hour) Collection may occur in conditions of limited access Potential for an operative to be struck from behind by other road users Due to loading / driving responsibilities, driver's situational awareness of position of other operatives may be limited Where operatives operating job and finish system, will tend to rush during round Light levels vary according to time of day / year (early in morning / during winter), degree to which artificial lighting is available (heavy shadows might impact on visibility), and weather conditions Workers are issued and are wearing appropriate PPE (e.g. high-visibility jackets) Ice on windscreen / mirrors affects visibility

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Slips and trips • Uneven surfaces / slopes / kerbs in collection area/grassy areas	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	Operatives running/jogging to next collection point if operating job and finish system Light levels vary according to time of day / year (early in morning / during winter), degree to which artificial lighting is available (heavy shadows might impact on visibility), and weather conditions Unusual hazards such as low hanging cables or those on the ground. Seasonal variations – risk of slip/trip when ground is wet, muddy or icy.
Violence • From members of the public		During very early morning collection rounds / due to collection vehicle blocking road
Stress	Most likely outcome – no absence [acute stress / headaches / high blood pressure] Most severe outcome [chronic ill-health]	Job and finish system in operation Peer pressure from other crew members to rush to complete round
Fatigue	Most likely outcome –no absence / minor injury [sprains] *Most severe outcome – major injury [MSD]*	Repetitious activity Few / no breaks taken from collection activities during course of shift Running between receptacles due to job and finish system Long collection rounds e.g. after Christmas / bank holidays
Pets/insects	Most likely outcome – minor injury no absence [bite/scratch/sting] *Most severe outcome – major injury [bacterial infection/ severe trauma*]	Risk of injury from uncontrolled domestic animals (dogs) Rural areas – greater risk from wild animals (foxes) Seasonal variation – greater risk of insect bite/sting during summer

Table D31 Operation of vehicle machinery

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Workplace transport • Large number of vehicular manoeuvres, (both collection vehicle and other road users) • Large numbers of operative movements • Collection/other vehicle striking operatives • Reversing activity whilst operating machinery	Collection vehicle striking operatives – Most likely outcome – major injury [crushing] *Most severe outcome – single fatality [crushing]* Other road traffic vehicle striking operatives – Most likely outcome – major injury [crushing] Most severe outcome – single fatality [crushing]	Operation of machinery from both sides of the vehicle influences level of risk Collection often occurs during busy periods on the roads (e.g. rush hour) Collection may occur in conditions of limited access Potential for an operative to be struck from behind by other road users Due to loading / driving responsibilities, driver's situational awareness of position of other operatives may be limited Where operatives operating job and finish system, will tend to rush during round Light levels vary according to time of day / year (early in morning / during winter), degree to which artificial lighting is available (heavy shadows might impact on visibility), and weather conditions Workers are issued and are wearing appropriate PPE (e.g. high-visibility jackets) Ice on windscreen / mirrors affects visibility

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Entrapment in machinery • Entrapment of fingers, limbs or clothing in machinery • In hoist • Attempting to manually compact waste in hopper • Retrieving receptacles fallen into hopper	Most likely outcome – major injury [crushing/traumatic amputation] *Most severe outcome – single fatality [crushing]*	Entrapment between lifting mechanism and RCV May be related to initial mechanical failure – e.g. failure of hydraulics, leads to manual intervention such as climbing on hopper. Inadequate or no guarding mechanisms. Stop controls can be over-ridden. No standardisation of stop buttons across vehicles. Variation in crew (e.g. agency) workers can lead to lack of communication and increased risk It is possible for receptacles to become jammed on the mechanism in an upright position. To free the bin operatives may be required to reach up and pull on it compounding risk of musculoskeletal injury Risk of injury from container doors opening sharply when operating machinery Operatives supposed to stand clear of machinery in action and not attempt to manually intervene Violation of safe working practices Sufficient safe systems of work required
Electrocution • Raising hoppers into overhead power cables.	Most likely outcome – major injury [electric shock] *Most severe outcome – single fatality [electric shock]*	Potential for operatives to be unaware of the presence of low overhead power cables. New / inexperienced operatives may be unfamiliar with the characteristics of the collection round

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Struck by falling objects • Objects falling from receptacles/vehicle hoppers onto operatives of machinery • Hit by falling waste/receptacles/moving hoist. • Hit by bin being lowered whilst attached to hoist	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – single fatality [crushing/head injury]*	Operatives have to stand clear of the bin when it is raised. Bin lids opens when inverted above head height At the top most point the hoist / mechanism shakes the bin to remove the contents
Violence • From members of the public		During very early morning collection rounds / due to collection vehicle blocking road
Stress	Chronic ill-health	Job and finish system in operation Peer pressure from other crew members to rush to complete round

Table D32 Emptying collection vehicle contents at drop-off point

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Workplace transport • Reversing activity • Non-segregation of pedestrians and vehicles • Large number of vehicular manoeuvres • Large numbers of operative movements • Collection vehicle striking operatives	Most likely outcome – major injury [crushing] *Most severe outcome – single fatality [crushing]*	Reversing operations have 'blind spots' covered by CCTV, but are contingent on driver using this Yard/tipping hall layout - limited space for manoeuvres, one-way system may impact on operations Number of vehicles tipping/unloading in same yard (affect number of vehicular movements). There can be a several pieces of mobile plant (e.g. shovel loaders) operating in area. Where operatives operating job and finish system, will tend to rush to leave yard Workers are issued and are wearing appropriate PPE (particularly high-visibility jackets) Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) Inexperienced drivers / unfamiliarity with vehicle
Slips and Trips • Uneven surfaces in yards • Maintenance / cleaning of yard surfaces	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) May be stray items on floor of tipping area due to poor housekeeping Risk of contamination from spillages on floor surfaces reduces grip

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Falls • On climbing into / out of cab • Pulling over vehicle sheeting	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – single fatality [fall from height – head injury]*	Limited access to cab (e.g. small tipping yard/other vehicles in close proximity) may restrict use of proper access technique Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) Use of appropriate fall arrest system for working at height on vehicles
Entrapment in machinery • Failure of tipping hydraulics • Entrapment of fingers, limbs or clothing in machinery • In hoist	Most likely outcome – major injury [crushing/traumatic amputation] *Most severe outcome – single fatality [crushing]*	Entrapment between lifting mechanism and RCV May be related to initial mechanical failure – e.g. failure of hydraulics, leads to manual intervention such as climbing on hopper. Inadequate or no guarding mechanisms. Stop controls can be over-ridden. No standardisation of stop buttons across vehicles. Variation in crew (e.g. agency) workers can lead to lack of communication and increased risk Operatives supposed to stand clear of machinery in action and not attempt to manually intervene Violation of safe working practices Sufficient safe systems of work required It is possible for waste/recyclables to become jammed in the mechanism. Operatives may intervene manually compounding the risk of injury Risk of injury from container doors opening sharply when operating machinery

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Struck by falling objects • Hit by falling waste/recyclables when unloading/tipping	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	Operatives have to stand clear of the rear tail section of vehicle when it is being raised to tip. As tipping occurs it is possible for items to fall out It is possible for items to become jammed on the vehicle mechanism. Operatives may attempt to reach up and pull on them compounding risk of objects falling out.
Noise • Emptying glass / tins into tipping bays • Combined noise from multiple vehicles tipping simultaneously	Most likely outcome – minor injury no absence [temporary hearing loss] *Most severe outcome – major injury [complete deafness]*	Tipping within an enclosed space (bay), refraction of sound waves. Tipping glass / tins into bays creates greatest noise Operatives wear appropriate PPE (ear defenders) Numerous vehicles tipping/unloading and mobile plant operating in confined areas produces noise
Handling sharp objects • Tipping contents of hopper • (tins / glass) • Needlestick injury	Most likely outcome – minor injury no absence [cuts] *Most severe outcome – major injury [cuts]*	Bucket of mobile plant used to smash bottles and squash cans to increase capacity of bay. Risk of injury from shards of glass in bays and surrounding areas – good housekeeping will mitigate risk Likelihood of shards of smashed glass from bays flying into eyes Operatives wearing appropriate gloves and safety glasses. Require footwear with mid-sole protection
Microbiological hazards	Most likely outcome – minor injury no absence *Most severe outcome – major injury*	Exposure to hazardous substances, airborne particles, dust

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Chemical hazards • Unloading hazardous material • Exposure to inappropriately discarded chemicals	Most likely outcome – minor injury no absence *Most severe outcome – major injury*	Risk from chemicals that have been emptied inappropriately by public into general waste spilling onto operatives when tipping/unloading. Assume use of appropriate PPE (gloves, aprons and goggles) when dealing with hazardous material (e.g. batteries, oil). Assume batteries placed in sealed containers
Fatigue • Mental fatigue		Few / no breaks taken from collection activities during course of shift Long collection rounds e.g. after Christmas / bank holidays
Stress	Chronic ill-health	Job and finish system in operation Peer pressure from other crew members to rush to complete round

D6.2 POST-COLLECTION ACTIVITIES

For those activities that are generic across all the subsystems, the hazard identification sheets have been summarised and have not been repeated for each subsystem. These are shown in Section D6.2.1. Specific activities not covered by the generic activities, or where the hazards are sufficiently different, separate hazard identification tables have been presented. These are presented in the following sections:

- Section D6.2.2 – transfer/bulking station;
- Section D6.2.3 – MRF;
- Section D6.2.4 – composting and MBT;
- Section D6.2.5 – incineration; and
- Section D6.2.6 – landfill.

D6.2.1 Generic activities

This section lists those activities that are generic across the post-collection subsystems, unless otherwise stated.

Hazards for the following generic activities are shown:

- Reversing operations
- Unloading collection vehicle
- Generic loading of material (using shovel loader)
- Loading of material onto articulated lorries
- General housekeeping
- Maintenance

Table D33 Reversing operations

Hazards/Risks	*Range of consequences/harm outcomes*	*Assumptions/other information*
Workplace transport • Reversing activity • Non-segregation of pedestrians and vehicles • Large number of vehicular manoeuvres • Large numbers of operative movements • Collection vehicle striking operatives	Most likely outcome – major injury [crushing] *Most severe outcome – single fatality [crushing]*	• Reversing operations have 'blind spots' covered by CCTV, but are contingent on driver using this • Yard/tipping hall layout - limited space for manoeuvres, one-way system may impact on operations • Number of vehicles tipping/unloading in same yard (affect number of vehicular movements). There can be a several pieces of mobile plant (e.g. shovel loaders) operating in area. • Where operatives operating job and finish system, will tend to rush to leave yard • Workers are issued and are wearing appropriate PPE (particularly high-visibility jackets) • Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) • Inexperienced drivers / unfamiliarity with vehicle • Sleepers in place to help prevent reversing too far backwards into pit (where in existence)
Slips and Trips • Uneven surfaces in yards • Maintenance / cleaning of yard surfaces	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	• Operatives running to access cab and leave yard (if operating job and finish system tend to hurry) • Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) • May be stray items on floor of tipping area due to poor housekeeping

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Falls • Banksmen climbing into / out of cab	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [crushing/fracture]*	• Light levels vary according to time of day / year (early in morning / during winter), degree to which artificial lighting is available (heavy shadows might impact on visibility), and weather conditions • Contaminants (e.g. oil) on steps, or ice in poor weather • Greater risk during egress (less control / visibility) • Poor technique – e.g. jumping out of cab instead of descending backwards • Material on the sole of the boot which could reduce the grip between boot and step

Table D34 Unloading collection vehicle contents at drop-off point

Hazards/Risks	*Range of consequences/harm outcomes*	*Assumptions/other information*
Workplace Transport • Reversing activity of other vehicles • Non-segregation of pedestrians and vehicles • Large number of vehicular manoeuvres • Large numbers of operative movements • Vehicle striking operatives Landfill: • Driving vehicle forward when the rear is still upright • Collection / loading vehicle striking operative when they exit cab • Jogging of vehicle to free blocked material	Most likely outcome – major injury [crushing] Most severe outcome – single fatality [crushing]	• Yard/tipping hall layout - limited space for manoeuvres, one-way system may impact on operations • Number of vehicles tipping/unloading in same yard (affect number of vehicular movements). There can be a several pieces of mobile plant (e.g. shovel loaders) operating in area. • Where operatives operating job and finish system, will tend to rush to leave yard • Workers are issued and are wearing appropriate PPE (particularly high-visibility jackets) • Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) • Inexperienced drivers / unfamiliarity with vehicle • Landfill: • Risk of becoming stuck / bogged down • Number of vehicles tipping/unloading on same site (affect number of vehicular movements). • Weather such as fog, rain etc. will affect visibility • Exposed site – wind could increase the risk of vehicle tipping over
Workplace transport • Struck by door	Most likely outcome – no absence Most severe outcome – minor injury [cuts / bruising]	• High winds could result in door being banged against the body • Poor access technique – not holding onto the door
Workplace transport (transfer, not MRF) • Vehicle tipping over • Stillages tipping over	Most likely outcome – major injury [crushing/ fracture] Most severe outcome – single fatality [crushing]	• Vehicle / stillages tipping over – e.g. when removing stillages from vehicle using fork-lift truck. • Risk of either vehicle or stillage tipping over if not loaded properly, e.g. inappropriately balanced on forks • Tipping could be caused by driving too fast around corners

Hazards/Risks	*Range of consequences/harm outcomes*	*Assumptions/other information*
Operating of vehicle machinery/hydraulics • Failure of tipping hydraulics • Entrapment of fingers, limbs or clothing in machinery	Most likely outcome – major injury [crushing/traumatic amputation] Most severe outcome – single fatality [crushing]	• May be related to initial mechanical failure – e.g. failure of hydraulics, leads to manual intervention such as climbing on hopper. • Inadequate or no guarding mechanisms. Stop controls can be over-ridden. • No standardisation of stop buttons across vehicles. • Variation in crew (e.g. agency) workers can lead to lack of communication and increased risk • Operatives supposed to stand clear of machinery in action and not attempt to manually intervene • Violation of safe working practices • Sufficient safe systems of work required • It is possible for waste/recyclables to become jammed in the mechanism. Operatives may intervene manually compounding the risk of injury • Risk of injury from container doors opening sharply when operating machinery. • Variation depending upon vehicle type i.e. whether driver needs to exit cab to operate tipping mechanics or Stillage vehicle
Struck by falling objects • Hit by falling waste/recyclables when unloading/tipping	Most likely outcome – minor injury no absence [cuts / bruises] Most severe outcome – major injury [fracture]	• Operatives have to stand clear of the rear tail section of vehicle when it is being raised to tip. • As tipping occurs it is possible for items to fall out • It is possible for items to become jammed on the vehicle mechanism. Operatives may attempt to reach up and pull on them compounding risk of objects falling out.
Microbiological hazards	Most likely outcome – minor injury no absence Most severe outcome – major injury	• Exposure to hazardous substances, airborne particles, dust, bioaerosols • Exposures to airborne hazards - The cabs of the vehicles used on-site are fitted with air filters to remove particulate dust.

Hazards/Risks	*Range of consequences/harm outcomes*	*Assumptions/other information*
Noise • Emptying glass / tins into tipping bays • Combined noise from multiple vehicles tipping simultaneously	Most likely outcome – minor injury no absence [temporary hearing loss] Most severe outcome – major injury [complete deafness]	• Tipping within an enclosed space (bay), refraction of sound waves. • Tipping glass / tins into bays creates greatest noise • Operatives wear appropriate PPE (ear defenders) • Numerous vehicles tipping/unloading and mobile plant operating in confined areas produces noise
Handling sharp objects • Tipping contents of hopper • (tins / glass) • Needlestick injury	Most likely outcome – minor injury no absence [cuts] Most severe outcome – major injury [cuts]	• Bucket of mobile plant often used to smash bottles and squash cans to increase capacity of bays. • Risk of injury from shards of glass in bays and surrounding areas – good housekeeping will mitigate risk • Likelihood of shards of smashed glass from bays flying into eyes • Operatives wearing appropriate gloves and safety glasses/boots. • Require footwear with mid-sole protection.
Slips and Trips • Uneven surfaces in yards • Maintenance / cleaning of yard surfaces • inadequate housekeeping in yards Landfill: • Walking on compacted waste	Most likely outcome – minor injury no absence [cuts / bruises] Most severe outcome – major injury [fracture]	• Operatives running to access cab and leave yard (if operating job and finish system tend to hurry) • Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) • May be stray items on floor of tipping area due to poor housekeeping • Risk of contamination from spillages on floor surfaces reduces grip • Landfill: • Material may become lodged in the cleats of the boots thus reducing the boots grip

Hazards/Risks	*Range of consequences/harm outcomes*	*Assumptions/other information*
Falls • From steps / cab	From stationary vehicle – Most likely outcome – minor injury [cuts / bruises] Most severe outcome – major injury [fracture] From moving vehicle – Most likely outcome – minor injury [cuts / bruises] Most severe outcome – single fatality [crushing]	• Light levels vary according to time of day / year (early in morning / during winter), degree to which artificial lighting is available (heavy shadows might impact on visibility), and weather conditions • Contaminants (e.g. oil) on steps, or ice in poor weather • Greater risk during egress (less control / visibility) • Poor technique – e.g. jumping out of cab instead of descending backwards • Material on the sole of the boot which could reduce the grip between boot and step • Operatives may be rushing e.g. if operating job and finish system • Landfill: • Adoption of good access/egress technique • Light levels may vary according to time of year and the degree to which artificial lighting is available • Potential for a reduced grip on the access/egress step
Falls (windrow composting) • Pulling over vehicle sheeting (if not automatic) on roll-on, roll-off vehicle	Most likely outcome – minor injury no absence [cuts / bruises] Most severe outcome – single fatality [head injury]	• Provision of appropriate harness and fall arrest system for working at height on vehicles. • Walking on load to sheet the load compounds the risk of falling into voids in load. • Operatives issued with and use appropriate PPE • Variations depending upon vehicle type, sheeting may be placed in situ either manually or automatically
Chemical hazards • Unloading hazardous material • Exposure to inappropriately discarded chemicals	Most likely outcome – minor injury no absence Most severe outcome – major injury	• Risk from chemicals that have been emptied inappropriately by public into recyclable containers spilling onto operatives when unloading. • Assume use of appropriate PPE (gloves, aprons and goggles) when dealing with hazardous material (e.g. batteries, oil). • Assume batteries placed in sealed containers • Oil to be disposed of in appropriate sealed container

Table D35 Generic loading of material (using shovel loader)

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Workplace Transport • Frequent reversing activity • Non-segregation of pedestrians and vehicles • Operative movements in close proximity • Shovel loader striking pedestrian operatives • Shovel loader striking operatives (e.g. when manually operating controls to retract roof) (MBT)	Most likely outcome – major injury [crushing] *Most severe outcome – single fatality [crushing]*	• Yard/tipping hall layout - limited space for manoeuvres, one-way system may impact on operations • Number of vehicles tipping/unloading in same yard (affect number of vehicular movements). There can be a several pieces of mobile plant (e.g. shovel loaders) operating in area. • Workers are issued and are wearing appropriate PPE (particularly high-visibility jackets) • Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) • Inexperienced drivers / unfamiliarity with vehicle
Falls • On access / egress to shovel cab / bulk container lorry	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [crushing/fracture]*	• Limited access to cab may restrict use of proper access technique • Increased risk due to contaminants (e.g. oil) on steps. • Greater risk during egress (less control / visibility) • Poor technique – e.g. jumping out of cab instead of descending backwards • Material on the sole of the boot which could reduce the grip between boot and step • Operatives issued with and use appropriate PPE
Struck by falling objects • Hit by falling waste/recyclables when loading/tipping	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	• Operatives have to stand clear of the rear tail section of vehicle when it is being raised to tip. • As tipping occurs it is possible for items to fall out • It is possible for items to become jammed on the conveyor mechanism. • Operatives should stand clear of shovel loader when in operation • As tipping occurs it is possible for items to fall from the raised shovel to the ground below

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Dust • Risk of inhalation • Risk of eye contamination	Most likely outcome – minor injury no absence [e.g. eye contamination] Most severe outcome – major [e.g. chronic lung condition]	• Exposure to hazardous substances, airborne particles, dusts • Operatives issued with and wearing the appropriate PPE (e.g. gloves, goggles, dust masks) • Windy conditions increase dust levels in air • Operatives to be aware of location of eye baths and procedures for use.
Microbiological hazards	Most likely outcome – minor injury no absence *Most severe outcome – major injury*	• Exposure to hazardous substances, airborne particles, dust, bioaerosols • Cabs of vehicles used on-site fitted with air filters to remove particulate dust
Vibration	Most likely outcome – minor injury no absence [back pain] *Most severe outcome – major [chronic MSD, nerve damage]*	• Vibration from spending a long time driving vehicle on an uneven surface • Provision of vibration dampening in some vehicle seats
Manual handling (MBT – loading first vessel)	Most likely outcome – minor injury [sprain] Most severe outcome-greater than 3 day (short term reversible)	• Reaching above shoulder height. • Force required to pull open and push doors closed (unknown) • Frequency of operation dependent upon tonnage of material passing through process.
Manual handling of the sheet • Sheet is pulled over the trailer from the ground by throwing over a pull cord from one side of the trailer to the other. The sheet is then pulled over the trailer using the cord. (composting)	Most likely outcome – minor injury no absence *Most severe outcome – > 3 day loss time*	• Variations depending upon vehicle type, sheeting may be placed in situ either manually or automatically
Slips and Trips • Uneven surfaces in yards • Maintenance / cleaning of yard surfaces	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	• Operatives/drivers have to manually un block holes in the piping which blows air through the compost due to compost compacting in them during the filling process of the vessel.

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Noise - From screening / shredding machine	Most likely outcome – minor injury no absence [temporary hearing loss] *Most severe outcome – major injury [complete deafness]*	- Screener / shredder in action can be very noisy – ear defenders are provided
Operating of vehicle machinery/hydraulics - Failure of hydraulic arm	Most likely outcome – major injury [crushing/traumatic amputation] *Most severe outcome – single fatality [crushing]*	- Inadequate or no guarding mechanisms. Stop controls can be over-ridden. - Violation of safe working practices - Sufficient safe systems of work required - May be related to initial mechanical failure – e.g. failure of hydraulics, leads to manual intervention

Table D36 Loading of material onto articulated lorries

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Workplace Transport • Reversing activity of other vehicles • Non-segregation of pedestrians and vehicles • Large number of vehicular manoeuvres • Large numbers of operative movements • Vehicle striking operatives	Most likely outcome – major injury [crushing] *Most severe outcome – single fatality [crushing]*	• Reversing operations have ‘blind spots’ covered by CCTV, but are contingent on driver using this • Yard/tipping/collection hall layout - limited space for manoeuvres, one-way system may impact on operations • Visibility obstructed by other large lorries • Number of vehicles tipping/unloading in same yard (affect number of vehicular movements). There can be a several pieces of mobile plant (e.g. shovel loaders) operating in area. • Where operatives operating job and finish system, will tend to rush to leave yard • Workers are issued and are wearing appropriate PPE (particularly high-visibility jackets) • Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) • Inexperienced drivers / unfamiliarity with vehicle
Struck by falling objects • Hit by waste falling out of loading vehicle	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	• As loading occurs with shovel loaders it is possible for items to fall out. • Workers are issued and wearing the appropriate PPE • Operatives should stand clear of shovel loader when in operation • As tipping occurs it is possible for items to fall from the raised shovel to the ground below

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Falls from height • Pulling over vehicle sheeting (if not automatic) • Falling from cab of vehicle • Banksmen climbing into / out of cab	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – single fatality [head injury]*	• Limited access (e.g. small collection hall/other vehicles in close proximity) may restrict use of proper technique. • Variations depending upon vehicle type, sheeting may be placed in situ either manually or automatically • Increased risk due to possible contaminants (e.g. oil) on steps. • Material on the sole of the boot that could reduce the grip between boot and surface being stood upon. • Provision of appropriate harness and fall arrest system for working at height on vehicles. • Walking on load to sheet the load compounds the risk of falling into voids in load. • Operatives issued with and use appropriate PPE • Contaminants (e.g. oil) on steps, or ice in poor weather • Greater risk during egress (less control / visibility) • Poor technique – e.g. jumping out of cab instead of descending backwards • Material on the sole of the boot which could reduce the grip between boot and step • Light levels vary according to time of day / year (early in morning / during winter), degree to which artificial lighting is available (heavy shadows might impact on visibility), and weather conditions
Dust • Risk of inhalation • Risk of eye contamination	Most likely outcome – minor injury no absence [e.g. eye contamination] Most severe outcome – major [e.g. chronic lung condition]	• Exposure to hazardous substances, airborne particles, dusts when collecting ash waste. • This process can generate large amounts of dust. • Operatives are issued with and wearing the appropriate PPE (e.g. gloves, goggles, dust masks) • Windy conditions influence dust levels in atmosphere • Operatives to be aware of location of eye baths and procedure for use.

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Microbiological hazards	Most likely outcome – minor injury no absence *Most severe outcome – major injury*	• Exposure to hazardous substances, airborne particles, dust, bioaerosols • Exposures to airborne hazards - The cabs of the vehicles used on-site are fitted with air filters to remove particulate dust • Incinerator (Removal of by-products): • APC residue – (particles of dust in hot gases and flue gas) prior to collection is injected with lime and activated carbon to treat dioxins. • Risk of exposure therefore to hazardous substances, airborne particles, dusts etc. • Operatives are issued with and wearing the appropriate PPE (gloves, dust masks, safety glasses, overalls). • Operators to be aware where emergency showers and eye baths are situated. • Assume COSHH statement is in place and safety data sheets relative to each chemical available. • Spilled oil to be disposed of in appropriate receptacle.
Slips and Trips • Uneven surfaces in yards • Maintenance / cleaning of yard surfaces	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	• Operatives running to access cab and leave yard (if operating job and finish system tend to hurry) • Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) • May be stray items on floor of tipping area due to poor housekeeping • Risk of contamination from spillages on floor surfaces reduces grip

Table D37 General housekeeping

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Workplace transport • Non-segregation of pedestrians and vehicles • Large number of vehicular manoeuvres / reversing • Large numbers of operative movements	Most likely outcome – major injury [crushing] *Most severe outcome – single fatality [crushing]*	• Potential for loss of line of sight and driver accidentally reversing into operatives conducting housekeeping duties. • Site layout - limited space for manoeuvres, compounds risk from non-segregation of pedestrians and vehicles. • There can be a several pieces of mobile plant (e.g. shovel loaders) operating in areas. • Number of vehicles tipping/unloading in same yard (affect number of vehicular movements). There can be a several pieces of mobile plant (e.g. shovel loaders) operating in area. • Workers are issued and are wearing appropriate PPE (particularly high-visibility jackets) • Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility)
Microbiological/chemical hazards • Exposure to hazardous substances e.g. spillages, airborne particles • E.g. Urea, lime (incinerator)	Most likely outcome – minor injury no absence *Most severe outcome – major injury*	• Risk of exposure to hazardous substances around site, airborne particles, dusts etc. • Assume operatives are issued with and wearing the appropriate PPE (gloves, dust masks, safety glasses, overalls). • Operators to be aware of emergency procedures if exposed to hazardous material . • Assume COSHH statement is in place and safety data sheets relative to each chemical available. • Use of hazardous cleaning products • Exposure to hazardous substances – dusts, airborne particles • Droplet damping system used • Cleaning air holes of contaminant (MBT/composting)

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Slips and Trips • Uneven surfaces in yards • Maintenance / cleaning of yard surfaces	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	• Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) • May be stray items on floor of tipping area due to poor housekeeping • Risk of contamination from spillages on floor surfaces reduces grip
Lifting/carrying • Heavy housekeeping equipment • Stretching/straining when conducting cleaning duties	Most likely outcome – minor injury no absence [strain / sprain] Most severe outcome – major injury [serious strain / sprain, chronic MSD]	• Time constraints lead to poor technique. • Correct use of lifting procedures and equipment as required.
Noise	Most likely outcome – minor injury no absence [temporary hearing loss] *Most severe outcome – major injury [complete deafness]*	• Operation of heavy plant can be noisy • General operation of MRF site is often very noisy, outside of the sorting cabins
Dust • Risk of inhalation • Risk of eye contamination	Most likely outcome – minor injury no absence [e.g. eye contamination] *Most severe outcome – major [e.g. chronic lung condition]*	• Exposure to airborne particles, dusts e.g. when conducting housekeeping duties • Operatives are issued with and wearing the appropriate PPE (e.g. gloves, goggles, dust masks) • Windy conditions increase level of dust in atmosphere • Operatives to be aware of location of eye baths and procedures for use.
Use of high-pressure hose	Most likely outcome – minor, no absence *Most severe outcome – major – absence from work and could lead to an increased risk in an accident or MSD*	• To jet wash floors

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Falls - On climbing out of / into cab (if using shovel loader to clean up)	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – single fatality*	- Increased risk due to contaminants (e.g. oil) on steps. - Greater risk during egress (less control / visibility) - Poor technique – e.g. jumping out of cab instead of descending backwards - Light levels may vary according to time of year and the degree to which artificial lighting is available
Falls from height (incinerator) - Falling into waste pit - Falls on stair ways	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – single fatality [head injury]*	- Waste manually swept into bunker by operatives, risk of falling over the bay edge. - Material on the sole of the boot that could reduce the grip between boot and surface being stood upon compounds risk of fall. - Use of appropriate harness and fall arrest system required - Operatives issued with and use appropriate PPE (hard hat)
Entrapment in machinery - Of fingers, limbs or clothing in machinery	Most likely outcome – minor injury no absence *Most severe outcome – major injury [crushing/traumatic amputation]*	- Machinery lockout systems to avoid entrapment - Related to either initial mechanical failure – e.g. failure of hydraulics, leads to manual intervention or removal of blockage - Assume all equipment is guarded however, may be inadequate or no guarding mechanisms. - Stop controls can be over-ridden. - Variation in operatives (e.g. contractors) workers can lead to lack of communication and increased risk. - Risk compounded by operatives unfamiliar with site. - Parts of plant machinery operates automatically and may start up without warning, should be key lockout system - Violation of safe working practices - Sufficient safe systems of work required - Working in close proximity to screening / shredding machines
Hot pipe work/steam egress (incinerator)	Most likely outcome – minor injury no absence [minor scald] *Most severe outcome – major injury [major burn]*	- Risk of injury when operatives are cleaning around and under pipe work. - All pipe work lagged and operatives to wear PPE provided (gloves). - Warning signs in situ in areas of extreme heat. - Risk compounded by operatives unfamiliar with ERF site.

Table D38 Maintenance

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Entrapment in machinery • Of fingers, limbs or clothing in machinery / conveyors • Variation depending upon machinery/guarding type	Most likely outcome – minor injury no absence *Most severe outcome – major injury [crushing/traumatic amputation]*	• Machinery lockout systems to avoid entrapment • Related to either initial mechanical failure – e.g. failure of hydraulics, leads to manual intervention or removal of blockage • Presence of guarding mechanisms. • Stop controls can be over-ridden. • Variation in operatives (e.g. contractors) workers can lead to lack of communication and increased risk. • Operatives may be unfamiliar with machinery • Parts of plant machinery operates automatically and may start up without warning, should be key lockout system • Violation of safe working practices • Sufficient safe systems of work required • Incinerator: • May be related to initial mechanical failure – e.g. failure of hydraulics, leads to manual intervention • Assume all equipment is guarded however, may be inadequate or no guarding mechanisms. • Risk compounded by operatives unfamiliar with ERF site.
Microbiological/chemical hazards Incinerator: • E.g. Urea, lime • Chemical spills	Most likely outcome – minor injury no absence *Most severe outcome – major injury*	• Exposure to hazardous substances, airborne particles, dust, bioaerosols • Incinerator: • Risk of exposure to hazardous substances utilised around incinerator site, airborne particles, dusts etc. • Assume operatives are issued with and wearing the appropriate PPE (gloves, dust masks, safety glasses, overalls). • Operators to be aware where emergency showers are situated. • Assume COSHH statement is in place and safety data sheets relative to each chemical available. • Risk compounded by operatives unfamiliar with ERF site.

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Slips and Trips • Uneven surfaces in yards • Maintenance / cleaning of yard surfaces	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	• Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) • May be stray items on floor of tipping area due to poor housekeeping • Risk of contamination from spillages on floor surfaces reduces grip
Lifting/carrying • Heavy maintenance equipment • Stretching/straining when conducting maintenance duties	Most likely outcome – minor injury no absence [strain / sprain] Most severe outcome – major injury [serious strain / sprain, chronic MSD]	• Need to ensure adequate MH training. • Risk compounded by time constraints leading to poor technique. • Correct use of lifting procedures and equipment as required.
Noise	Most likely outcome – minor injury no absence [temporary hearing loss] *Most severe outcome – major injury [complete deafness]*	• Operation of heavy plant can be noisy • General operation of MRF site is often very noisy, outside of the sorting cabins • Many areas of incinerator plant can be noisy due to operation of machinery. • Turbine room – particular hazard. • Assume provision and appropriate use of PPE (ear defenders).
Hot pipe work/steam egress (incinerator)	Most likely outcome – minor injury no absence [minor scald] *Most severe outcome – major injury [major burn]*	• All pipe work lagged and operatives to wear PPE provided (gloves). • Warning signs in situ in areas of extreme heat. • Risk compounded by operatives unfamiliar with ERF site.
Dust • Risk of inhalation • Risk of eye contamination	Most likely outcome – minor injury no absence [e.g. eye contamination] *Most severe outcome – major [e.g. chronic lung condition]*	• Exposure to hazardous substances, airborne particles, dusts e.g. when conducting maintenance • Assume operatives are issued with and wearing the appropriate PPE (e.g. gloves, goggles, dust masks) • Risk compounded by windy conditions.

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Stress	Most likely outcome – minor, no absence *Most severe outcome – Chronic – absence from work and could lead to an increased risk in an MSD*	• Peer pressure to behave in a risky manner from other crew members – compounded by staff shortages. • Self-imposed time-pressures
Fatigue	Most likely outcome – minor, no absence *Most severe outcome – Chronic – absence from work and could lead to an increased risk in an accident or MSD*	• Few / no breaks taken from maintenance activities during course of shift. • Busy periods e.g. after Christmas / bank holidays • Risk of fatigue may be compounded by staff shortages

D6.2.2 Transfer/bulking station specific

Table D39 Handling of heavy or hazardous waste

Hazards/Risks	*Range of consequences/harm outcomes*	*Assumptions/other information*
Lifting / carrying • Heavy / large objects	Most likely outcome – minor injury no absence [strain / sprain] Most severe outcome – major injury [serious strain / sprain, chronic MSD]	• Heavy items such as fridges/furniture occasionally need to be unloaded at transfer/bulking station • Time constraint may lead to poor technique. • Correct use of lifting procedures and equipment as required.
Chemical hazards • Unloading hazardous material	Most likely outcome – minor injury no absence *Most severe outcome – major injury*	• Risk from chemicals that have been emptied inappropriately by public into general waste spilling onto operatives when tipping/unloading. • Assume COSHH statement is in place and safety data sheets relative to each chemical available. • Assume use of appropriate PPE (gloves, aprons and goggles) when dealing with hazardous material (e.g. batteries, oil). • Assume batteries placed in sealed containers. • Assume oil is discarded of and stored at transfer/bulking station in appropriate sealed containers. • Operatives aware of procedures to follow in the event of an accidental spill. • Location of emergency showers and eye baths and procedures for use.
Explosion / fire	Most likely outcome – major injury [burns, traumatic injury] Most severe outcome – multiple fatalities	• Need to avoid flame/sparks when dealing with flammable material

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Slips and Trips • Uneven surfaces in yards • Maintenance / cleaning of yard surfaces	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	• Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) • May be stray items on floor of tipping area due to poor housekeeping • Risk of contamination from spillages on floor surfaces reduces grip

D6.2.3 MRF specific

Table D40 Manual sorting of materials on conveyor belt

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Handling sharp objects • In material presented on conveyor belt • Needlestick hazard	Most likely outcome – minor injury no absence [cuts] *Most severe outcome – major injury [cuts / lacerations]*	• Operatives should be provided with appropriate PPE, e.g. gloves • Emergency stop system in operation when operatives observe a needlestick (safe working procedures)
Upper limb disorders	Most likely outcome – minor injury no absence [strain / sprain] *Most severe outcome – major injury [strain / sprain]*	• Leaning forward over conveyor belt, out-stretched reach, • Highly repetitious task leads to localised fatiguing of muscles • Trunk twisting motions • Rapid line speeds • Pace of work controlled by conveyor
Lower limb disorders	Most likely outcome – minor injury no absence [strain / sprain] *Most severe outcome – major injury [strain / sprain]*	• Standing in same place for duration of day (postural fixity)
Entrapment in conveyor	Most likely outcome – minor injury no absence [crushing] *Most severe outcome – major injury [severe crushing]*	• Loose clothing / jewellery may become entrapped in conveyor belt • Influenced by speed of conveyor belt • Conveyor design influences presence of pinch points • Presence of guards around conveyor belt
Chemical hazards		• Chemical contamination in material presented
Microbiological hazards		• Dust, Weil’s disease • Functioning air-conditioning / separate sorting cabin

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Noise	Most likely outcome – minor injury no absence [temporary hearing loss] *Most severe outcome – major injury [complete deafness]*	• Especially if no separate sorting cabin • Workers need to be issued with ear defenders
Stress	Chronic ill-health	• Pace of conveyor system in operation not controlled by operatives • Monotonous task, limited opportunities for job rotation • Limited breaks from work

Table D41 Baling of materials

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Entrapment in machinery • Of fingers, limbs or clothing in machinery	Most likely outcome – minor injury no absence *Most severe outcome – major injury [crushing/traumatic amputation]*	• Machinery lockout systems to avoid entrapment • Related to either initial mechanical failure leads to manual intervention or removal of blockage • Presence of guarding mechanisms. • Stop controls can be over-ridden. • Variation in operatives (e.g. contractors) workers can lead to lack of communication and increased risk. • Operatives may be unfamiliar with machinery • Parts of plant machinery operates automatically and may start up without warning, should be key lockout system • Violation of safe working practices • Sufficient safe systems of work required
Explosion • Due to pressure build up in plastic bottles	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – single fatality [trauma]*	• Need to ensure that all plastic bottles have lids removed or are pierced (either manually or automatically) • Flying shrapnel if in proximity to other operatives
Struck by falling objects • Hit by falling bales during loading	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	• Operatives have to stand clear of loading activity • Bales should be stacked securely and in a stable manner

D6.2.4 Composting and MBT specific

Table D42 Inserting temperature probes into top of in-vessel

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Microbiological hazards	Most likely outcome – minor injury no absence *Most severe outcome – major injury*	• Exposure to hazardous substances, airborne particles, dust, bioaerosols
Falls • On climbing onto roof of in-vessel	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – single fatality [fall from height – head injury]*	• Increased risk due to contaminants (e.g. oil) on steps. • Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) • Windy conditions may influence risk
Slips and Trips • Uneven surfaces / inadequate housekeeping in yards / around clamps • Pipe work / other hazards located on roof top	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	• Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) • May be stray items on floor of tipping area due to poor housekeeping • Risk of contamination from spillages on floor surfaces reduces grip
Manual handling • Lifting / carrying probes • Pulling / pushing probes to insert / remove	Most likely outcome – minor injury no absence [sprain / strain] *Most severe outcome – major injury [severe strain / sprain]*	• Weight of probes / ease of insertion influences risk

Table D43 Turning windrows

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Falls • On access / egress to shovel cab	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [crushing/fracture]*	• Limited access to cab may restrict use of proper access technique • Increased risk due to contaminants (e.g. oil) on steps. • Greater risk during egress (less control / visibility) • Poor technique – e.g. jumping out of cab instead of descending backwards • Material on the sole of the boot which could reduce the grip between boot and step
Dust • Risk of inhalation • Risk of eye contamination	Most likely outcome – minor injury no absence [e.g. eye contamination] *Most severe outcome – major [e.g. chronic lung condition]*	• Exposure to airborne particles, dusts e.g. when conducting housekeeping duties • Operatives are issued with and wearing the appropriate PPE (e.g. gloves, goggles, dust masks) • Windy conditions increase level of dust in atmosphere • Operatives to be aware of location of eye baths and procedures for use.

Table D44 Manual pre-sorting of material prior to screening / shredding

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Workplace Transport • Frequent reversing activity • Non-segregation of pedestrians and vehicles • Operative movements in close proximity • Shovel loader and/or RCV striking pedestrian operatives	Most likely outcome – major injury [crushing] *Most severe outcome – single fatality [crushing]*	• Yard/tipping hall layout - limited space for manoeuvres, one-way system may impact on operations • Number of vehicles tipping/unloading in same yard (affect number of vehicular movements). There can be a several pieces of mobile plant (e.g. shovel loaders) operating in area. • Workers are issued and are wearing appropriate PPE (particularly high-visibility jackets) • Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) • Inexperienced drivers / unfamiliarity with vehicle
Handling sharp objects • Needlestick injuries	Most likely outcome – minor injury no absence [cuts] *Most severe outcome – major injury [cuts]*	• Task is performed prior to the feedstock being processed
Slips and Trips • Uneven surfaces in yards • Maintenance / cleaning of yard surfaces	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	• Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) • May be stray items on floor of tipping area due to poor housekeeping • Risk of contamination from spillages on floor surfaces reduces grip
Microbiological hazards	Most likely outcome – minor injury no absence *Most severe outcome – major injury*	• Exposure to hazardous substances, airborne particles, dust, bioaerosols • Exposure to animal waste / carcasses

Table D45 Opening / closing door of in-vessel

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Workplace transport • Non-segregation of pedestrians and vehicles • Large number of vehicular manoeuvres • Collection / loading vehicle striking operatives (e.g. when manually operating controls to retract roof)	Most likely outcome – major injury [crushing] Most severe outcome – single fatality [crushing]	• Reversing operations have ‘blind spots’ covered by CCTV, but are contingent on driver using this facility • There can be a several pieces of mobile plant (e.g. shovel loaders) operating in area. • Workers are issued and are wearing appropriate PPE (particularly high-visibility jackets) • Light levels may vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) • Visibility within enclosed composting halls can be a significant problem in winter, as steam generated from the feedstock prior to processing can give rise to issues regarding the movement of personnel and machines within the enclosed working area.
Microbiological hazards	Most likely outcome – minor injury no absence *Most severe outcome – major injury*	• Exposure to hazardous substances, airborne particles, dust, bioaerosols

Table D46 Loading in-vessel

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Workplace transport • Non-segregation of pedestrians and vehicles • Large number of vehicular manoeuvres • Collection / loading vehicle striking operatives (e.g. when manually operating controls to retract roof)	Most likely outcome – major injury [crushing] Most severe outcome – single fatality [crushing]	• Reversing operations have 'blind spots' covered by CCTV, but are contingent on driver using this facility • There can be a several pieces of mobile plant (e.g. shovel loaders) operating in area. • Workers are issued and are wearing appropriate PPE (particularly high-visibility jackets) • Light levels may vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) • Visibility within enclosed composting halls can be a significant problem in winter, as steam generated from the feedstock prior to processing can give rise to issues regarding the movement of personnel and machines within the enclosed working area.
Microbiological hazards	Most likely outcome – minor injury no absence *Most severe outcome – major injury*	• Exposure to hazardous substances, airborne particles, dust, bioaerosols
Struck by falling objects • Hit by falling waste/recyclables when unloading/tipping	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	• Operatives have to stand clear of the rear tail section of vehicle when it is being raised to tip. • As tipping occurs it is possible for items to fall out • It is possible for items to become jammed on the vehicle mechanism. Operatives may attempt to reach up and pull on them compounding risk of objects falling out.

D6.2.5 Incinerator specific

Table D47 Removal of large items of waste from feed chute with manually operated crane

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Struck by falling objects • Hit by falling waste/recyclables from crane.	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	• Variations depending upon crane type i.e. whether operative is enclosed in cab. • Risk varies depending upon type/weight of waste item (i.e. fridge freezer). • Operative wearing appropriate PPE – e.g. hard hats.

Table D48 Delivery of hazardous substances in bulk

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Workplace Transport • Collision with other vehicles on-site • Reversing activity • Non-segregation of pedestrians and vehicles	Most likely outcome – major injury [crushing] *Most severe outcome – single fatality*	• Number of vehicles driving around site • Reversing/manoeuvring operations have ‘blind spots’ covered by CCTV, but are contingent on driver using this. • Silo storage area – may be limited space for manoeuvres, one-way system may impact on operations. • Inexperienced drivers / unfamiliarity with vehicle • Workers are issued and are wearing appropriate PPE (particularly high-visibility jackets)
Manual handling • Lifting / carrying pipes • Pulling / pushing pipes to insert / remove	Most likely outcome – minor injury no absence [sprain / strain] *Most severe outcome – major injury [severe strain / sprain]*	• Weight of pipes / ease of insertion influences risk • Pipes may be flexible as opposed to rigid, therefore may be difficult to handle and not have handholds

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Slips and Trips • Uneven surfaces in yards • Maintenance / cleaning of yard surfaces	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	• Operatives running to access cab and leave yard (if operating job and finish system tend to hurry) • Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) • May be stray items on floor of tipping area due to poor housekeeping • Risk of contamination from spillages on floor surfaces reduces grip
Falls • From steps / cab	Most likely outcome – minor injury [cuts / bruises] Most severe outcome – major injury [fracture]	• Light levels vary according to time of day / year (early in morning / during winter), degree to which artificial lighting is available (heavy shadows might impact on visibility), and weather conditions • Contaminants (e.g. oil) on steps • Greater risk during egress (less control / visibility) • Poor technique – e.g. jumping out of cab instead of descending backwards • Material on the sole of the boot which could reduce the grip between boot and step • Operatives may be rushing e.g. if operating job and finish system

Hazards/Risks	*Range of consequences/harm outcomes*	*Assumptions/other information*
Microbiological/chemical hazards • From chemical spills • Operatives manual feed into system • Possible inhalation of substances	Most likely outcome – minor injury no absence *Most severe outcome – major injury*	• Risk of exposure to hazardous substances, airborne particles, dusts when loading silos. • Hazardous compounds are normally delivered into incineration process automatically. • Manual intervention may be required at times of mechanical/technical system failures. • Assume operatives are issued with and wearing the appropriate PPE (gloves, dust masks, safety glasses, overalls). • Risk of accidental splashing if delivery drivers have to remove blanking caps from tank vent lines. Full-face visor required. • Operators to be aware where emergency showers and eye baths are situated. • Assume COSHH statement is in place and safety data sheets relative to each chemical available • Chemicals should be stored in purpose built containers surrounded by a bund.
Explosion	Most likely outcome – major injury [burns, traumatic injury] Most severe outcome – multiple fatalities	• Tanker to be earthed to silo system to prevent static sparks. • No naked flames in vicinity.

D6.2.6 Landfill specific

Table D49 Driving vehicle to tipping face along the access road

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Workplace Transport • Non-segregation of pedestrians and vehicles • Collection vehicles colliding on narrow roads	Most likely outcome – minor injury [cuts / bruises, whiplash, shock] *Most severe outcome – single fatality [crushing, internal injuries]*	• Light levels vary according to time of day / year (early in morning / during winter), degree to which artificial lighting is available (heavy shadows might impact on visibility), and weather conditions • Potential driver distractions – mobile phone, alcohol in blood levels • Fatigue / sleep deprivation– e.g. early start following weekend • Driving experience and familiarity with collection vehicle • Inexperienced driver / unfamiliar with vehicle • Where operatives operating job and finish system will tend to rush to tip waste. • Workers are issued and are wearing appropriate PPE (particularly high-visibility jackets). • Prior knowledge of site layout/relevant information provided on-site entry • Appropriate signage/speed limits in use • Use of a well designed site layout avoiding sharp bends, steep inclines, appropriate road materials etc. will aid to reduce the risk
Heat stress	Most likely outcome – no absence [minor dehydration] Most severe outcome – minor absence [dehydration / unconsciousness]	• Due to long periods spent in cab without appropriate ventilation / consumption of water
Stress	Most likely outcome – no absence [acute stress / headaches / high blood pressure] Most severe outcome [chronic ill-health]	• Difficult driving conditions influence stress levels (e.g. high traffic density, difficult access, road rage from other road users) • Peer pressure to drive in a risky manner from other crew members – compounded by job and finish system • Self-imposed time-pressures

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Vibration - From time spent in vehicle whilst in motion	Most likely outcome – no absence *Most severe outcome – major injury [MSD injury]*	- Vibration from driving over potholes / uneven road surfaces manifests in MSD issues relating primarily to handling activities conducted during normal course of day
Struck by falling object - Contents of cab falling and hitting crew member or driver	Most likely outcome – no absence *Most severe outcome – minor injury [cuts / bruising]*	- Various work clothes, crew members lunch etc. may be stored loose in the cab

Table D50 Reversing operations

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Workplace Transport • Non-segregation of pedestrians and vehicles • Poorly compacted tipping face • Collection and landfill compaction vehicles colliding or striking operatives	Most likely outcome – major injury [crushing] *Most severe outcome – single fatality [crushing]*	• Reversing operations have 'blind spots' covered by CCTV, but are contingent on driver using this • Number of vehicles tipping/unloading on same site (affect number of vehicular movements). There can be a mobile plant e.g. shovel loader and compactors • Where operatives operating job and finish system, will tend to rush to leave site • Workers are issued and are wearing appropriate PPE (particularly high-visibility jackets) • Light levels vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) • Inexperienced drivers / unfamiliarity with vehicle • No dedicated tipping bays or stopping points (will vary from site to site) for collection vehicle

Table D51 Driving of large compaction vehicles

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Workplace Transport • Non-segregation of pedestrians and vehicles • Reversing • Colliding with other vehicles	Most likely outcome – minor injury [cuts / bruises, whiplash, shock] *Most severe outcome – single fatality [crushing, internal injuries]*	• Light levels vary according to time of day / year (early in morning / during winter), degree to which artificial lighting is available (heavy shadows might impact on visibility), and weather conditions • Potential driver distractions – mobile phone, alcohol in blood levels • Fatigue / sleep deprivation– e.g. early start following weekend • Driving experience and familiarity with vehicle • Workers are issued and are wearing appropriate PPE (particularly high-visibility jackets). • Potential for loss of line of sight and driver accidentally backing into operatives. • No defined driving space • Repetitive task • High winds may affect the stability of a high sided vehicle • Poor visibility of the tipping edge
Workplace Transport • Vehicle tipping over	Most likely outcome – minor injury [cuts / bruises, shock] *Most severe outcome – single fatality [crushing, internal injuries]*	
Heat stress	Most likely outcome – no absence [minor dehydration] Most severe outcome – minor absence [dehydration / unconsciousness]	• Due to long periods spent in cab without appropriate ventilation / consumption of water
Stress	Most likely outcome – no absence [acute stress / headaches / high blood pressure] Most severe outcome [chronic ill-health]	• Difficult driving conditions e.g. weather • Time-pressures to shovel and compact waste to keep up with the level of tipping
Vibration • From time spent in vehicle whilst in motion	Most likely outcome – no absence *Most severe outcome – major injury [MSD injury]*	• Vibration from spending a long time driving vehicle on an uneven surface

Table D52 Checking leachate levels and maintenance activities

Hazards/Risks	***Range of consequences/harm outcomes***	***Assumptions/other information***
Slips and Trips • Uneven surfaces / slopes	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	• Light levels may vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) • Material may become lodged in the cleats of the boots thus reducing the boots grip
Falls from height • Height of well above ground level could be variable	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fatality]*	• Inappropriate height of well / guarding to protect against fall • Uneven surface around the well / trip hazards
Harmful substances • Methane gas		• Sealed wells giving off high concentrations of gas when lid seal is broken • Direction of wind • Extent of gas release will vary from well to well • Gas analysis via a hand held analyser to assess gas mixture before starting work
Explosive atmosphere • Build up / mixture of gas under pressure • Air supply line to pumps under pressure • Leachate return line under pressure	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fatality]*	• Release of pressure via valves to pumps • Isolator taps fitted to every well and to the end of every leg on the supply line • Gas analysis via a hand held analyser to assess gas mixture before starting work • Manometer to assess suction on waste from gas system before work starts
Manual handling - MSD • Lifting out pumps from well using block and tackle • Pushing reading tape into the well	Chronic – risk related to other manual handling tasks performed	

Table D53 Litter picking and general housekeeping

Hazards/Risks	*Range of consequences/harm outcomes*	*Assumptions/other information*
Workplace transport - Non-segregation of pedestrians and vehicles	Most likely outcome – major injury [crushing] *Most severe outcome – single fatality*	- Number of vehicles tipping/unloading on same site (affect number of vehicular movements). - Where operatives operating job and finish system, will tend to rush to tip/unload and leave site - Workers are issued and are wearing appropriate PPE (particularly high-visibility jackets) - Light levels may vary according to time of year (early in morning / during winter) and the degree to which artificial lighting is available (heavy shadows might impact on visibility) - Weather such as fog, rain etc. will affect visibility - Inexperienced drivers / unfamiliarity with vehicle
Slips and Trips - Walking on compacted waste - Walking over uneven ground	Most likely outcome – minor injury no absence [cuts / bruises] *Most severe outcome – major injury [fracture]*	- Light levels may vary according to time of year and the degree to which artificial lighting is available - Material may become lodged in the cleats of the boots thus reducing the boots grip
Microbiological hazards	Most likely outcome – minor injury no absence *Most severe outcome – major injury*	- Exposure to hazardous substances, airborne particles, dust
Lone Working		- Working out of sight of others

D7 ANNEX D2 – RISK ASSESSMENT WORKSHOPS

D7.1 INTRODUCTION

Four workshops were arranged with participants from industry to validate the risk ratings produced as part of the project. Each workshop focused on different aspects of the waste and recyclables industry. The workshops covered the following subsystems:

• Kerbside/door-to-door (high-rise flats) collections	(2 workshops)
• Transfer/bulking station, MRF, landfill and incineration	(1 workshop)
• MBT and composting (both in-vessel and windrow)	(1 workshop)

D7.1.1 Purpose of workshops

The purpose of the workshops was to utilise the skills and knowledge of the attendees to ensure that the risk ratings produced as part of the project are as robust as possible.

The following were requested to be reviewed by the workshop attendees prior to the workshop:

- The key activities that are carried out in each area (circulated prior to workshop).
- The assessed hazards associated with each of these activities (circulated prior to workshop).

The main purpose of the workshop was to review the assumptions made in the project team's risk assessment, in particular:

- Exposure frequency (relative to the number of receptacles collected or mass of material processed for collection and post-collection respectively). This is essentially the repetition frequency of each activity. For example, the number of climbs in and out of the vehicle.
- Probability and consequence ratings (on a 1 to 5 rating scale) for each hazard or groups of hazard relevant to the activities being considered.

D7.1.2 Expertise and experience required at each workshop

- Operational experience of the system under consideration (need to be able to estimate how often the different activities are carried out relative to either the number of collections or the mass of waste processed)
- Knowledge of the system in more than one site or application in different areas would be beneficial
- Health and safety knowledge of the particular activities
- Different stakeholders, e.g. private, public, community, trade unions, workers.

D7.2 WORKSHOP PROGRAMME

D7.2.1 Aims and objectives

The overall aim of the workshops was to provide robust estimates of the hard-wired factors in the risk comparison tool. The objectives were:

- Review the activities associated with the subsystem(s);

- Review the hazards identified;
- Derive frequency modification factors;
- Review the hazard probability ratings; and
- Review the hazard consequence ratings.

D7.2.2 Outline programme

Table D54 Workshop programme

Time	*Task*
10.00-10.30	Arrive and coffee
10.30-10.40	Introductions and domestics
10.40-11.00	Project overview, risk tool and workshop objectives
11.00-12.00	Discussion – components and hazards
12.00-12.30	Introduction – risk rating validation
12.30-13.00	Lunch
13.00-14.30	Discussion – risk rating validation
14.30-14.45	Break
14.45-15.45	Discussion – risk rating validation (cont)
15.45-16.00	Summary and risk profile review
16.00	Finish

D7.4 JOINING INSTRUCTIONS

The following subsections show the background information circulated to attendees at the outset (Section D7.4.1) and information of the risk assessment approach (Section D7.4.2 – collection workshops – and Section D7.4.3 – post-collection workshops). In addition attendees were sent drafts of the relevant hazard matrices (from Tables D15 to D22), and drafts of the component lists and descriptions (from Tables B60 to B67 in Appendix B).

D7.4.1 Initial background note

Waste and recyclables health and safety research workshops

Background

The Health and Safety Laboratory (HSL) are undertaking a project on behalf of the Health and Safety Executive, the Department for Environment, Food and Rural Affairs, the Scottish Executive and the Welsh Assembly to develop a tool able to assess the occupational health and safety of systems for collection, transfer, treatment and processing of household waste and recyclables. The purpose of this is to provide Local Authorities (LAs) with information to enable the selection of the most appropriate systems to meet their environmental targets, whilst complying with health and safety duties. This tool is aimed at allowing LAs to compare the level of relative risk between different approaches to waste and recyclables management.

As part of this work HSL have carried out a hazard identification study and have assessed each hazard (on a 1 to 5 scale) in terms of conditional probability (probability that given exposure to the hazard harm will occur) and consequence (most likely harm). In addition, part of the methodology requires assumptions on the frequency (relative to the number of receptacles collected or mass of material processed for collection and post-collection respectively) that each activity is carried out – this is essentially the repetition frequency of each activity (e.g. the number of climbs in and out of the vehicle). The HSL project team have also estimated these activity related frequencies.

Proposed workshops

Four workshops are planned, each focusing on different aspects of the waste and recyclables industry, to examine and validate the project team's assessments and assumptions. These workshops will cover the following areas:

- Kerbside/door-to-door (high-rise flats) collections	(2 workshops)
- MRF, transfer/bulking station, landfill and incineration	(1 workshop)
- MBT and composting (both in-vessel and windrow)	(1 workshop)

The two collection workshops will cover the same material and are designed to allow a wider range of people to be involved than could be accommodated in a single workshop.

Purpose of workshops

The purpose of the workshops is to review and validate the assessments that have been carried out by the HSL project team, including the activities, the hazards, the hazard ratings and the activity exposure frequencies. It is hoped that by discussing the hazards, examining the assumptions made and utilising the experience and knowledge of the attendees that the 'hard wired' part of the tool can be made as robust as possible.

Preparation

The following will be required to be reviewed by the workshop attendees prior to the workshop:

- The key activities that are carried out in each area (to be circulated at the beginning of January).
- The hazards associated with each of these activities (to be circulated at the beginning of January).

In addition, it is requested that, where possible, attendees collect and bring any relevant incident/accident data or risk assessments relating to the waste/recyclable management systems being considered (at that workshop) to the workshop.

Outline structure of workshop

- Background to the risk assessment methodology and the risk tool summarised (a briefing note will be sent at the beginning of January prior to the workshops)
- Discussion of activities and hazards (based on pre-workshop review)
- Review/validate risk assessment assumptions for each activity and hazard:

    - Exposure frequency
    - Probability rating
    - Consequence rating
- Sense check risk profiles with attendee knowledge, experience, and any incident/accident data or risk assessments that attendees have brought to the workshop
- Round up

D7.4.2 Collection risk tool background

Waste and recyclables health and safety research workshops

Background

The Health and Safety Laboratory (HSL) are undertaking a project on behalf of the Health and Safety Executive, the Department for Environment, Food and Rural Affairs, the Scottish Executive and the Welsh Assembly to develop a tool able to assess the occupational health and safety of systems for collection, transfer, treatment and processing of household waste and recyclables. The purpose of this is to provide Local Authorities (LAs) with information to enable the selection of the most appropriate systems to meet their environmental targets, whilst complying with health and safety duties.

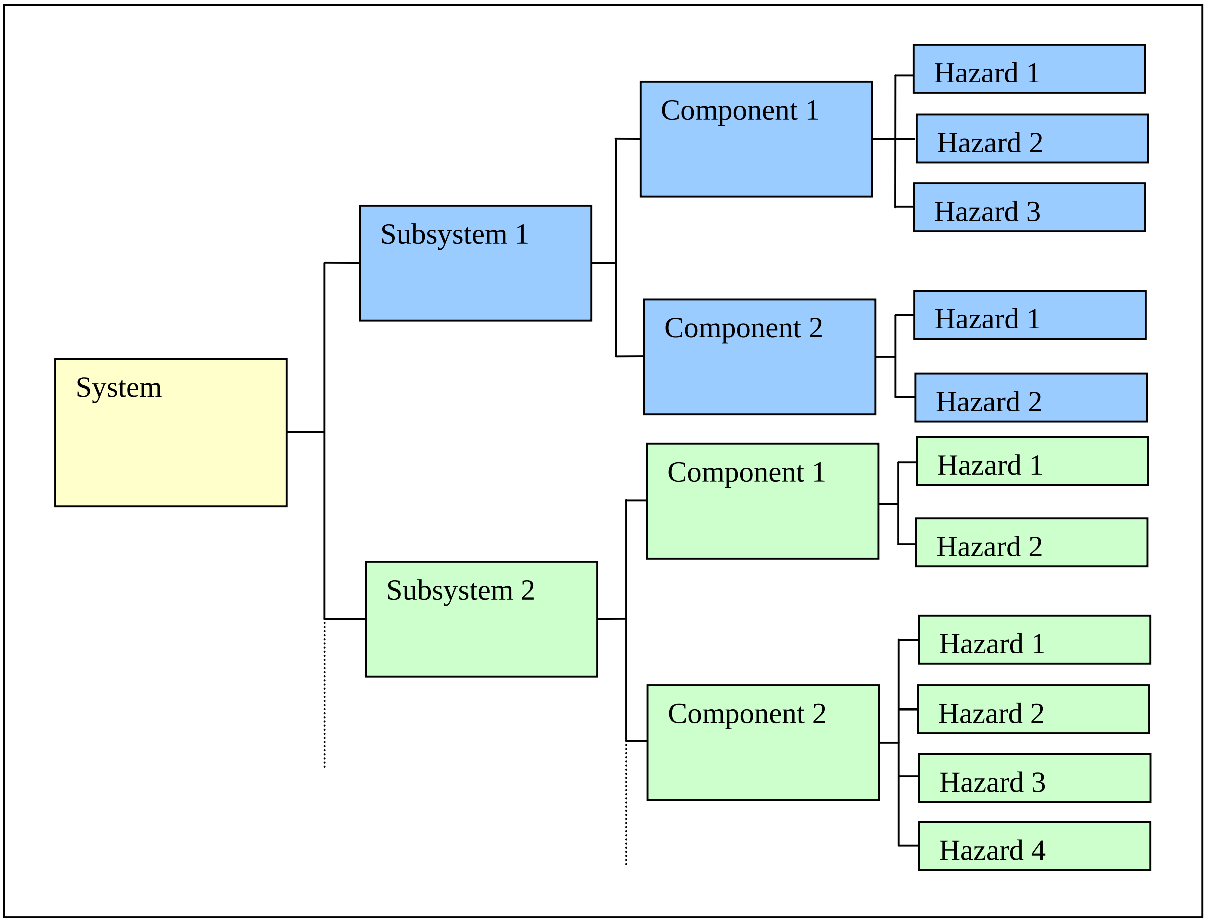

Figure D1 Structure of waste/recyclables management system

Overview of the Risk Comparator Tool

The purpose of this tool is to compare the relative risk of harm presented by the various waste schemes. In doing so it identifies the risk of all types of occupationally related harm including the chronic and acute affects of injuries and ill health that may result from reasonably foreseeable non-trivial hazards.

The concept of the tool is based around system, subsystem, component and hazard. The relationship between these is shown diagrammatically in Figure D1.

The use of the tool in the comparative risk assessment process is outlined in Figure D2.

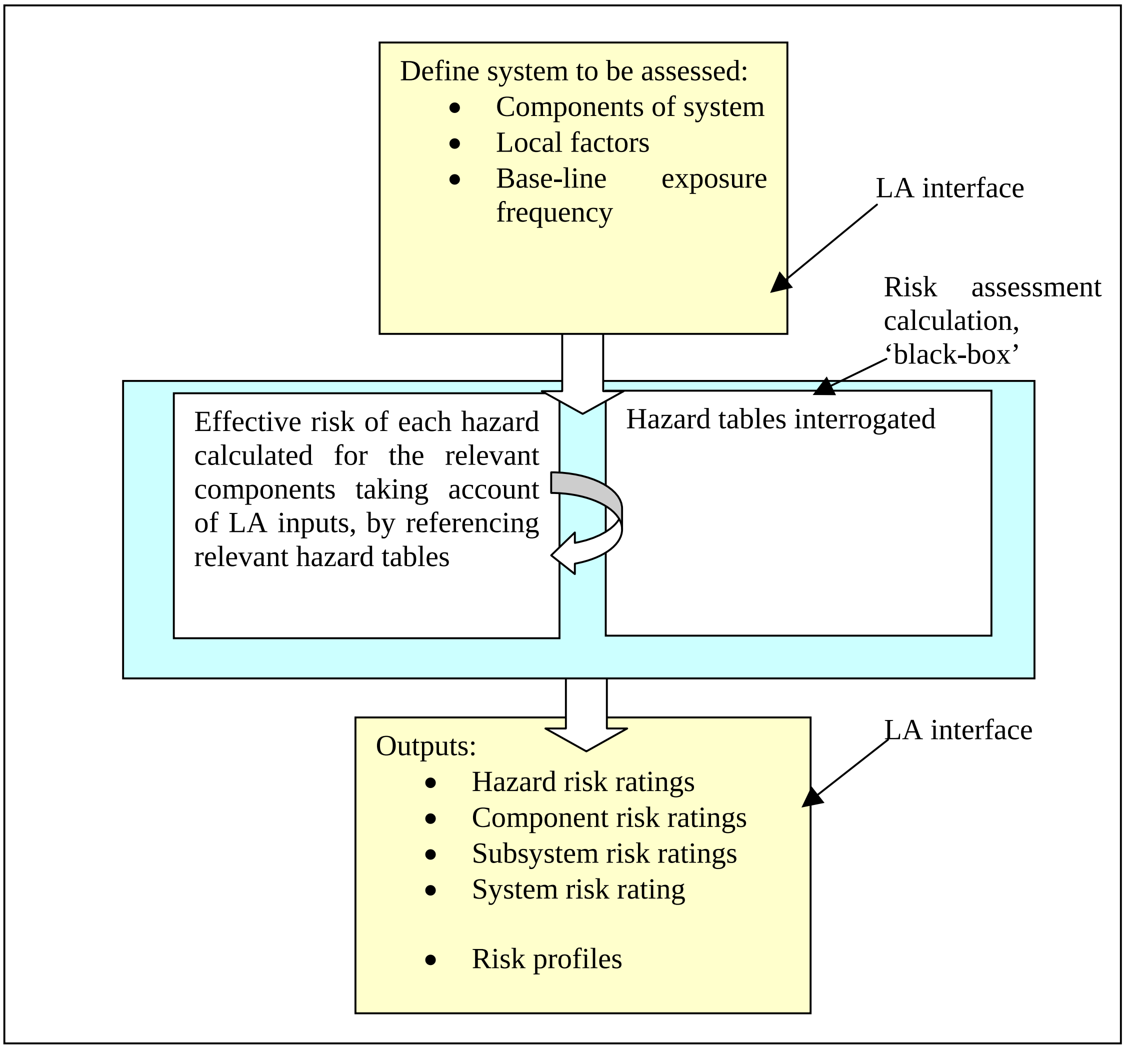

Figure D2 Risk assessment process

. In order to evaluate a system the Local Authority (LA) specifies the components of the system; for example, for the collection of residual waste in wheeled bins subsystem, the components would look something like:

- Assembly of collection crew at start of shift
- Driving from location to location
- Getting in and out of cab

- Wheeled bin collect and return
- Wheeled bins empty
- Walking to and from collection point
- Operating compactor
- Emptying collection vehicle

For each component there would be a number of hazards/hazard outcome categories; for example, for wheeled bins empty this would include:

- Chemical
- Entrapment in machinery
- Falling bins
- Falling rubbish
- Insects
- Manual handling
- Microbiological
- Moving mechanism
- Noise
- Pets
- Slips and trips
- Stress
- Violence
- Workplace transport

For each component there would be a number of hazards/hazard outcome categories; for example, for wheeled bins empty this would include:

- Chemical
- Entrapment in machinery
- Falling bins
- Falling rubbish
- Insects
- Manual handling
- Microbiological
- Moving mechanism
- Noise
- Pets
- Slips and trips
- Stress
- Violence
- Workplace transport

For each of these hazards, the level of risk would be estimated.

In addition to defining the system in terms of its constituent components, the LA also provides details of local factors such as the number of houses, anticipated set-out rate, frequency of collection and distributions in other localisation factors (described in Appendix 1). This data is then used to inform the risk modelling within the tool to deliver a number of outputs that provide information on the system risk rating and profile and detail on the component and hazard risk ratings that underpin the system risk rating.

The tool utilises a semi-quantified risk ranking approach as this allows hazard risk scores to be combined to give a suitable comparative assessment at the component, subsystem and system level. Because the tool is limited to comparative analysis, a collective approach to risk is used; this means the risk to an exposed population and not to any specific individual. This tool is not intended to provide any assessment of whether the safety of workers and others is ensured *So Far As Is Reasonably Practicable* (SFAIRP).

The risk ranking is based on three risk elements, which are combined to give the collective risk:

- Exposure to a hazard – the frequency at which the hazard generating activity is carried out;
- Criticality of the exposure – the likelihood (or conditional probability) that harm occurs due to (and given) the exposure; and
- Consequences – a measure of the different harm outcomes given that exposure to the hazard causes harm.

Mathematically, the collective risk is calculated as the sum of the frequency index, conditional probability (criticality) index and twice the consequence index. Each risk element is based on a scale of 1-5 using ranking tables (see Tables D55- D57).

Exposure rating

Exposure to the hazard is calculated dynamically and is based on LA inputs and hard-wired factors. For collection systems this is calculated from:

Exposure frequency = *number of households* ×
number of collections (per defined period of time) ×
set-out rate (proportion) ×
activity specific modifier

where the *number of households*, *number of collections* and *set-out rate* are LA inputs and the *activity specific modifier* is a hard wired factor. This factor is component specific and has been estimated by the project team based on discussions with limited parts of industry. One of the aims of the workshop is to review these factors and provide a more robust estimate. The exposure frequency ranking is calculated from the exposure frequency utilising Table 1, where *N* is a number that is automatically generated by the risk tool at the point of assessment to normalise the rating scale.

Table D55 Exposure frequency rating scale

Exposure frequency ranking	***Exposure frequency***
1	*N* ÷ 1000 or lower
2	Up to *N* ÷ 100
3	Up to *N* ÷ 10
4	Up to *N*
5	*Greater than N*

Probability rating

For each hazard a probability rating, on the scale of 1 to 5 (as shown in Table D56, where *C* is some arbitrary constant), has been estimated by the project team. It is important to stress that this is the probability that exposure to the activity leads to harm (any level of harm), given that someone is exposed to the hazard. Where the hazard has both a chronic and acute outcome two probability ratings have been derived, otherwise just a probability for the specific harm type (acute or chronic) has been derived.

The values estimated are hard-wired into the risk assessment tool. Therefore, a further aim of the risk assessment workshop is to review these probability ratings for each hazard.

Table D56 Probability rating scale

Probability ranking	***Conditional probability***	***Descriptor***[28]
1	*C* ÷ 10000 or lower	Rare
2	*C* ÷ 1000	Unlikely
3	*C* ÷ 100	Possible
4	*C* ÷ 10	Probable
5	*C* or greater	Likely

Consequence rating

For each hazard a consequence rating, on the scale of 1 to 5 (as shown in Table D57), has been estimated by the project team. Both a chronic and acute consequence have been assessed where relevant. It is important to stress that the consequence has been estimated for the most likely outcome and not the worst case.

Again, the values estimated are hard-wired into the risk assessment tool. Therefore, a further aim of the risk assessment workshop is to review these consequence ratings for each hazard.

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[28] *The descriptors are relative and should not be treated as absolute.*

Table D57 Consequence rating scale

Ranking	*Descriptor*	*Acute effects*		*Chronic effects*
		Safety	*Health*	*Health*
1	Negligible	Slight, minor injury with no absence or less	Minor health effect with no absence, e.g. fainting	
2	Low	Requires first aid treatment	Minor health effect requiring treatment	Short term reversible
3	Moderate	> 3 day loss time accident	Moderate health effect leading to > 3 day absence	Long term reversible
4	High	Major injury	Major health effect, e.g. permanent/ long term health effect	Long term irreversible
5	Very high	Single fatality	Fatality	Permanent severe disability/ fatality

Scenarios

A further complication for collection systems is that each hazard is assessed for a number of scenarios that take into account how the level of risk varies as a function of the following factors: housing density; amount of waste/recyclable in the receptacle; and environmental risk (road traffic density, traffic speed (road type) and terrain). Figure D3 illustrates the 27 scenarios that are considered. Only the 8 scenarios at the extremities of each combination of factor, highlighted in yellow in Figure D3, are required to be assessed as the others, shown in grey, can be estimated based on the others.

This approach allows the risk tool to estimate the most appropriate risk for the hazard by utilising LA estimates of how these factors are distributed. This is the approach taken in the risk tool to make the risk estimations relevant for a specific LA.

Environmental Risk	***Housing density***	***Mass of material in container***		
		Low	***Average***	***High***
Low	Low	🟨	◼	🟨
	Medium	◼	◼	◼
	High	🟨	◼	🟨
Medium	Low	◼	◼	◼
	Medium	◼	◼	◼
	High	◼	◼	◼
High	Low	🟨	◼	🟨
	Medium	◼	◼	◼
	High	🟨	◼	🟨

Figure D3 Scenario matrix

The probability and consequence ratings must therefore be reviewed for each of the scenarios highlighted in yellow in Figure D3.

Proposed workshops

Four workshops are planned, each focusing on different aspects of the waste and recyclables industry, to examine and validate the project team's assessments and assumptions. The workshop you have been invited to attend on *#date#* in *#location#* will cover systems for kerbside collection (or doorstep collection in flats) of household waste and recyclables.

Purpose of workshops

The purpose of the workshops is to review and validate the assessments that have been carried out by the HSL project team, including the activities, the hazards, the hazard probability and consequence ratings, and the activity exposure frequency modification factors. It is hoped that by discussing the hazards, examining the assumptions made and utilising the experience and knowledge of the attendees that the 'hard wired' part of the tool can be made as robust as possible.

Preparation

When invitations were distributed we indicated that some preparatory work was needed to ensure that the workshops can cover the issues using informed opinion and where possible, quantitative data. It is requested that in addition to reviewing the information sent, where possible, attendees collect and bring any relevant incident/accident data and risk assessments relating to the waste/recyclable management systems being considered (at that workshop) to the workshop.

Appendix 1: Localisation factors

The risk tool uses three key localisation factors: housing density, environmental risk and container weight. How each of these is distributed must be selected by the LA.

Housing density: housing density is defined as falling into one of three density categories. The proportion of households falling in each of the three density categories is required. Therefore three values are required to be entered, and the total must sum to 1.

Environmental factor: the proportion of households falling into one of three environmental risk categories, high medium or low. For each housing density category it is necessary to estimate the proportion falling into each risk category, and the total across the 3 categories must sum to 1. Guidance will be produced that will allow LAs to estimate overall environmental risk factors based on the road types, traffic density and terrain.

Container weight: the amount of material in the container of interest needs to be estimated. This has been defined as the proportion of households having containers for collection that are light, average or heavy. Again the methodology will allow for this distribution to vary across the housing types. Therefore, for each housing density the proportion of households with containers falling into each weight category needs to be estimated, and the total across the categories for each housing density must sum to 1.

The requirements for LA localisation factors input data is summarised in Table D58. It is important to stress that each group of three factors, as illustrated by the colouring, must sum to one.

Table D58 Local Authority localisation factors

Housing density		Mass in receptacle			Environmental risk		
	Proportion	Light	Average	Heavy	Low	Medium	High
Low	🟩	🟦	🟦	🟦	🟨	🟨	🟨
Medium	🟩	🟨	🟨	🟨	🟦	🟦	🟦
High	🟩	🟦	🟦	🟦	🟨	🟨	🟨

D7.4.3 Post-collection tool background

Waste and recyclables health and safety research workshops

Background

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Overview of the Risk Comparator Tool

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The concept of the tool is based around system, subsystem, component and hazard. The relationship between these is shown diagrammatically in Figure D1.

The use of the tool in the comparative risk assessment process is outlined in Figure D2. In order to evaluate a system the Local Authority (LA) specifies the components of the system; for example, for the collection of residual waste in wheeled bins subsystem, the components would look something like:

- Assembly of collection crew at start of shift
- Driving from location to location
- Getting in and out of cab
- Wheeled bin collect and return
- Wheeled bins empty
- Walking to and from collection point
- Operating compactor
- Emptying collection vehicle

For each component there would be a number of hazards/hazard outcome categories; for example, for wheeled bins empty this would include:

- Chemical
- Entrapment in machinery
- Falling bins
- Falling rubbish
- Insects
- Manual handling
- Microbiological
- Moving mechanism
- Noise
- Pets
- Slips and trips
- Stress
- Violence
- Workplace transport

For each of these hazards, the level of risk would be estimated.

In addition to defining the system in terms of its constituent components, the LA also provides details of local factors such as the number of houses, anticipated set-out rate, frequency of collection and total mass of material collected. This data is then used to inform the risk modelling within the tool to deliver a number of outputs that provide information on the system risk rating and profile and detail on the component and hazard risk ratings that underpin the system risk rating.

The tool utilises a semi-quantified risk ranking as this allows hazard risk scores to be combined to give a suitable comparative assessment at the component, subsystem and system level. Because the tool is limited to comparative analysis, a collective approach to risk is used; this means the risk to an exposed population and not to any specific individual. This tool is not intended to provide any assessment of whether the safety of workers and others is ensured *So Far As Is Reasonably Practicable* (SFAIRP).

The risk ranking is based three of risk elements, which are combined to give the collective risk:

- Exposure to a hazard – the frequency at which the hazard generating activity is carried out;
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- Consequences – a measure of the different harm outcomes given that exposure to the hazard causes harm.

Mathematically, the collective risk is calculated as the sum of the frequency index, conditional probability (criticality) index and twice the consequence index. Each risk element is based on a scale of 1-5 using ranking tables (see Tables D55-D57).

Exposure rating

Exposure to the hazard is calculated dynamically and is based on LA inputs and hard wired factors. For post-collection systems this is calculated from:

Exposure frequency = *tonnage of material* (per defined period of time)
X *number of operations per tonne of material modifier*

where the *tonnage of material* is an LA input and the *number of operations per tonne of material modifier* is a hard wired factor. This factor is component specific and has been estimated by the project team based on discussions with limited parts of industry. One of the aims of the workshop is to review these factors and provide a more robust estimate. The exposure frequency ranking is calculated from the exposure frequency utilising Table D55, where *N* is a number that is automatically generated by the risk tool at the point of assessment to normalise the rating scale.

Probability rating

For each hazard a probability rating, on the scale of 1 to 5 (as shown in Table D56, where *C* is some arbitrary constant), has been estimated by the project team. It is important to stress that this is the probability that exposure to the activity leads to harm (any level of harm), given that someone is exposed to the hazard. Where the hazard has both a chronic and acute outcome two probability ratings have been derived, otherwise just a probability for the specific harm type has been derived.

The values estimated are hard-wired into the risk assessment tool. Therefore, a further aim of the risk assessment workshop is to review these probability ratings for each hazard.

Consequence rating

For each hazard a consequence rating, on the scale of 1 to 5 (as shown in Table D57), has been estimated by the project team. Both a chronic and acute consequence have been assessed where relevant. It is important to stress that the consequence has been estimated for the most likely outcome and not the worst case.

Again, the values estimated are hard-wired into the risk assessment tool. Therefore, a further aim of the risk assessment workshop is to review these consequence ratings for each hazard.

Proposed workshops

Four workshops are planned, each focusing on different aspects of the waste and recyclables industry, to examine and validate the project team's assessments and assumptions. The workshop you have been invited to attend on *#date#* in *#location#* will cover *#systems#*.

Purpose of workshops

The purpose of the workshops is to review and validate the assessments that have been carried out by the HSL project team, including the activities, the hazards, the hazard probability and consequence ratings, and the activity exposure frequency modification factors. It is hoped that by discussing the hazards, examining the assumptions made and utilising the experience and knowledge of the attendees that the 'hard wired' part of the tool can be made as robust as possible.

Preparation

When invitations were distributed we indicated that some preparatory work was needed to ensure that the workshops can cover the issues using informed opinion and where possible, quantitative data. It is requested that in addition to reviewing the information sent, where possible, attendees collect and bring any relevant incident/accident data and risk assessments relating to the waste/recyclable management systems being considered (at that workshop) to the workshop.

D8 ANNEX D3 – HAZARD RATINGS

This annex lists the assumed probability and consequence ratings for each of the hazard categories, where P is the probability from 1 to 5 and C is the consequence from 1 to 5.

D8.1 EXPOSURE TO CHEMICALS

Table D59 Collection hazard acute ratings for the chemical hazard category

		Low housing density								*High housing density*							
		Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
		Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component		*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*
1 Assembling of collection crew at start of shift		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
4 High-rise bags collect		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
5 Disposable bags collect		1	2	1.5	2	1	2	1.5	2	1	2	1.5	2	1	2	1.5	2
6 Reusable bags collect and bag return		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
7a Big wheeled bins collect and bin return	Euro	1	2	2	2	1	2	2	2	1	2	2	2	1	2	2	2
7b	Palladin	1	2	2	2	1	2	2	2	1	2	2	2	1	2	2	2
10 Slave wheeled bin collect		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
11 Slave bag/box collect		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2

	Low housing density								***High housing density***							
	Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
	Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
12 Wheeled bin collect and bin return	1	2	1.5	2	1	2	1.5	2	1	2	1.5	2	1	2	1.5	2
14 Reusable bags empty	1	2	1.5	2	1	2	1.5	2	1	2	1.5	2	1	2	1.5	2
19 Kerbsider box sort and empty	1	2	1.5	2	1	2	1.5	2	1	2	1.5	2	1	2	1.5	2
20 Stillage box sort and empty (collect and sort)	1	2	1.5	2	1	2	1.5	2	1	2	1.5	2	1	2	1.5	2
21 Stillage box sort and empty (separate collect and sort)	1	2	1.5	2	1	2	1.5	2	1	2	1.5	2	1	2	1.5	2

Table D60 Collection hazard chronic ratings for the chemical hazard category

	Low housing density								***High housing density***							
	Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
	Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
1 Assembling of collection crew at start of shift	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3

Table D61 Post-collection hazard ratings for the chemical hazard category

	Acute		*Chronic*	
Component	***Prob.***	***Cons.***	***Prob.***	***Cons.***
Transfer/bulking station				
7 Handling heavy/hazardous waste	3	2		
10 General housekeeping	2	2	1	3
11 Maintenance	2	2	1	3
MRF				
3 Pre-sorting materials	1	2		
6 Manual sorting	3	2		
10 General housekeeping	2	2	1	3
11 Maintenance	2	2	1	3
MBT				
3 Visual inspection of waste	1	2		
15 General housekeeping	2	2	1	3
16 Maintenance	2	2	1	3
In-vessel composting				
3 Manual pre-sorting	1	2		
15 General housekeeping	2	2	1	3
16 Maintenance	2	2	1	3
Open windrow composting				
3 Manual pre-sorting	1	2		
13 Maintenance	2	2	1	3
14 General housekeeping	2	2	1	3
Incineration				
4 Delivery of hazardous substances in bulk	3	2	1	3
7 General housekeeping	2	2	1	3
8 Maintenance	2	2	1	3

	Acute		*Chronic*	
Component	***Prob.***	***Cons.***	***Prob.***	***Cons.***
Landfill				
5 General housekeeping	2	2	1	3
6 Maintenance	2	2	1	3

D8.2 COLLISION WITH OTHER VEHICLES

Table D62 Collection hazard acute ratings for the collision with other vehicles hazard category

	Low housing density								***High housing density***							
	Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
	Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
1 Assembling of collection crew at start of shift	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1
2 Driving from location to location	1	2	1	2	2	3	2	3	1	2	1	2	2	3	2	3
26 Emptying collection vehicle	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1

Table D63 Post-collection hazard ratings for the collision with other vehicles hazard category

Component			*Acute*		*Chronic*	
			Prob.	*Cons.*	*Prob.*	*Cons.*
Transfer/bulking station						
1a	Inward vehicle movements	RCV	3	1		
1b		Stillage	3	1		
1c		Kerbsider	3	1		
2b	Unloading vehicle	Stillage	2	2		
4	Loading lorries		2	1		
5	Onward vehicle movements		3	1		
MRF						
1a	Inward vehicle movements	RCV	3	1		
1b		Artic	3	1		
4	Loading material onto conveyors and mechanical sorting		2	1		
7a	Storage of recovered fractions	Fork-lift	2	2		
7b		Shovel loader	2	1		
8a	Loading lorries	Fork-lift	2	2		
8b		Shovel loader	2	1		
9	Onward vehicle movements		3	1		
MBT						
1a	Inward vehicle movements	RCV	3	1		
1b		Artic	3	1		
4	Loading material into sorting drum and mechanical sorting		2	1		
5	Loading material into a vehicle		2	1		
6	Unloading transfer vehicle at compost tunnel		2	1		
7	Loading material into hopper		2	1		
8	Opening and closing doors of in-vessel		2	1		
9	Transferring material between vessels and to maturation pad		2	1		
11	Turning windrows		2	1		

Component			Acute		Chronic	
			Prob.	Cons.	Prob.	Cons.
12	Loading material into screener/miller		2	1		
13	Loading lorries		2	1		
14	Onward vehicle movements		3	1		
In-vessel composting						
1a	Inward vehicle movements	RCV	3	1		
1b		Stillage	3	1		
1c		Artic	3	1		
2b	Unloading vehicle	Stillage	2	2		
4	Loading material into shredder		2	1		
5	Loading material into bulk container		2	1		
6	Opening and closing doors of in-vessel		2	1		
7	Loading first vessel		2	1		
8	Transferring material between vessels and to maturation pad		2	1		
10	Turning windrows		2	1		
11	Finished product taken to stockpiles		2	1		
12	Screening material and bagging finished product		2	1		
13	Loading lorries		2	1		
14	Onward vehicle movements		3	1		
Open windrow composting						
1a	Inward vehicle movements	RCV	3	1		
1b		Artic	3	1		
4	Loading material into shredder		2	1		
5	Loading material into truck to be taken to windrows		2	1		
6	Loading material onto windrow		2	1		
8	Turning windrows		2	1		
9	Finished product taken to stockpiles		2	1		
10	Screening material and bagging finished product		2	1		

Component			***Acute***		***Chronic***	
			Prob.	***Cons.***	***Prob.***	***Cons.***
11	Loading lorries		2	1		
12	Onward vehicle movements		3	1		
Incineration						
1a	Inward vehicle movements	RCV	3	1		
1b		Artic	3	1		
4	Delivery of hazardous substances in bulk		2	1		
5	Removal of by-products		2	1		
6	Onward vehicle movements		3	1		
Landfill						
1	Driving on access road		1	2		
2	Reversing		2	1		
4	Driving of compaction vehicles		1	2		

D8.3 EXPOSURE TO DUST

Table D64 Collection hazard acute ratings for the exposure to dust hazard category

		Low housing density								*High housing density*							
		Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
		Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component		*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*
4 High-rise bags collect		3	1	4	1	3	1	4	1	3	1	4	1	3	1	4	1
10 Slave wheeled bin collect		1	1	2	1	1	1	2	1	1	1	2	1	1	1	2	1
11 Slave bag/box collect		1	1	2	1	1	1	2	1	1	1	2	1	1	1	2	1
14 Reusable bags empty		1	1	3	1	1	1	3	1	1	1	3	1	1	1	3	1
15a Big wheeled bins empty	Euro	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1
15b	Palladin	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1
18 Wheeled bins empty		1	1	2	1	1	1	2	1	1	1	2	1	1	1	2	1
22 Slave wheeled bin empty		2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1
26 Emptying collection vehicle		3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1

Table D65 Collection hazard chronic ratings for the exposure to dust hazard category

	Low housing density								***High housing density***							
	Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
	Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
26 Emptying collection vehicle	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5

Table D66 Post-collection hazard ratings for the exposure to dust hazard category

			Acute		*Chronic*	
Component			***Prob.***	***Cons.***	***Prob.***	***Cons.***
Transfer/bulking station						
2a	Unloading vehicle	RCV	3	1	1	3.5
2b		Stillage	3	1	1	3.5
2c		Kerbsider	3	1	1	3.5
4	Loading lorries		3	1	1	3.5
6	General housekeeping		3	1	1	3.5
7	Maintenance		3	1	1	3.5
MRF						
2a	Unloading vehicle	RCV	3.5	1	1	3.5
2b		Artic	3.5	1	1	3.5
3	Pre-sorting materials		2	1	1	3.5
4	Loading material onto conveyors and mechanical sorting		3.5	1	1.5	3.5
5	Manual sorting		3.5	1	1.5	3.5
6	Baling materials		3.5	1	1.5	3.5
7b	Storage of recovered fractions	Shovel loader	3.5	1	1	3.5
8b	Loading lorries	Shovel loader	3.5	1	1	3.5
10	General housekeeping		3.5	1	1	3.5
11	Maintenance		3.5	1	1	3.5
MBT						
2a	Unloading vehicle	RCV	3	1	1	3.5
2b		Artic	3	1	1	3.5
3	Visual inspection of waste		2	1	1	3.5
4	Loading material into sorting drum and mechanical sorting		3	1	1.5	3.5
5	Loading material into a vehicle		3	1	1	3.5
6	Unloading vehicle at compost tunnel		3	1	1	3.5
7	Loading material into hopper		3	1	1	3.5

Component			Acute		Chronic	
			Prob.	Cons.	Prob.	Cons.
9	Transferring material between vessels and to maturation pad		3	1	1	3.5
11	Turning windrows		3	1	1	3.5
12	Loading material into screener/miller		4	1	1.5	3.5
13	Loading lorries		3	1	1	3.5
15	General housekeeping		3	1	1	3.5
16	Maintenance		3	1	1	3.5
In-vessel composting						
2a	Unloading vehicle	RCV	3	1	1	3.5
2b		Stillage	3	1	1	3.5
2c		Artic	3	1	1	3.5
3	Manual pre-sorting		2	1	1	3.5
4	Loading material into shredder		4	1	1.5	3.5
5	Loading material into bulk container		3	1	1	3.5
7	Loading first vessel		3	1	1	3.5
8	Transferring material between vessels and to maturation pad		3	1	1	3.5
10	Turning windrows		3	1	1	3.5
11	Finished product taken to stockpiles		3	1	1	3.5
12	Screening material and bagging finished product		4	1	1.5	3.5
13	Loading lorries		3	1	1	3.5
15	General housekeeping		3	1	1	3.5
16	Maintenance		3	1	1	3.5
Open windrow composting						
2a	Unloading vehicle	RCV	2	1	1	3.5
2b		Stillage	2	1	1	3.5
3	Manual pre-sorting		2	1	1	3.5
4	Loading material into shredder		4	1	1.5	3.5
5	Loading material into truck to be taken to windrows		2	1	1	3.5

Component			Acute		Chronic	
			Prob.	*Cons.*	*Prob.*	*Cons.*
6	Loading material onto windrow		2	1	1	3.5
8	Turning windrows		3	1	1	3.5
9	Finished product taken to stockpiles		2	1	1	3.5
10	Screening material and bagging finished product		4	1	1.5	3.5
11	Loading lorries		2	1	1	3.5
13	General housekeeping		3	1	1	3.5
14	Maintenance		3	1	1	3.5
Incineration						
2a	Unloading vehicle	RCV	3	1	1	3.5
2b		Stillage	3	1	1	3.5
5	Removal of by-products		3	1	1	3.5
7	General housekeeping		3	1	1	3.5
8	Maintenance		3	1	1	3.5
Landfill						
3	Tipping collection vehicle		3	1	1	3.5
4	Driving compaction vehicles		3	1	1	3.5

D8.4 EXPOSURE TO ELECTRICITY

Table D67 Collection hazard acute ratings for the electricity hazard category

	Low housing density								***High housing density***							
	Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
	Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
1 Assembling of collection crew at start of shift	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
25 Kerbsider hopper empty	1	5	1	5	1	5	1	5	0	5	0	5	0	5	0	5

Table D68 Post-collection hazard ratings for the electricity hazard category

	Acute		*Chronic*	
Component	***Prob.***	***Cons.***	***Prob.***	***Cons.***
Transfer/bulking station				
6 General housekeeping	1	3		
7 Maintenance	2	4		
MRF				
10 General housekeeping	1	3		
11 Maintenance	2	4		
MBT				
15 General housekeeping	1	3		
16 Maintenance	2	4		
In-vessel composting				
15 General housekeeping	1	3		
16 Maintenance	2	4		
Open windrow composting				
13 General housekeeping	1	3		
14 Maintenance	2	4		
Incineration				
7 General housekeeping	1	3		
8 Maintenance	2	4		
Landfill				
5 General housekeeping	1	3		
6 Maintenance	2	4		

D8.5 MOVING MECHANISM

Table D69 Collection hazard acute ratings for the moving mechanism hazard category

		Low housing density								*High housing density*							
		Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
		Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component		***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
1 Assembling of collection crew at start of shift		2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5
15a Big wheeled bins empty	Euro	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
15b	Palladin	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
18 Wheeled bins empty		1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
22 Slave wheeled bin empty		1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
24 RCV compaction		1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
25 Kerbsider hopper empty		1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
26 Emptying collection vehicle		1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3

Table D70 Post-collection hazard ratings for the moving mechanism hazard category

				Acute		*Chronic*	
Component				***Prob.***	***Cons.***	***Prob.***	***Cons.***
Transfer/bulking station							
2a	Unloading vehicle	RCV		1	3		
2b		Stillage		1	3		
2c		Kerbsider		1	3		
3	Handling heavy/hazardous waste			1	3		
7	Maintenance			2	3		
MRF							
2a	Unloading vehicle	RCV		1	3		
2b		Artic		1	3		
4	Loading material onto conveyors and mechanical sorting			1	3		
5	Manual sorting			3	2		
6	Baling materials			1	3		
7a	Storage of recovered fractions	Fork-lift		1	3		
8a	Loading lorries	Fork-lift		1	3		
11	Maintenance			2	3		
MBT							
2a	Unloading vehicle	RCV		1	3		
2b		Artic		1	3		
4	Loading material into sorting drum and mechanical sorting			1	3		
12	Loading material into screener/miller			1	3		
16	Maintenance			2	3		
In-vessel composting							
2a	Unloading vehicle	RCV		1	3		
2b		Stillage		1	3		
2c		Artic		1	3		
4	Loading material into shredder			1	3		

			Acute		***Chronic***	
Component			***Prob.***	***Cons.***	***Prob.***	***Cons.***
12	Screening material and bagging finished product		1	3		
16	Maintenance		2	3		
Open windrow composting						
2a	Unloading vehicle	RCV	1	3		
2b		Artic	1	3		
4	Loading material into shredder		1	3		
10	Screening material and bagging finished product		1	3		
14	Maintenance		2	3		
Incineration						
2a	Unloading vehicle	RCV	1	3		
2b		Artic	1	3		
4	Delivery of hazardous substances in bulk		1	3		
8	Maintenance		2	3		
Landfill						
3	Tipping collection vehicle		1	3		
6	Maintenance		2	3		

D8.6 FALLING OBJECTS

Table D71 Collection hazard acute ratings for the falling object hazard category

		Low housing density								*High housing density*							
		Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
		Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component		***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
2 Driving from location to location	(other)	2	1	2	1	2.5	1	2.5	1	2	1	2	1	2.5	1	2.5	1
7a Big wheeled bins (Euro) collect and bin return	(bins)	2	2	2	2.5	3	2	3	2.5	2	2	2	2.5	3	2	3	2.5
	(other)			3	1			3	1			3	1			3	1
7b Big wheeled bins (Palladin) collect and bin return	(bins)	2	2	2	2.5	3	2	3	2.5	2	2	2	2.5	3	2	3	2.5
	(other)			3	1			3	1			3	1			3	1
10 Slave wheeled bin collect	(bins)	2	1	2	2	3	1	3	2	2	1	2	2	3	1	3	2
12 Wheeled bin collect and bin return	(bins)	2	1	2	2	3	1	3	2	2	1	2	2	3	1	3	2
15a Big wheeled bins (Euro) empty	(bins)	1	4	1.5	4	1	4	1.5	4	1	4	1.5	4	1	4	1.5	4
15b Big wheeled bins (Palladin) empty	(bins)	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4
18 Wheeled bins empty	(bins)	1	3	1.5	4	1	3	1.5	4	1	3	1.5	4	1	3	1.5	4
20 Stillage box sort and empty (collect and sort)	(other)	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1

	Low housing density								High housing density							
	Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
	Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
21 Stillage box sort and empty (separate collect and sort)(other)	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1
22 Slave wheeled bin empty (bins)	1.5	3	2	3	1.5	3	2	3	1.5	3	2	3	1.5	3	2	3
26 Emptying collection vehicle (other)	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2

Table D72 Post-collection hazard ratings for the falling object (other) hazard category

Component			*Acute*		*Chronic*	
			Prob.	*Cons.*	*Prob.*	*Cons.*
Transfer/bulking station						
2a	Unloading vehicle	RCV	1.5	2		
2b		Stillage	1.5	2		
2c		Kerbsider	1.5	2		
3	Handling heavy/hazardous waste		3	3		
4	Loading lorries		1.5	2		
7	Maintenance		3	2		
MRF						
2a	Unloading vehicle	RCV	1.5	2		
2b		Artic	1.5	2		
4	Loading material onto conveyors and mechanical sorting		1.5	2		
5	Manual sorting		3	1		
6	Baling materials		1	4		
7a	Storage of recovered fractions	Fork-lift	1	4		
7b		Shovel loader	1.5	2		
8a	Loading lorries	Fork-lift	1	4		
8b		Shovel loader	1.5	2		
11	Maintenance		3	2		
MBT						
2a	Unloading vehicle	RCV	1.5	2		
2b		Artic	1.5	2		
4	Loading material into sorting drum and mechanical sorting		1.5	2		
5	Loading material into a vehicle		1.5	2		
7	Loading material into hopper		1.5	2		
9	Transferring material between vessels and to maturation pad		1.5	2		
12	Loading material into screener/miller		1.5	2		

		Acute		*Chronic*	
Component		***Prob.***	***Cons.***	***Prob.***	***Cons.***
13 Loading lorries		1.5	2		
16 Maintenance		3	2		
In-vessel composting					
2a Unloading vehicle	RCV	1.5	2		
2b	Stillage	1.5	2		
2c	Artic	1.5	2		
4 Loading material into shredder		1.5	2		
5 Loading material into bulk container		1.5	2		
7 Loading first vessel		1.5	2		
8 Transferring material between vessels and to maturation pad		1.5	2		
11 Finished product taken to stockpiles		1.5	2		
12 Screening material and bagging finished product		1.5	2		
13 Loading lorries		1.5	2		
16 Maintenance		3	2		
Open windrow composting					
2a Unloading vehicle	RCV	1.5	2		
2b	Artic	1.5	2		
4 Loading material into shredder		1.5	2		
5 Loading material into truck to be taken to windrows		1.5	2		
6 Loading material onto windrow		1.5	2		
9 Finished product taken to stockpiles		1.5	2		
10 Screening material and bagging finished product		1.5	2		
11 Loading lorries		1.5	2		
14 Maintenance		3	2		
Incineration					
2a Unloading vehicle	RCV	1.5	2		
2b	Artic	1.5	2		

Component	***Acute***		***Chronic***	
	Prob.	***Cons.***	***Prob.***	***Cons.***
5 Removal of by-products	1.5	2		
8 Maintenance	3	2		
Landfill				
1 Driving on access road	2.5	1		
3 Tipping collection vehicle	1.5	2		

D8.7 FALLING OVER (STANDING WHEN VEHICLE IN MOTION)

Table D73 Collection hazard acute ratings for the falling over (standing when vehicle in motion) hazard category

	Low housing density								*High housing density*							
	Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
	Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
2 Driving from location to location	1	2	1	2	2	2	2	2	1	2	1	2	2	2	2	2
21 Stillage box sort and empty (separate collect and sort)	1	2	1	2	2	2	2	2	1	2	1	2	2	2	2	2

D8.8 FALLS FROM HEIGHT

Table D74 Collection hazard acute ratings for the falls from height hazard category

		Low housing density								*High housing density*							
		Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
		Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component		***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
1 Assembling of collection crew at start of shift		1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5
2 Driving from location to location	(tailgate)	1	4	1	4	1	5	1	5	1	4	1	4	1	5	1	5
	(within stillage)	2	4	2	4	2	5	2	5	2	4	2	4	2	5	2	5
3 Getting in and out of cab		1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5
4 High-rise bags collect		1	3	1.5	4	2	3	2	4	1	3	1.5	4	2	3	2	4
5 Disposable bags collect		1	2.5	1	2.5	1.5	2.5	1.5	2.5	1	2.5	1	2.5	1.5	2.5	1.5	2.5
6 Reusable bags collect and bag return		1	2.5	1	2.5	1.5	2.5	1.5	2.5	1	2.5	1	2.5	1.5	2.5	1.5	2.5
8 Food waste collect and receptacle return		1	2.5	1	2.5	1.5	2.5	1.5	2.5	1	2.5	1	2.5	1.5	2.5	1.5	2.5
9 Kerbside box collect and box return		1	2.5	1	2.5	1.5	2.5	1.5	2.5	1	2.5	1	2.5	1.5	2.5	1.5	2.5
12 Wheeled bin collect and bin return		1	2.5	1	2.5	1.5	2.5	1.5	2.5	1	2.5	1	2.5	1.5	2.5	1.5	2.5

	Low housing density								*High housing density*							
	Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
	Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
14 Reusable bags empty	2	2.5	2.5	2.5	2	2.5	2.5	2.5	2	2.5	2.5	2.5	2	2.5	2.5	2.5
16 Food waste empty	2.5	2.5	3	2.5	2.5	2.5	3	2.5	2.5	2.5	3	2.5	2.5	2.5	3	2.5
20 Stillage box sort and empty (collect and sort)	2	2.5	2.5	2.5	2	2.5	2.5	2.5	2	2.5	2.5	2.5	2	2.5	2.5	2.5
21 Stillage box sort and empty (separate collect and sort)	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5
26 Emptying collection vehicle	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5

Table D75 Post-collection hazard ratings for the falls from height hazard category

			Acute		***Chronic***	
Component			***Prob.***	***Cons.***	***Prob.***	***Cons.***
Transfer/bulking station						
1a	Inward vehicle movements	RCV	1.5	2.5		
1b		Stillage	1.5	2.5		
1c		Kerbsider	1.5	2.5		
2a	Unloading vehicle	RCV	1.5	3		
2b		Stillage	1.5	2.5		
2c		Kerbsider	1.5	2.5		
4	Loading lorries		2	4		
5	Onward vehicle movements		1.5	2.5		
6	General housekeeping		1	3		
7	Maintenance		2	4		
MRF						
1a	Inward vehicle movements	RCV	1.5	2.5		
1b		Artic	1.5	2.5		
2a	Unloading vehicle	RCV	1.5	2.5		
2b		Artic	2	4		
4	Loading material onto conveyors and mechanical sorting		1.5	2.5		
6	Baling materials		1.5	2.5		
7a	Storage of recovered fractions	Fork-lift	1.5	2.5		
7b		Shovel loader	1.5	2.5		
8a	Loading lorries	Fork-lift	2	4		
8b		Shovel loader	2	4		
9	Onward vehicle movements		1.5	2.5		
10	General housekeeping		1	3		
11	Maintenance		2	4		
MBT						
1a	Inward vehicle movements	RCV	1.5	2.5		

Component			Acute		Chronic	
			Prob.	*Cons.*	*Prob.*	*Cons.*
1b		Artic	1.5	2.5		
2a	Unloading vehicle	RCV	1.5	3		
2b		Artic	2	4		
4	Loading material into sorting drum and mechanical sorting		1.5	2.5		
5	Loading material into a vehicle		1.5	2.5		
6	Unloading transfer vehicle at compost tunnel		1.5	2.5		
7	Loading material into hopper		1.5	2.5		
9	Transferring material between vessels and to maturation pad		1.5	2.5		
10	Inserting temperature probes		3	2.5		
11	Turning windrows		1.5	2.5		
12	Loading material into screener/miller		1.5	2.5		
13	Loading lorries		2	4		
14	Onward vehicle movements		1.5	2.5		
15	General housekeeping		1	3		
16	Maintenance		2	4		
In-vessel composting						
1a	Inward vehicle movements	RCV	1.5	2.5		
1b		Stillage	1.5	2.5		
1c		Artic	1.5	2.5		
2a	Unloading vehicle	RCV	1.5	2.5		
2b		Stillage	1.5	2.5		
2c		Artic	2	4		
4	Loading material into shredder		1.5	2.5		
5	Loading material into bulk container		1.5	2.5		
7	Loading first vessel		1.5	2.5		
8	Transferring material between vessels and to maturation pad		1.5	2.5		
9	Inserting temperature probes		3	2.5		
10	Turning windrows		1.5	2.5		

			Acute		Chronic	
Component			***Prob.***	***Cons.***	***Prob.***	***Cons.***
11	Finished product taken to stockpiles		1.5	2.5		
12	Screening material and bagging finished product		1.5	2.5		
13	Loading lorries		2	4		
14	Onward vehicle movements		1.5	2.5		
15	General housekeeping		1	3		
16	Maintenance		2	4		
Open windrow composting						
1a	Inward vehicle movements	RCV	1.5	2.5		
1b		Artic	1.5	2.5		
2a	Unloading vehicle	RCV	1.5	2.5		
2b		Artic	2	4		
3	Manual pre-sorting		1.5	2.5		
4	Loading material into shredder		1.5	2.5		
5	Loading material into truck to be taken to windrows		1.5	2.5		
6	Loading material onto windrow		1.5	2.5		
8	Turning windrows		1.5	2.5		
9	Finished product taken to stockpiles		1.5	2.5		
10	Screening material and bagging finished product		1.5	2.5		
11	Loading lorries		2	4		
12	Onward vehicle movements		1.5	2.5		
13	General housekeeping		1	3		
14	Maintenance		2	4		
Incineration						
1a	Inward vehicle movements	RCV	1.5	2.5		
1b		Artic	1.5	2.5		
2a	Unloading vehicle	RCV	1.5	3		
2b		Artic	2	4		

	Acute		*Chronic*	
Component	***Prob.***	***Cons.***	***Prob.***	***Cons.***
4 Delivery of hazardous substances in bulk	2	4		
5 Removal of by-products	2	4		
6 Onward vehicle movements	1.5	2.5		
7 General housekeeping	1	3		
8 Maintenance	2	4		
Landfill				
3 Tipping collection vehicle	1.5	3		
4 Driving compaction vehicles	1.5	3		
5 General housekeeping	1	3		
6 Maintenance	1	4		

D8.9 FIRE AND EXPLOSION

Table D76 Collection hazard acute ratings for the fire and explosion hazard category

	Low housing density								***High housing density***							
	Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
	Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
2 Driving from location to location	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table D77 Post-collection hazard ratings for the fire and explosion hazard category

	Acute		*Chronic*	
Component	***Prob.***	***Cons.***	***Prob.***	***Cons.***
Transfer/bulking station				
3 Handling heavy/hazardous waste	1	3		
7 Maintenance	2	1		
MRF				
4 Loading material onto conveyors and mechanical sorting	1	1		
6 Baling materials	2	2		
11 Maintenance	2	1		
MBT				
4 Loading material into sorting drum and mechanical sorting	1	1		
16 Maintenance	2	3		
In-vessel composting				
16 Maintenance	2	3		
Open windrow composting				
14 Maintenance	2	3		
Incineration				
4 Delivery of hazardous substances in bulk	1	3		
8 Maintenance	2	1		
Landfill				
6 Maintenance	1	2		

D8.10 HANDLING SHARP OBJECTS

Table D78 Collection hazard acute ratings for the handling sharp objects hazard category

		Low housing density								***High housing density***							
		Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
		Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component		***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
4 High-rise bags collect		1.5	2	2	2	1.5	2	2	2	1.5	2	2	2	1.5	2	2	2
5 Disposable bags collect		3	2	3.5	2	3	2	3.5	2	3	2	3.5	2	3	2	3.5	2
6 Reusable bags collect and bag return		1	2	1.5	2	1	2	1.5	2	1	2	1.5	2	1	2	1.5	2
7a Big wheeled bins collect and bin return	Euro	0	2	2	2	0	2	2	2	0	2	2	2	0	2	2	2
7b	Palladin	0	2	2	2	0	2	2	2	0	2	2	2	0	2	2	2
10 Slave wheeled bin collect		1.5	2	2	2	1.5	2	2	2	1.5	2	2	2	1.5	2	2	2
11 Slave bag/box collect		1.5	2	2	2	1.5	2	2	2	1.5	2	2	2	1.5	2	2	2
12 Wheeled bin collect and bin return		0	2	2	2	0	2	2	2	0	2	2	2	0	2	2	2
13 Disposable bags empty		1.5	2	2	2	1.5	2	2	2	1.5	2	2	2	1.5	2	2	2
14 Reusable bags empty		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
19 Kerbsider box sort and empty		1.5	2	2	2	1.5	2	2	2	1.5	2	2	2	1.5	2	2	2

	Low housing density								*High housing density*							
	Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
	Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
20 Stillage box sort and empty (collect and sort)	1.5	2	2	2	1.5	2	2	2	1.5	2	2	2	1.5	2	2	2
21 Stillage box sort and empty (separate collect and sort)	1.5	2	2	2	1.5	2	2	2	1.5	2	2	2	1.5	2	2	2

Table D79 Post-collection hazard ratings for the handling sharp objects hazard category

	Acute		*Chronic*	
Component	***Prob.***	***Cons.***	***Prob.***	***Cons.***
Transfer/bulking station				
3 Handling heavy/hazardous waste	3	2		
6 General housekeeping	1	2		
7 Maintenance	2	2		
MRF				
3 Pre-sorting materials	3	2		
5 Manual sorting	3.5	2		
10 General housekeeping	1	2		
11 Maintenance	2	2		
MBT				
3 Visual inspection of waste	3	2		
15 General housekeeping	1	2		
16 Maintenance	2	2		
In-vessel composting				
3 Manual pre-sorting	3	2		
15 General housekeeping	1	2		
16 Maintenance	2	2		
Open windrow composting				
3 Manual pre-sorting	3	2		
13 General housekeeping	1	2		
14 Maintenance	2	2		
Incineration				
7 General housekeeping	1	2		
8 Maintenance	2	2		

	Acute		*Chronic*	
Component	***Prob.***	***Cons.***	***Prob.***	***Cons.***
Landfill				
5 General housekeeping	1	2		
6 Maintenance	2	2		

D8.11 EXPOSURE TO EXTREME TEMPERATURES AND SUNSHINE

Table D80 Collection hazard acute ratings for the extreme temperature hazard category

		Low housing density								*High housing density*							
		Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
		Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component		***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
2 Driving from location to location		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4 High-rise bags collect		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
5 Disposable bags collect		2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2
6 Reusable bags collect and bag return		2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2
7a Big wheeled bins collect and bin return	Euro	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2
7b	Palladin	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2
8 Food waste collect and receptacle return		2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2
9 Kerbside box collect and box return		2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2
10 Slave wheeled bin collect		2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2
11 Slave bag/box collect		2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2
12 Wheeled bin collect and bin return		2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2

	Low housing density								***High housing density***							
	Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
	Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
13 Disposable bags empty	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2
14 Reusable bags empty	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2
16 Food waste empty	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2
17 High-rise slave sacks empty	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2
19 Kerbsider box sort and empty	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2
20 Stillage box sort and empty (collect and sort)	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2
21 Stillage box sort and empty (separate collect and sort)	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2
23 Walking to and from collection point	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2

Table D81 Collection hazard chronic ratings for the extreme temperature hazard category

		Low housing density								*High housing density*							
		Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
		Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component		***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
5 Disposable bags collect		1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5
6 Reusable bags collect and bag return		1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5
7a Big wheeled bins collect and bin return	Euro	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5
7b	Palladin	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5
8 Food waste collect and receptacle return		1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5
9 Kerbside box collect and box return		1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5
10 Slave wheeled bin collect		1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5
11 Slave bag/box collect		1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5
12 Wheeled bin collect and bin return		1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5
13 Disposable bags empty		1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5
14 Reusable bags empty		1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5
16 Food waste empty		1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5

	Low housing density								***High housing density***							
	Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
	Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
17 High-rise slave sacks empty	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5
19 Kerbsider box sort and empty	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5
20 Stillage box sort and empty (collect and sort)	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5
21 Stillage box sort and empty (separate collect and sort)	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5
23 Walking to and from collection point	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5	1	3.5

Table D82 Post-collection hazard ratings for the extreme temperature hazard category

	Acute		*Chronic*	
Component	***Prob.***	***Cons.***	***Prob.***	***Cons.***
Transfer/bulking station				
3 Handling heavy/hazardous waste	1.5	1.5		
6 General housekeeping	1.5	1.5		
7 Maintenance	1.5	1.5		
MRF				
10 General housekeeping	1.5	1.5		
11 Maintenance	1.5	1.5		
MBT				
15 General housekeeping	1.5	1.5		
16 Maintenance	1.5	1.5		
In-vessel composting				
15 General housekeeping	1.5	1.5		
16 Maintenance	1.5	1.5		
Open windrow composting				
13 General housekeeping	1.5	1.5		
14 Maintenance	1.5	1.5		
Incineration				
7 General housekeeping	1.5	1.5		
8 Maintenance	1.5	1.5		
Landfill				
4 Driving compaction vehicles	1.5	1		
5 General housekeeping	2.5	2	1	3.5
6 Maintenance	2.5	2	1	3.5

D8.12 HIGH-PRESSURE HOSE

Table D83 Collection hazard acute ratings for the high-pressure hose hazard category

		Low housing density								***High housing density***							
		Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
		Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component		***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
1 Assembling of collection crew at start of shift		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
15a Big wheeled bins empty	Euro	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
15b	Palladin	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
18 Wheeled bins empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
22 Slave wheeled bin empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
24 RCV compaction		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
25 Kerbsider hopper empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
26 Emptying collection vehicle		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2

Table D84 Post-collection hazard ratings for the high-pressure hose hazard category

Component			Acute		Chronic	
			Prob.	Cons.	Prob.	Cons.
Transfer/bulking station						
2a	Unloading vehicle	RCV	1	2		
2b		Stillage	1	2		
2c		Kerbsider	1	2		
6	General housekeeping		1	2		
7	Maintenance		2	2		
MRF						
2a	Unloading vehicle	RCV	1	2		
2b		Artic	1	2		
10	General housekeeping		1	2		
11	Maintenance		2	2		
MBT						
2a	Unloading vehicle	RCV	1	2		
2b		Artic	1	2		
15	General housekeeping		1	2		
16	Maintenance		2	2		
In-vessel composting						
2a	Unloading vehicle	RCV	1	2		
2b		Stillage	1	2		
2c		Artic	1	2		
15	General housekeeping		1	2		
16	Maintenance		2	2		
Open windrow composting						
2a	Unloading vehicle	RCV	1	2		
2b		Artic	1	2		
13	General housekeeping		1	2		

Component		*Acute*		*Chronic*	
		Prob.	*Cons.*	*Prob.*	*Cons.*
14 Maintenance		2	2		
Incineration					
2a Unloading vehicle	RCV	1	2		
2b	Artic	1	2		
7 General housekeeping		1	2		
8 Maintenance		2	2		
Landfill					
3 Tipping collection vehicle		1	2		
6 Maintenance		2	2		

D8.13 HOT PIPE WORK AND STEAM

Table D85 Post-collection hazard ratings for the hot pipe work and steam hazard category

Component	*Acute*		*Chronic*	
	Prob.	*Cons.*	*Prob.*	*Cons.*
Incineration				
7 General housekeeping	1.5	2		
8 Maintenance	1.5	2		

D8.14 INSECTS AND VERMIN BITES

Table D86 Collection hazard acute ratings for the insects and vermin bite hazard category

			Low housing density								*High housing density*							
			Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
			Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component			*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*
4	High-rise bags collect		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	Disposable bags collect		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	Reusable bags collect and bag return		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7a	Big wheeled bins collect and bin return	Euro	1	1	1.5	1	1	1	1.5	1	1	1	1.5	1	1	1	1.5	1
7b		Palladin	1	1	1.5	1	1	1	1.5	1	1	1	1.5	1	1	1	1.5	1
8	Food waste collect and receptacle return		1	1	1.5	1	1	1	1.5	1	1	1	1.5	1	1	1	1.5	1
9	Kerbside box collect and box return		1	1	1.5	1	1	1	1.5	1	1	1	1.5	1	1	1	1.5	1
10	Slave wheeled bin collect		1	1	1.5	1	1	1	1.5	1	1	1	1.5	1	1	1	1.5	1
11	Slave bag/box collect		1	1	1.5	1	1	1	1.5	1	1	1	1.5	1	1	1	1.5	1
12	Wheeled bin collect and bin return		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	Disposable bags empty		1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1

		Low housing density								***High housing density***							
		Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
		Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component		***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
14 Reusable bags empty		1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1
15a Big wheeled bins empty	Euro	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1
15b	Palladin	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1
16 Food waste empty		1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1
17 High-rise slave sacks empty		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18 Wheeled bins empty		1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1
19 Kerbsider box sort and empty		1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1
20 Stillage box sort and empty (collect and sort)		1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1
21 Stillage box sort and empty (separate collect and sort)		1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1
22 Slave wheeled bin empty		1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1
24 RCV compaction		1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1
25 Kerbsider hopper empty		1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1	1.5	1
26 Emptying collection vehicle		2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1

Table D87 Post-collection hazard ratings for the insects and vermin bite hazard category

Component			Acute		Chronic	
			Prob.	*Cons.*	*Prob.*	*Cons.*
Transfer/bulking station						
2a	Unloading vehicle	RCV	2	1		
2b		Stillage	2	1		
2c		Kerbsider	2	1		
3	Handling heavy/hazardous waste		1	1		
6	General housekeeping		1	1		
7	Maintenance		1	1		
MRF						
2a	Unloading vehicle	RCV	2	1		
2b		Artic	2	1		
3	Pre-sorting materials		2	1		
5	Manual sorting		1.5	1		
10	General housekeeping		1	1		
11	Maintenance		1	1		
MBT						
2a	Unloading vehicle	RCV	2	1		
2b		Artic	2	1		
3	Visual inspection of waste		2	1		
10	Inserting temperature probes		1	1		
15	General housekeeping		1	1		
16	Maintenance		1	1		
In-vessel composting						
2a	Unloading vehicle	RCV	2	1		
2b		Stillage	2	1		
2c		Artic	2	1		
3	Manual pre-sorting		2	1		

Component			***Acute***		***Chronic***	
			Prob.	***Cons.***	***Prob.***	***Cons.***
9	Inserting temperature probes		1	1		
15	General housekeeping		1	1		
16	Maintenance		1	1		
Open windrow composting						
2a	Unloading vehicle	RCV	2	1		
2b		Artic	2	1		
3	Manual pre-sorting		2	1		
7	Monitoring compost process (temperature/visual observations)		1	1		
13	General housekeeping		1	1		
14	Maintenance		1	1		
Incineration						
2a	Unloading vehicle	RCV	2	1		
2b		Artic	2	1		
7	General housekeeping		1	1		
8	Maintenance		1	1		
Landfill						
3	Tipping collection vehicle		2	1		
5	General housekeeping		2	1		
6	Maintenance		2	1		

D8.15 MANUAL HANDLING

Table D88 Collection hazard acute ratings for the manual handling hazard category

			Low housing density								***High housing density***							
			Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
			Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component			***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
4	High-rise bags collect		2	1	2.5	1.5	2.5	1	3.5	1.5	3	1.5	4	2.5	3	1.5	4.5	2.5
5	Disposable bags collect		1.5	1	2	1.5	1.5	1	3	1.5	2	1.5	3	2	2.5	1.5	3.5	2.5
6	Reusable bags collect and bag return		1	1	1	1.5	1.5	1	3	1.5	2	1.5	3	2	2.5	1.5	3.5	2.5
7a	Big wheeled bins collect and bin return	Euro	1	1	1.5	1.5	2	1	3.5	1.5	1.5	1.5	3	2	3	1.5	4	2.5
7b		Palladin	1.5	1.5	2	2	3	2	4	2.5	2	2	3	2.5	4	2	4.5	3
8	Food waste collect and receptacle return		1	1	1	1.5	1	1	2.5	1.5	1.5	1.5	2.5	2	2	1.5	3	2.5
9	Kerbside box collect and box return		1	1	2	1.5	1	1	2.5	1.5	1.5	1.5	2.5	2	2	1.5	3	2.5
10	Slave wheeled bin collect		1	1	2	1.5	1.5	1	3	1.5	2.5	1.5	3.5	2	2.5	1.5	4	2.5
11	Save bag/box collect		1	1	2	1.5	1.5	1	3	1.5	2.5	1.5	3.5	2	2.5	1.5	4	2.5
12	Wheeled bin collect and bin return		1	1	1.5	1	1.5	1	2	1.5	1	1.5	2	2	2	1.5	3	2

		Low housing density								***High housing density***							
		Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
		Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component		***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
13 Disposable bags empty		2	1	2	1.5	2	1	3.5	1.5	2.5	1.5	3.5	2	3	1.5	4	2.5
14 Reusable bags empty		1.5	1	2.5	1.5	2.5	1	4	1.5	3	1.5	4	2	3.5	1.5	4.5	2.5
15a Big wheeled bins empty	Euro	1	1	2	1.5	2	1	3.5	1.5	2.5	1.5	3.5	2	3	1.5	4	2.5
15b	Palladin	1.5	1.5	2.5	2	2.5	1.5	4	2	3	2	4	2.5	3.5	2	4.5	3
16 Food waste empty		1	1	1	1	1	1	1.5	1	1.5	1	2.5	1.5	2	1.5	2.5	2
17 High-rise slave sacks empty		1.5	1	2.5	1.5	2.5	1	4	1.5	3	1.5	4	2	3.5	1.5	4.5	2.5
18 Wheeled bins empty		1	1	1	1	1.5	1	2.5	1.5	2	1.5	2.5	2	2.5	1.5	3	2.5
19 Kerbsider box sort and empty		1	1	1	1	1	1	1.5	1	1.5	1	2	1.5	2	1.5	2	2
20 Stillage box sort and empty (collect and sort)		1	1	2	1.5	2	1	2.5	1.5	2	1.5	3	2	2.5	1.5	3	2.5
21 Stillage box sort and empty (separate collect and sort)		1	1	2	1.5	2	1	3	1.5	2.5	1.5	3.5	2	3	1.5	3.5	2.5
22 Slave wheeled bin empty		1	1	1	1	1.5	1	2.5	1.5	2	1.5	2.5	2	2.5	1.5	3	2.5

Table D89 Collection hazard chronic ratings for the manual handling hazard category

			Low housing density								***High housing density***							
			Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
			Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component			***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
4	High-rise bags collect		1.5	2	2	2	2	2	2.5	2.5	2	2	2.5	3	2.5	2.5	3.5	3.5
5	Disposable bags collect		1	2	1.5	2	1.5	2	2	2.5	1.5	2	2	3	2	2.5	3	3.5
6	Reusable bags collect and bag return		1	2	1.5	2	1.5	2	2	2.5	1.5	2	2	3	2	2.5	3	3.5
7a	Big wheeled bins collect and bin return	Euro	1.5	2	1.5	2	1.5	2	2	2.5	1.5	2	2	3	2	2.5	3	3.5
7b		Palladin	2	2	2	2.5	2	2.5	3	3.5	2	2.5	2.5	3.5	2.5	3	4	4
8	Food waste collect and receptacle return		1	2	1	2	1	2	2	2.5	1	2	1.5	3	1.5	2.5	2.5	3.5
9	Kerbside box collect and box return		1	2	1	2	1	2	2	2.5	1	2	1.5	3	1.5	2.5	2.5	3
10	Slave wheeled bin collect		1	2	1.5	2	1.5	2	2	2.5	2	2	2.5	3	2.5	2	3.5	3.5
11	Save bag/box collect		1	2	1.5	2	1.5	2	2	2.5	2	2	2.5	3	2.5	2	3.5	3.5
12	Wheeled bin collect and bin return		1	2	1	2	1	2	1.5	2	1	2	1.5	2	1.5	2	2	2.5
13	Disposable bags empty		1	2	1.5	2	1.5	2	2	2	1.5	2	2	2.5	2	2	3	3
14	Reusable bags empty		1.5	2	2	2	2	2	2.5	2	2	2	2.5	2.5	3	2.5	4	3

		Low housing density								***High housing density***							
		Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
		Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component		***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
15a Big wheeled bins empty	Euro	1	2	1.5	2	1.5	2	2	2	1.5	2	2	2.5	2.5	2	3	3
15b	Palladin	1.5	2	2	2	2	2	3	3	2	2	2.5	3	3	2.5	4	3.5
16 Food waste empty		1	2	1	2	1	2	1	2	1	2	1.5	2	1	2	1.5	2
17 High-rise slave sacks empty		1.5	2	2	2	2	2	2.5	2	2	2	2.5	2.5	3	2.5	4	3
18 Wheeled bins empty		1	2	1	2	1	2	1.5	2	1	2	1.5	2	1.5	2	2	2
19 Kerbsider box sort and empty		1	2	1	2	1	2	1	2	1	2	1.5	2	1	2	1.5	2
20 Stillage box sort and empty (collect and sort)		1	2	1	2	1.5	2	2	2	1.5	2	2	2	1.5	2	2.5	3
21 Stillage box sort and empty (separate collect and sort)		1	2	1.5	2	1.5	2	2	2	1.5	2	2	2.5	2	2	3	3
22 Slave wheeled bin empty		1	2	1	2	1	2	1.5	2	1	2	1.5	2	1.5	2	2	2

Table D90 Post-collection hazard ratings for the manual handling hazard category

Component	***Acute***		***Chronic***	
	Prob.	***Cons.***	***Prob.***	***Cons.***
Transfer/bulking station				
3 Handling heavy/hazardous waste	3	2	2	2
6 General housekeeping	3	1	2	2
7 Maintenance	3	1	2	2
MRF				
3 Pre-sorting materials	2	2	1	2
5 Manual sorting	4	2	2	3
6 Baling materials	3	2	1.5	2
10 General housekeeping	3	1	1	2
11 Maintenance	3	1	2	2
MBT				
3 Visual inspection of waste	2	2	1	2
10 Inserting temperature probes	2	1	2	2
15 General housekeeping	3	1	1	2
16 Maintenance	3	1	2	2
In-vessel composting				
3 Manual pre-sorting	2	2	1	2
9 Inserting temperature probes	2	1	2	2
12 Screening material and bagging finished product	3	2	3	3
15 General housekeeping	3	1	1	2
16 Maintenance	3	1	2	2
Open windrow composting				
3 Manual pre-sorting	2	2	1	2
7 Monitoring compost process (temperature/visual observations)	2	1	2	2

	Acute		*Chronic*	
Component	***Prob.***	***Cons.***	***Prob.***	***Cons.***
10 Screening material and bagging finished product	3	2	3	3
13 General housekeeping	3	1	1	2
14 Maintenance	3	1	2	2
Incineration				
4 Delivery of hazardous substances in bulk	3	1	1.5	2
7 General housekeeping	3	1	1	2
8 Maintenance	3	1	2	2
Landfill				
5 General housekeeping	3	1	1	2
6 Maintenance	3	1	2	2

D8.16 EXPOSURE TO METHANE GAS

Table D91 Post-collection hazard ratings for exposure to methane gas hazard category

	Acute		*Chronic*	
Component	***Prob.***	***Cons.***	***Prob.***	***Cons.***
MBT				
16 Maintenance	1	3		
In-vessel composting				
16 Maintenance	1	3		
Open windrow composting				
14 Maintenance	1	3		
Landfill				
6 Maintenance	1	3		

D8.17 MICROBIOLOGICAL

Table D92 Collection hazard acute ratings for the microbiological hazard category

		Low housing density								*High housing density*							
		Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
		Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component		***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
4 High-rise bags collect		1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2
5 Disposable bags collect		3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2
6 Reusable bags collect and bag return		2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1
7a Big wheeled bins collect and bin return	Euro	1	2	2	2	1	2	2	2	1	2	2	2	1	2	2	2
7b	Palladin	1	2	2	2	1	2	2	2	1	2	2	2	1	2	2	2
8 Food waste collect and receptacle return		1.5	1.5	2	1.5	1.5	1.5	2	1.5	1.5	1.5	2	1.5	1.5	1.5	2	1.5
9 Kerbside box collect and box return		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10 Slave wheeled bin collect		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11 Slave bag/box collect		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12 Wheeled bin collect and bin return		1	2	2	2	1	2	2	2	1	2	2	2	1	2	2	2
13 Disposable bags empty		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5

		Low housing density								***High housing density***							
		Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
		Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component		***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
14 Reusable bags empty		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
15a Big wheeled bins empty	Euro	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2
15b	Palladin	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2
16 Food waste empty		1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2
17 High-rise slave sacks empty		1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2
18 Wheeled bins empty		1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2
19 Kerbsider box sort and empty		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
20 Stillage box sort and empty (collect and sort)		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
21 Stillage box sort and empty (separate collect and sort)		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
22 Slave wheeled bin empty		1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2
23 Walking to and from collection point		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
24 RCV compaction		2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5
26 Emptying collection vehicle		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Table D93 Collection hazard chronic ratings for the microbiological hazard category

			Low housing density								*High housing density*							
			Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
			Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component			***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
4	High-rise bags collect		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
5	Disposable bags collect		2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5	2	1.5
6	Reusable bags collect and bag return		2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1
7a	Big wheeled bins collect and bin return	Euro	1	1	2	1	1	1	2	1	1	1	2	1	1	1	2	1
7b		Palladin	1	1	2	1	1	1	2	1	1	1	2	1	1	1	2	1
8	Food waste collect and receptacle return		1.5	2	2	2	1.5	2	2	2	1.5	2	2	2	1.5	2	2	2
9	Kerbside box collect and box return		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Slave wheeled bin collect		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11	Slave bag/box collect		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	Wheeled bin collect and bin return		1	1	2	1	1	1	2	1	1	1	2	1	1	1	2	1
13	Disposable bags empty		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5

		Low housing density								***High housing density***							
		Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
		Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component		***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
14 Reusable bags empty		2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5
15a Big wheeled bins empty	Euro	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
15b	Palladin	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
16 Food waste empty		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
17 High-rise slave sacks empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
18 Wheeled bins empty		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
19 Kerbsider box sort and empty		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
20 Stillage box sort and empty (collect and sort)		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
21 Stillage box sort and empty (separate collect and sort)		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
22 Slave wheeled bin empty		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
23 Walking to and from collection point		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
24 RCV compaction		2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5
26 Emptying collection vehicle		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Table D94 Post-collection hazard ratings for the microbiological hazard category

			Acute		*Chronic*	
Component			***Prob.***	***Cons.***	***Prob.***	***Cons.***
Transfer/bulking station						
2a	Unloading vehicle	RCV	2	3	3	3
2b		Stillage	2	3	3	3
2c		Kerbsider	2	3	3	3
3	Handling heavy/hazardous waste		3	2	2.5	3
4	Loading lorries		2	3	2	3
6	General housekeeping		2.5	3	3	3
7	Maintenance		3	2.5	3	3
MRF						
2a	Unloading vehicle	RCV	2	2	1	2
2b		Artic	2	2	1	2
3	Pre-sorting materials		3	2	2	3
4	Loading material onto conveyors and mechanical sorting		2	2	1.5	2
5	Manual sorting		3	3	2.5	3
6	Baling materials		1	1	1	1
7	Storage of recovered fractions	Fork-lift	1	1	1	1
7		Shovel loader	1	1	1	1
8a	Loading lorries	fork-lift	1	1	1	1
8b		Shovel loader	1	1	1	1
10	General housekeeping		2.5	2	2.5	2
11	Maintenance		2.5	2	2	2
MBT						
2a	Unloading vehicle	RCV	2	3	3	3
2b		Artic	2	3	3	3
3	Visual inspection of waste		3	2.5	2.5	3
4	Loading material into sorting drum and mechanical sorting		2	2	3	3
5	Loading material into a vehicle		2	2	3	3

			Acute		*Chronic*	
Component			***Prob.***	***Cons.***	***Prob.***	***Cons.***
6	Unloading transfer vehicle at compost tunnel		2	3	3	3
7	Loading material into hopper		2	2	3	3
9	Transferring material between vessels and to maturation pad		2	2	2	2
10	Inserting temperature probes		1	2	1	2
11	Turning windrows		2	2	3	3
12	Loading material into screener/miller		2	2	3	3
13	Loading lorries		2	2.5	2	3
15	General housekeeping		2.5	3	3	3
16	Maintenance		3	2.5	3	3
In-vessel composting						
2a	Unloading vehicle	RCV	3	2	3	3
2b		Stillage	3	2	3	3
2c		Artic	3	2	3	3
3	Manual pre-sorting		3	2.5	3	3
4	Loading material into shredder		2	3	3	3
5	Loading material into bulk container		2	3	3	3
7	Loading first vessel		2	3	3	3
8	Transferring material between vessels and to maturation pad		2	3	3	3
9	Inserting temperature probes		1	2	1	2
10	Turning windrows		2	2	2	3
11	Finished product taken to stockpiles		3	2	3	3
12	Screening material and bagging finished product		3	2.5	2.5	3
13	Loading lorries		2	2.5	2	3
15	General housekeeping		2.5	3	3	3
16	Maintenance		3	2.5	3	3
Open windrow composting						
2a	Unloading vehicle	RCV	2	2	1	2

Component		Acute		Chronic	
		Prob.	Cons.	Prob.	Cons.
2b	Artic	2	2	1	2
3 Manual pre-sorting		3	2	2	3
4 Loading material into shredder		1.5	2	2	2.5
5 Loading material into truck to be taken to windrows		2	2	1	2
6 Loading material onto windrow		2	2	1	2
7 Monitoring compost process (temperature/visual observations)		3	2	2	3
8 Turning windrows		2	2	2	3
9 Finished product taken to stockpiles		3	2	3	3
10 Screening material and bagging finished product		3	2.5	2.5	3
11 Loading lorries		2	2	3	3
13 General housekeeping		2.5	3	3	3
14 Maintenance		3	2.5	3	3
Incineration					
2a Unloading vehicle	RCV	2	3	3	3
2b	Artic	2	3	3	3
3 Removal of large items of waste from feed chute		2	2	2	2
4 Delivery of hazardous substances in bulk		1	2	1	2
5 Removal of by-products		2	2	1	2
7 General housekeeping		2.5	3	3	3
8 Maintenance		3	2.5	3	3
Landfill					
3 Tipping collection vehicle		2	2	2	2
4 Driving compaction vehicles		2	2	2	2
5 General housekeeping		2	2	2	2
6 Maintenance		2	2	2	2

D8.18 EJECTION OF MATERIAL

Table D95 Collection hazard acute ratings for the ejection of material hazard category

	Low housing density								***High housing density***							
	Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
	Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
19 Kerbsider box sort and empty	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
20 Stillage box sort and empty (collect and sort)	1	2	2	2	1	2	2	2	1	2	2	2	1	2	2	2
21 Stillage box sort and empty (separate collect and sort)	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
24 RCV compaction	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Table D96 Post-collection hazard ratings for the ejection of material hazard category

	Acute		*Chronic*	
Component	***Prob.***	***Cons.***	***Prob.***	***Cons.***
MRF				
6 Baling materials	2	2		
MBT				
12 Loading material into screener/miller	2	2		
In-vessel composting				
4 Loading material into shredder	2	2		
Open windrow composting				
4 Loading material into shredder	2	2		

D8.19 NOISE

Table D97 Collection hazard acute ratings for the exposure to noise hazard category

		Low housing density								***High housing density***							
		Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
		Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component		***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
1 Assembling of collection crew at start of shift		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 Slave wheeled bin collect		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
11 Slave bag/box collect		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
15a Big wheeled bins empty	Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15b	Palladin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18 Wheeled bins empty		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 Kerbsider box sort and empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
20 Stillage box sort and empty (collect and sort)		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
21 Stillage box sort and empty (separate collect and sort)		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
22 Slave wheeled bin empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
24 RCV compaction		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Component	***Low housing density***								***High housing density***							
	Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
	Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
	P	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
25 Kerbsider hopper empty	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
26 Emptying collection vehicle	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2

Table D98 Collection hazard chronic ratings for the exposure to noise hazard category

Component		***Low housing density***								***High housing density***							
		Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
		Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
		P	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
1 Assembling of collection crew at start of shift		1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5
10 Slave wheeled bin collect		1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5
11 Slave bag/box collect		1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5
15a Big wheeled bins empty	Euro	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5

	Low housing density								***High housing density***							
	Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
	Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
15b Palladin	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5
18 Wheeled bins empty	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5
19 Kerbsider box sort and empty	2	4	3	4	2	4	3	4	2	4	3	4	2	4	3	4
20 Stillage box sort and empty (collect and sort)	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3
21 Stillage box sort and empty (separate collect and sort)	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3
22 Slave wheeled bin empty	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3
24 RCV compaction	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5
25 Kerbsider hopper empty	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4
26 Emptying collection vehicle	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5

Table D99 Post-collection hazard ratings for the exposure to noise hazard category

			Acute		*Chronic*	
Component			***Prob.***	***Cons.***	***Prob.***	***Cons.***
Transfer/bulking station						
2a	Unloading vehicle	RCV	1	2	1	2
2b		Stillage	1	2	1	2
2c		Kerbsider	1	2	1	2
4	Loading lorries		1	2	2	2.5
6	General housekeeping		1	2	2	2.5
7	Maintenance		1	2	2	2.5
MRF						
2a	Unloading vehicle	RCV	1	2	1	2
2b		Artic	1	2	1	2
3	Pre-sorting materials				2	2.5
4	Loading material onto conveyors and mechanical sorting		1	2	3	4
5	Manual sorting				2	2.5
6	Baling materials		1	2	2	2.5
7a	Storage of recovered fractions	Fork-lift			2	2.5
7b		Shovel loader	1	2	2	2.5
8a	Loading lorries	Fork-lift			2	2.5
8b		Shovel loader	1	2	2	2.5
10	General housekeeping		1	2	2	2.5
11	Maintenance		1	2	2	2.5
MBT						
2a	Unloading vehicle	RCV	1	2	1	2
2b		Artic	1	2	1	2
3	Visual inspection of waste				2	2.5
4	Loading material into sorting drum and mechanical sorting		1	2	3	4
5	Loading material into a vehicle				2	2.5

			Acute		Chronic	
Component			***Prob.***	***Cons.***	***Prob.***	***Cons.***
6	Unloading transfer vehicle at compost tunnel				2	2.5
7	Loading material into hopper				2	2.5
8	Opening and closing doors of in-vessel				2	2.5
9	Transferring material between vessels and to maturation pad				2	2.5
10	Inserting temperature probes				2	2.5
11	Turning windrows				2	2.5
12	Loading material into screener/miller		1	2	2	2.5
13	Loading lorries				2	2.5
15	General housekeeping		1	2	2	2.5
16	Maintenance		1	2	2	2.5
In-vessel composting						
2a	Unloading vehicle	RCV	1	2	1	2
2b		Stillage	1	2	1	2
2c		Artic	1	2	1	2
3	Manual pre-sorting				2	2.5
4	Loading material into shredder		1	2	2	2.5
5	Loading material into bulk container				2	2.5
6	Opening and closing doors of in-vessel				2	2.5
7	Loading first vessel				2	2.5
8	Transferring material between vessels and to maturation pad				2	2.5
9	Inserting temperature probes				2	2.5
10	Turning windrows				2	2.5
11	Finished product taken to stockpiles				2	2.5
12	Screening material and bagging finished product		1	2	2	2.5
13	Loading lorries				2	2.5
15	General housekeeping		1	2	2	2.5
16	Maintenance		1	2	2	2.5

			Acute		*Chronic*	
Component			***Prob.***	***Cons.***	***Prob.***	***Cons.***
Open windrow composting						
2a	Unloading vehicle	RCV	1	2	1	2
2b		Artic	1	2	1	2
3	Manual pre-sorting				1	2
4	Loading material into shredder		1	2	1	2
5	Loading material into truck to be taken to windrows		1	2	1	2
6	Loading material onto windrow				1	2
8	Turning windrows				1	2
9	Finished product taken to stockpiles				1	2
10	Screening material and bagging finished product		1	2	2	2.5
11	Loading lorries				1	2
13	General housekeeping				1	2
14	Maintenance				1	2.5
Incineration						
2a	Unloading vehicle	RCV			1	2
2b		Artic			1	2
3	Removal of large items of waste from feed chute				1	2
4	Delivery of hazardous substances in bulk				1	2
5	Removal of by-products				1	2
7	General housekeeping		1	2	1	2
8	Maintenance		1	2	1	2
Landfill						
4	Driving compaction vehicles				1	2
5	General housekeeping				1	2
6	Maintenance				1	2

D8.20 OTHER ANIMALS

Table D100 Collection hazard acute ratings for the other animals hazard category

			Low housing density								*High housing density*							
			Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
			Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component			***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
4	High-rise bags collect		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
5	Disposable bags collect		1.5	2	1	2	1.5	2	1	2	1.5	2	1	2	1.5	2	1	2
6	Reusable bags collect and bag return		2	2	1	2	2	2	1	2	2	2	1	2	2	2	1	2
7a	Big wheeled bins collect and bin return	Euro	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
7b		Palladin	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
8	Food waste collect and receptacle return		2	2	1	2	2	2	1	2	2	2	1	2	2	2	1	2
9	Kerbside box collect and box return		2	2	1	2	2	2	1	2	2	2	1	2	2	2	1	2
10	Slave wheeled bin collect		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
11	Slave bag/box collect		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
12	Wheeled bin collect and bin return		2	2	1	2	2	2	1	2	2	2	1	2	2	2	1	2
13	Disposable bags empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2

		Low housing density								*High housing density*							
		Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
		Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component		***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
14 Reusable bags empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
15a Big wheeled bins empty	Euro	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
15b	Palladin	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
16 Food waste empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
17 High-rise slave sacks empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
18 Wheeled bins empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
19 Kerbsider box sort and empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
20 Stillage box sort and empty (collect and sort)		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
21 Stillage box sort and empty (separate collect and sort)		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
22 Slave wheeled bin empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
23 Walking to and from collection point		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
24 RCV compaction		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
25 Kerbsider hopper empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2

D8.21 SLIPS AND TRIPS

Table D101 Collection hazard acute ratings for the slips and trips hazard category

			Low housing density								*High housing density*							
			Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
			Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component			*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*
1	Assembling of collection crew at start of shift		2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5
3	Getting in and out of cab		2	1.5	2	1.5	3	1.5	3	1.5	2	1.5	2	1.5	3	1.5	3	1.5
4	High-rise bags collect		3	1.5	3	1.5	4	1.5	4	1.5	3	1.5	3	1.5	4	1.5	4	1.5
5	Disposable bags collect		3	1.5	3	1.5	4	1.5	4	1.5	3	1.5	3	1.5	4	1.5	4	1.5
6	Reusable bags collect and bag return		3	1.5	3	1.5	4	1.5	4	1.5	3	1.5	3	1.5	4	1.5	4	1.5
7a	Big wheeled bins collect and bin return	Euro	2	1.5	2	1.5	3	1.5	3	1.5	2	1.5	2	1.5	3	1.5	3	1.5
7b		Palladin	2	1.5	2	1.5	3	1.5	3	1.5	2	1.5	2	1.5	3	1.5	3	1.5
8	Food waste collect and receptacle return		2	1.5	2	1.5	3	1.5	3	1.5	2	1.5	2	1.5	3	1.5	3	1.5
9	Kerbside box collect and box return		2	1.5	2	1.5	3	1.5	3	1.5	2	1.5	2	1.5	3	1.5	3	1.5
10	Slave wheeled bin collect		1.5	1.5	1.5	1.5	3	1.5	3	1.5	1.5	1.5	1.5	1.5	3	1.5	3	1.5

		Low housing density								*High housing density*							
		Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
		Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component		***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
11 Slave bag/box collect		1.5	1.5	1.5	1.5	3	1.5	3	1.5	1.5	1.5	1.5	1.5	3	1.5	3	1.5
12 Wheeled bin collect and bin return		2	1.5	2	1.5	3	1.5	3	1.5	2	1.5	2	1.5	3	1.5	3	1.5
13 Disposable bags empty		1	1.5	1	1.5	1.5	1.5	1.5	1.5	1	1.5	1	1.5	1.5	1.5	1.5	1.5
14 Reusable bags empty		1	1.5	1	1.5	1.5	1.5	1.5	1.5	1	1.5	1	1.5	1.5	1.5	1.5	1.5
15a Big wheeled bins empty	Euro	1	1.5	1	1.5	1.5	1.5	1.5	1.5	1	1.5	1	1.5	1.5	1.5	1.5	1.5
15b	Palladin	1	1.5	1	1.5	1.5	1.5	1.5	1.5	1	1.5	1	1.5	1.5	1.5	1.5	1.5
16 Food waste empty		3	2	3.5	2	3	2	3.5	2	3	2	3.5	2	3	2	3.5	2
17 High-rise slave sacks empty		1	1.5	1	1.5	1.5	1.5	1.5	1.5	1	1.5	1	1.5	1.5	1.5	1.5	1.5
18 Wheeled bins empty		1	1.5	1	1.5	1.5	1.5	1.5	1.5	1	1.5	1	1.5	1.5	1.5	1.5	1.5
19 Kerbsider box sort and empty		1	1.5	1	1.5	1.5	1.5	1.5	1.5	1	1.5	1	1.5	1.5	1.5	1.5	1.5
20 Stillage box sort and empty (collect and sort)		3	2	3.5	2	3	2	3.5	2	3	2	3.5	2	3	2	3.5	2
21 Stillage box sort and empty (separate collect and sort)		1	1.5	1	1.5	1.5	1.5	1.5	1.5	1	1.5	1	1.5	1.5	1.5	1.5	1.5
22 Slave wheeled bin empty		1	1.5	1	1.5	1.5	1.5	1.5	1.5	1	1.5	1	1.5	1.5	1.5	1.5	1.5

	Low housing density								***High housing density***							
	Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
	Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
23 Walking to and from collection point	1.5	1.5	1.5	1.5	3	1.5	3	1.5	1.5	1.5	1.5	1.5	3	1.5	3	1.5
26 Emptying collection vehicle	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5

Table D102 Post-collection hazard ratings for the slips and trips hazard category

			Acute		*Chronic*	
Component			***Prob.***	***Cons.***	***Prob.***	***Cons.***
Transfer/bulking station						
1a	Inward vehicle movements	RCV	2.5	1.5		
1b		Stillage	2.5	1.5		
1c		Kerbsider	2.5	1.5		
2a	Unloading vehicle	RCV	2.5	1.5		
2b		Stillage	2.5	1.5		
2c		Kerbsider	2.5	1.5		
3	Handling heavy/hazardous waste		3	2		
4	Loading lorries		2.5	1.5		
6	General housekeeping		3	1.5		
7	Maintenance		3	2		
MRF						
1a	Inward vehicle movements	RCV	2.5	1.5		
1b		Artic	2.5	1.5		
2a	Unloading vehicle	RCV	2.5	1.5		
2b		Artic	2.5	1.5		
3	Pre-sorting materials		3	2		
5	Manual sorting		2.5	1.5		
6	Baling materials		2.5	1.5		
8a	Loading lorries	Fork-lift	2.5	1.5		
8b		Shovel loader	2.5	1.5		
10	General housekeeping		3	1.5		
11	Maintenance		3	2		
MBT						
1a	Inward vehicle movements	RCV	2.5	1.5		
1b		Artic	2.5	1.5		
2a	Unloading vehicle	RCV	2.5	1.5		

Component			Acute		Chronic	
			Prob.	*Cons.*	*Prob.*	*Cons.*
2b		Artic	2.5	1.5		
3	Visual inspection of waste		3	2		
10	Inserting temperature probes		3	2		
13	Loading lorries		2.5	1.5		
15	General housekeeping		3	1.5		
16	Maintenance		3	2		
In-vessel composting						
1a	Inward vehicle movements	RCV	2.5	1.5		
1b		Stillage	2.5	1.5		
1c		Artic	2.5	1.5		
2a	Unloading vehicle	RCV	2.5	1.5		
2b		Stillage	2.5	1.5		
2c		Artic	2.5	1.5		
3	Manual pre-sorting		3	2		
9	Inserting temperature probes		3	2		
12	Screening material and bagging finished product		2.5	1.5		
13	Loading lorries		2.5	1.5		
15	General housekeeping		3	1.5		
16	Maintenance		3	2		
Open windrow composting						
1a	Inward vehicle movements	RCV	2.5	1.5		
1b		Artic	2.5	1.5		
2a	Unloading vehicle	RCV	2.5	1.5		
2b		Artic	2.5	1.5		
3	Manual pre-sorting		3	2		
7	Monitoring compost process (temperature/visual observations)		3	2		
10	Screening material and bagging finished product		2.5	1.5		
11	Loading lorries		2.5	1.5		

Component			Acute		Chronic	
			Prob.	Cons.	Prob.	Cons.
13	General housekeeping		3	1.5		
14	Maintenance		3	2		
Incineration						
1a	Inward vehicle movements	RCV	2.5	1.5		
1b		Artic	2.5	1.5		
2a	Unloading vehicle	RCV	2.5	1.5		
2b		Artic	2.5	1.5		
4	Delivery of hazardous substances in bulk		3	1.5		
5	Removal of by-products		2.5	1.5		
7	General housekeeping		3	1.5		
8	Maintenance		3	2		
Landfill						
3	Tipping collection vehicle		2.5	1.5		
5	General housekeeping		3	2		
6	Maintenance		3	2		

D8.22 STRESS

Table D103 Collection hazard chronic ratings for the stress hazard category

			Low housing density								*High housing density*							
			Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
			Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component			***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
1	Assembling of collection crew at start of shift		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2	Driving from location to location		3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2
4	High-rise bags collect		1	2	1	2	1	2	1	2	2	2	2	2	2	2	2	2
5	Disposable bags collect		1	2	1	2	1	2	1	2	2	2	2	2	2	2	2	2
6	Reusable bags collect and bag return		1	2	1	2	1	2	1	2	2	2	2	2	2	2	2	2
7a	Big wheeled bins collect and bin return	Euro	1	2	1	2	1	2	1	2	2	2	2	2	2	2	2	2
7b		Palladin	1	2	1	2	1	2	1	2	2	2	2	2	2	2	2	2
8	Food waste collect and receptacle return		1	2	1	2	1	2	1	2	2	2	2	2	2	2	2	2
9	Kerbside box collect and box return		1	2	1	2	1	2	1	2	2	2	2	2	2	2	2	2
10	Slave wheeled bin collect		1	2	1	2	1	2	1	2	2	2	2	2	2	2	2	2
11	Slave bag/box collect		1	2	1	2	1	2	1	2	2	2	2	2	2	2	2	2

		Low housing density								High housing density							
		Low env. risk				High env. risk				Low env. risk				High env. risk			
		Low mass		High mass		Low mass		High mass		Low mass		High mass		Low mass		High mass	
Component		**P**	**C**	**P**	**C**	**P**	**C**	**P**	**C**	**P**	**C**	**P**	**C**	**P**	**C**	**P**	**C**
12 Wheeled bin collect and bin return		1	2	1	2	1	2	1	2	2	2	2	2	2	2	2	2
13 Disposable bags empty		1	2	1	2	1	2	1	2	1.5	2	1.5	2	1.5	2	1.5	2
14 Reusable bags empty		1	2	1	2	1	2	1	2	1.5	2	1.5	2	1.5	2	1.5	2
15a Big wheeled bins empty	Euro	1	2	1	2	1	2	1	2	1.5	2	1.5	2	1.5	2	1.5	2
15b	Palladin	1	2	1	2	1	2	1	2	1.5	2	1.5	2	1.5	2	1.5	2
16 Food waste empty		1	2	1	2	1	2	1	2	1.5	2	1.5	2	1.5	2	1.5	2
17 High-rise slave sacks empty		1	2	1	2	1	2	1	2	1.5	2	1.5	2	1.5	2	1.5	2
18 Wheeled bins empty		1	2	1	2	1	2	1	2	1.5	2	1.5	2	1.5	2	1.5	2
19 Kerbsider box sort and empty		1	2	1	2	1	2	1	2	2	2	2	2	2	2	2	2
20 Stillage box sort and empty (collect and sort)		1	2	1	2	1	2	1	2	1.5	2	1.5	2	1.5	2	1.5	2
21 Stillage box sort and empty (separate collect and sort)		1	2	1	2	1	2	1	2	2	2	2	2	2	2	2	2
22 Slave wheeled bin empty		1	2	1	2	1	2	1	2	1.5	2	1.5	2	1.5	2	1.5	2
23 Walking to and from collection point		0	0	0	0	0	0	0	0	1	2	1	2	1	2	1	2

	Low housing density								***High housing density***							
	Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
	Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
24 RCV compaction	1	2	1	2	1	2	1	2	1.5	2	1.5	2	1.5	2	1.5	2
25 Kerbsider hopper empty	1	2	1	2	1	2	1	2	1.5	2	1.5	2	1.5	2	1.5	2

Table D104 Post-collection hazard ratings for the stress hazard category

			Acute		*Chronic*	
Component			***Prob.***	***Cons.***	***Prob.***	***Cons.***
Transfer/bulking station						
4	Loading lorries				1.5	2
7	Maintenance				2	2
MRF						
3	Pre-sorting materials				1	2
4	Loading material onto conveyors and mechanical sorting				1.5	2
5	Manual sorting				2.5	2
7a	Storage of recovered fractions	Fork-lift			1.5	2
7b		Shovel loader			1.5	2
8a	Loading lorries	Fork-lift			1.5	2
8b		Shovel loader			1.5	2
11	Maintenance				2	2
MBT						
3	Visual inspection of waste				1	2
4	Loading material into sorting drum and mechanical sorting				1.5	2
5	Loading material into a vehicle				1.5	2
7	Loading material into hopper				1.5	2
9	Transferring material between vessels and to maturation pad				1.5	2
11	Turning windrows				1	2
12	Loading material into screener/miller				1.5	2
13	Loading lorries				1.5	2
16	Maintenance				2	2
In-vessel composting						
3	Manual pre-sorting				1	2
4	Loading material into shredder				1.5	2

Component	Acute		Chronic	
	Prob.	Cons.	Prob.	Cons.
5 Loading material into bulk container			1.5	2
7 Loading first vessel			1.5	2
8 Transferring material between vessels and to maturation pad			1.5	2
10 Turning windrows			1	2
11 Finished product taken to stockpiles			1.5	2
12 Screening material and bagging finished product			1.5	2
13 Loading lorries			1.5	2
16 Maintenance			2	2
Open windrow composting				
3 Manual pre-sorting			1	2
4 Loading material into shredder			1.5	2
5 Loading material into truck to be taken to windrows			1.5	2
8 Turning windrows			1	2
9 Finished product taken to stockpiles			1.5	2
10 Screening material and bagging finished product			1.5	2
11 Loading lorries			1.5	2
14 Maintenance			2	2
Incineration				
5 Removal of by-products			1.5	2
8 Maintenance			2	2
Landfill				
4 Driving compaction vehicles			1.5	2
5 General housekeeping			1.5	2
6 Maintenance			2	2

D8.23 MINOR TRAPPING

Table D105 Collection hazard acute ratings for the minor trapping hazard category

		Low housing density								*High housing density*							
		Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
		Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component		*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*P*	*C*
1 Assembling of collection crew at start of shift		3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1
3 Getting in and out of cab		4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1
7a Big wheeled bins collect and bin return	Euro	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1
10 Slave wheeled bin collect		3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1
12 Wheeled bin collect and bin return		3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1
15a Big wheeled bins empty	Euro	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1
18 Wheeled bins empty		3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1
19 Kerbsider box sort and empty		4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1
20 Stillage box sort and empty (collect and sort)		4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1
21 Stillage box sort and empty (separate collect and sort)		4	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1

	Low housing density								***High housing density***							
	Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
	Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
22 Slave wheeled bin empty	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1
26 Emptying collection vehicle	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1

Table D106 Post-collection hazard ratings for the minor trapping hazard category

			Acute		*Chronic*	
Component			*Prob.*	*Cons.*	*Prob.*	*Cons.*
Transfer/bulking station						
2a	Unloading vehicle	RCV	3	1		
2b		Stillage	3	1		
2c		Kerbsider	3	1		
3	Handling heavy/hazardous waste		4	2		
4	Loading lorries		3	1		
5	Onward vehicle movements		3	1		
6	General housekeeping		2	1		
7	Maintenance		4	1		
MRF						
2a	Unloading vehicle	RCV	3	1		
2b		Artic	3	1		
4	Loading material onto conveyors and mechanical sorting		3	1		
5	Manual sorting		2	1		
6	Baling materials		3	1		
7a	Storage of recovered fractions	Fork-lift	3	1		
7b		Shovel loader	3	1		
8a	Loading lorries	Fork-lift	3	1		
8b		Shovel loader	3	1		
9	Onward vehicle movements		3	1		
10	General housekeeping		2	1		
11	Maintenance		4	1		
MBT						
2a	Unloading vehicle	RCV	3	1		
2b		Artic	3	1		
4	Loading material into sorting drum and mechanical sorting		3	1		
5	Loading material into a vehicle		3	1		

Component			Acute		Chronic	
			Prob.	Cons.	Prob.	Cons.
6	Unloading transfer vehicle at compost tunnel		3	1		
7	Loading material into hopper		3	1		
9	Transferring material between vessels and to maturation pad		3	1		
10	Inserting temperature probes		2	1		
11	Turning windrows		3	1		
12	Loading material into screener/miller		3	1		
13	Loading lorries		3	1		
14	Onward vehicle movements		3	1		
15	General housekeeping		2	1		
16	Maintenance		4	1		
In-vessel composting						
2a	Unloading vehicle	RCV	3	1		
2b		Stillage	3	1		
2c		Artic	3	1		
4	Loading material into shredder		3	1		
5	Loading material into bulk container		3	1		
7	Loading first vessel		3	1		
8	Transferring material between vessels and to maturation pad		3	1		
9	Inserting temperature probes		2	1		
10	Turning windrows		3	1		
11	Finished product taken to stockpiles		3	1		
12	Screening material and bagging finished product		3	1		
13	Loading lorries		3	1		
14	Onward vehicle movements		3	1		
15	General housekeeping		2	1		
16	Maintenance		4	1		
Open windrow composting						

Component			Acute		Chronic	
			Prob.	***Cons.***	***Prob.***	***Cons.***
2a	Unloading vehicle	RCV	3	1		
2b		Artic	3	1		
4	Loading material into shredder		3	1		
5	Loading material into truck to be taken to windrows		3	1		
6	Loading material onto windrow		3	1		
8	Turning windrows		3	1		
9	Finished product taken to stockpiles		3	1		
10	Screening material and bagging finished product		3	1		
11	Loading lorries		3	1		
12	Onward vehicle movements		3	1		
13	General housekeeping		2	1		
14	Maintenance		4	1		
Incineration						
2a	Unloading vehicle	RCV	3	1		
2b		Artic	3	1		
4	Delivery of hazardous substances in bulk		3	1		
5	Removal of by-products		3	1		
6	Onward vehicle movements		3	1		
7	General housekeeping		2	1		
8	Maintenance		4	1		
Landfill						
3	Tipping collection vehicle		4	1		
4	Driving compaction vehicles		4	1		
5	General housekeeping		2	1		
6	Maintenance		4	1		

D8.24 VEHICLE TIPPING OVER

Table D107 Collection hazard acute ratings for the vehicle tipping over hazard category

	Low housing density								***High housing density***							
	Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
	Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
2 Driving from location to location	1.5	3.5	1.5	3.5	1.5	3.5	1.5	3.5	1.5	3.5	1.5	3.5	1.5	3.5	1.5	3.5
26 Emptying collection vehicle	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3

Table D108 Post-collection hazard ratings for the vehicle tipping over hazard category

			Acute		***Chronic***	
Component			***Prob.***	***Cons.***	***Prob.***	***Cons.***
Transfer/bulking station						
1a	Inward vehicle movements	RCV	1	3		
1b		Stillage	1	2		
1c		Kerbsider	1	2		
2a	Unloading vehicle	RCV	1	2		
2b		Stillage	1	3		
2c		Kerbsider	1	2		
3	Handling heavy/hazardous waste		2	3		
4	Loading lorries		2	2		
MRF						
1a	Inward vehicle movements	RCV	1	2		
1b		Artic	1	2		
2a	Unloading vehicle	RCV	1	2		
2b		Artic	1	2		
4	Loading material onto conveyors and mechanical sorting		2	2		
6	Baling materials		2	2		
7a	Storage of recovered fractions	Fork-lift	2	3		
7b		Shovel loader	2	2		
8a	Loading lorries	Fork-lift	2	3		
8b		Shovel loader	2	2		
MBT						
1a	Inward vehicle movements	RCV	1	3		
1b		Artic	1	3		
2a	Unloading vehicle	RCV	1	2		
2b		Artic	1	2		
4	Loading material into sorting drum and mechanical sorting		2	2		
5	Loading material into a vehicle		2	2		

			Acute		*Chronic*	
Component			***Prob.***	***Cons.***	***Prob.***	***Cons.***
6	Unloading transfer vehicle at compost tunnel		2	2		
7	Loading material into hopper		2	2		
8	Opening and closing doors of in-vessel		1	2		
9	Transferring material between vessels and to maturation pad		2	2		
11	Turning windrows		1.5	2		
12	Loading material into screener/miller		2	2		
13	Loading lorries		2	2		
In-vessel composting						
1a	Inward vehicle movements	RCV	1	3		
1b		Stillage	1	2		
1c		Artic	1	3		
2a	Unloading vehicle	RCV	1	2		
2b		Stillage	1	3		
2c		Artic	1	2		
4	Loading material into shredder		2	2		
5	Loading material into bulk container		2	2		
6	Opening and closing doors of in-vessel		1	2		
7	Loading first vessel		2	2		
8	Transferring material between vessels and to maturation pad		2	2		
10	Turning windrows		1.5	2		
11	Finished product taken to stockpiles		2	2		
12	Screening material and bagging finished product		2	2		
13	Loading lorries		2	2		
Open windrow composting						
1a	Inward vehicle movements	RCV	1	2		
1b		Artic	1	2		
2a	Unloading vehicle	RCV	1	2		
2b		Artic	1	2		

			Acute		***Chronic***	
Component			***Prob.***	***Cons.***	***Prob.***	***Cons.***
4	Loading material into shredder		2	2		
5	Loading material into truck to be taken to windrows		2	2		
6	Loading material onto windrow		1.5	2		
8	Turning windrows		1.5	2		
9	Finished product taken to stockpiles		2	2		
10	Screening material and bagging finished product		2	2		
11	Loading lorries		2	2		
Incineration						
1a	Inward vehicle movements	RCV	1	3		
1b		Artic	1	3		
2a	Unloading vehicle	RCV	1	2		
2b		Artic	1	2		
5	Removal of by-products		2	2		
Landfill						
1	Driving on access road		1	2		
2	Reversing		2.5	2		
3	Tipping collection vehicle		2.5	2		
4	Driving compaction vehicles		2.5	2		

D8.25 VIBRATION

Table D109 Collection hazard chronic ratings for the vibration hazard category

	Low housing density								*High housing density*							
	Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
	Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
2 Driving from location to location	1	2.5	1	2.5	1.5	2.5	1.5	2.5	1	2.5	1	2.5	1.5	2.5	1.5	2.5

Table D110 Post-collection hazard ratings for the vibration hazard category

Component			*Acute*		*Chronic*	
			Prob.	*Cons.*	*Prob.*	*Cons.*
Transfer/bulking station						
2b	Unloading vehicle	Stillage			2	2.5
3	Handling heavy/hazardous waste				2	2.5
4	Loading lorries				2	2.5
MRF						
4	Loading material onto conveyors and mechanical sorting				2	2.5
6	Baling materials				2	2.5
7a	Storage of recovered fractions	Fork-lift			2	2.5
7b		Shovel loader			2	2.5
8a	Loading lorries	Fork-lift			2	2.5
8b		Shovel loader			2	2.5
MBT						
4	Loading material into sorting drum and mechanical sorting				2	2.5
5	Loading material into a vehicle				2	2.5
6	Unloading transfer vehicle at compost tunnel				2	2.5
7	Loading material into hopper				2	2.5
8	Opening and closing doors of in-vessel				2	2.5
9	Transferring material between vessels and to maturation pad				2	2.5
11	Turning windrows				2	2.5
12	Loading material into screener/miller				2	2.5
13	Loading lorries				2	2.5
In-vessel composting						
2b	Unloading vehicle	Stillage			2	2.5
4	Loading material into shredder				2	2.5
5	Loading material into bulk container				2	2.5

Component	Acute		Chronic	
	Prob.	Cons.	Prob.	Cons.
6 Opening and closing doors of in-vessel			2	2.5
7 Loading first vessel			2	2.5
8 Transferring material between vessels and to maturation pad			2	2.5
10 Turning windrows			2	2.5
11 Finished product taken to stockpiles			2	2.5
12 Screening material and bagging finished product			2	2.5
13 Loading lorries			2	2.5
Open windrow composting				
4 Loading material into shredder			2	2.5
5 Loading material into truck to be taken to windrows			2	2.5
6 Loading material onto windrow			2	2.5
8 Turning windrows			2	2.5
9 Finished product taken to stockpiles			2	2.5
10 Screening material and bagging finished product			2	2.5
11 Loading lorries			2	2.5
Incineration				
3 Removal of large items of waste from feed chute			2	2.5
5 Removal of by-products			2	2.5
Landfill				
1 Driving on access road			1.5	2.5
4 Driving compaction vehicles			3	2.5

D8.26 VIOLENCE

Table D111 Collection hazard acute ratings for the violence hazard category

			Low housing density								*High housing density*							
			Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
			Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component			***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
2	Driving from location to location		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
4	High-rise bags collect		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
5	Disposable bags collect		1	2	1	2	1	2	1	2	2	2	2	2	2	2	2	2
6	Reusable bags collect and bag return		1	2	1	2	1	2	1	2	2	2	2	2	2	2	2	2
7a	Big wheeled bins collect and bin return	Euro	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
7b		Palladin	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
8	Food waste collect and receptacle return		1	2	1	2	1	2	1	2	2	2	2	2	2	2	2	2
9	Kerbside box collect and box return		1	2	1	2	1	2	1	2	2	2	2	2	2	2	2	2
10	Slave wheeled bin collect		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
11	Slave bag/box collect		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
12	Wheeled bin collect and bin return		1	2	1	2	1	2	1	2	2	2	2	2	2	2	2	2

		Low housing density								***High housing density***							
		Low env. risk				***High env. risk***				***Low env. risk***				***High env. risk***			
		Low mass		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***		***Low mass***		***High mass***	
Component		***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
13 Disposable bags empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
14 Reusable bags empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
15a Big wheeled bins empty	Euro	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
15b	Palladin	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
16 Food waste empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
17 High-rise slave sacks empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
18 Wheeled bins empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
19 Kerbsider box sort and empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
20 Stillage box sort and empty (collect and sort)		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
21 Stillage box sort and empty (separate collect and sort)		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
22 Slave wheeled bin empty		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
23 Walking to and from collection point		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
24 RCV compaction		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2

	Low housing density								High housing density							
	Low env. risk				High env. risk				Low env. risk				High env. risk			
	Low mass		High mass		Low mass		High mass		Low mass		High mass		Low mass		High mass	
Component	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
25 Kerbsider hopper empty	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
26 Emptying collection vehicle	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2

Table D112 Post-collection hazard ratings for the violence hazard category

			Acute		*Chronic*	
Component			***Prob.***	***Cons.***	***Prob.***	***Cons.***
Transfer/bulking station						
2a	Unloading vehicle	RCV	1	2		
2b		Stillage	1	2		
2c		Kerbsider	1	2		
MRF						
2a	Unloading vehicle	RCV	1	2		
2b		Artic	1	2		
MBT						
2a	Unloading vehicle	RCV	1	2		
2b		Artic	1	2		
In-vessel composting						
2a	Unloading vehicle	RCV	1	2		
2b		Stillage	1	2		
2c		Artic	1	2		
Open windrow composting						
2a	Unloading vehicle	RCV	1	2		
2b		Artic	1	2		
Incineration						
2a	Unloading vehicle	RCV	1	2		
2b		Artic	1	2		
Landfill						
3	Tipping collection vehicle		1	2		

D8.27 WORKPLACE TRANSPORT

Table D113 Collection hazard acute ratings for the workplace transport hazard category

			Low housing density								*High housing density*							
			Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
			Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component			***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
1	Assembling of collection crew at start of shift		1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4
2	Driving from location to location		1	4	1	4	2	4	2	4	1	4	1	4	2	4	2	4
3	Getting in and out of cab		1	4	1	4	1.5	4	1.5	4	1	4	1	4	1.5	4	1.5	4
5	Disposable bags collect		1	4	1	4	2	4	2	4	1	4	1	4	2	4	2	4
6	Reusable bags collect and bag return		1	4	1	4	2	4	2	4	1	4	1	4	2	4	2	4
7a	Big wheeled bins collect and bin return	Euro	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4
7b		Palladin	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4
8	Food waste collect and receptacle return		1	4	1	4	2	4	2	4	1	4	1	4	2	4	2	4
9	Kerbside box collect and box return		1	4	1	4	2	4	2	4	1	4	1	4	2	4	2	4
10	Slave wheeled bin collect		1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4
11	Slave bag/box collect		1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4

		Low housing density								*High housing density*							
		Low env. risk				*High env. risk*				*Low env. risk*				*High env. risk*			
		Low mass		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*		*Low mass*		*High mass*	
Component		***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***	***P***	***C***
12 Wheeled bin collect and bin return		1	4	1	4	2	4	2	4	1	4	1	4	2	4	2	4
13 Disposable bags empty		1.5	4	1.5	4	1.5	4	1.5	4	1.5	4	1.5	4	1.5	4	1.5	4
14 Reusable bags empty		1.5	4	1.5	4	1.5	4	1.5	4	1.5	4	1.5	4	1.5	4	1.5	4
15a Big wheeled bins empty	Euro	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4
15b	Palladin	1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4
16 Food waste empty		1.5	4	1.5	4	2	4	2	4	1.5	4	1.5	4	2	4	2	4
17 High-rise slave sacks empty		1	4	1	4	1	4	1	4	1	4	1	4	1	4	1	4
18 Wheeled bins empty		1.5	4	1.5	4	1.5	4	1.5	4	1.5	4	1.5	4	1.5	4	1.5	4
20 Stillage box sort and empty (collect and sort)		1.5	4	1.5	4	2	4	2	4	1.5	4	1.5	4	2	4	2	4
21 Stillage box sort and empty (separate collect and sort)		1.5	4	1.5	4	2	4	2	4	1.5	4	1.5	4	2	4	2	4
22 Slave wheeled bin empty		1.5	4	1.5	4	1.5	4	1.5	4	1.5	4	1.5	4	1.5	4	1.5	4
23 Walking to and from collection point		1	4	1	4	1.5	4	1.5	4	1	4	1	4	1.5	4	1.5	4
26 Emptying collection vehicle		2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4

Table D114 Post-collection hazard ratings for the workplace transport hazard category

			Acute		*Chronic*	
Component			***Prob.***	***Cons.***	***Prob.***	***Cons.***
Transfer/bulking station						
1a	Inward vehicle movements	RCV	2	4		
1b		Stillage	2	4		
1c		Kerbsider	2	4		
2a	Unloading vehicle	RCV	1	4		
2b		Stillage	1	4		
2c		Kerbsider	1	4		
3	Handling heavy/hazardous waste		1	4		
4	Loading lorries		1	4		
5	Onward vehicle movements		2	4		
6	General housekeeping		2	4		
MRF						
1a	Inward vehicle movements	RCV	2	4		
1b		Artic	2	4		
2a	Unloading vehicle	RCV	1	4		
2b		Artic	1	4		
3	Pre-sorting materials		2	4		
4	Loading material onto conveyors and mechanical sorting		1	4		
6	Baling materials		1	4		
7a	Storage of recovered fractions	Fork-lift	1	4		
7b		Shovel loader	1	4		
8a	Loading lorries	Fork-lift	1	4		
8b		Shovel loader	1	4		
9	Onward vehicle movements		2	4		
10	General housekeeping		2	4		
MBT						
1a	Inward vehicle movements	RCV	2	4		

			Acute		*Chronic*	
Component			***Prob.***	***Cons.***	***Prob.***	***Cons.***
1b		Artic	2	4		
2a	Unloading vehicle	RCV	1	4		
2b		Artic	1	4		
3	Visual inspection of waste		2	4		
4	Loading material into sorting drum and mechanical sorting		1	4		
5	Loading material into a vehicle		1	4		
6	Unloading transfer vehicle at compost tunnel		1	4		
7	Loading material into hopper		1	4		
8	Opening and closing doors of in-vessel		1	4		
9	Transferring material between vessels and to maturation pad		1	4		
12	Loading material into screener/miller		1	4		
13	Loading lorries		1	4		
14	Onward vehicle movements		2	4		
15	General housekeeping		2	4		
In-vessel composting						
1a	Inward vehicle movements	RCV	2	4		
1b		Stillage	2	4		
1c		Artic	2	4		
2a	Unloading vehicle	RCV	1	4		
2b		Stillage	1	4		
2c		Artic	1	4		
3	Manual pre-sorting		2	4		
4	Loading material into shredder		1	4		
5	Loading material into bulk container		1	4		
6	Opening and closing doors of in-vessel		1	4		
7	Loading first vessel		1	4		
8	Transferring material between vessels and to maturation pad		1	4		
11	Finished product taken to stockpiles		1	4		

Component			***Acute***		***Chronic***	
			Prob.	***Cons.***	***Prob.***	***Cons.***
12	Screening material and bagging finished product		1	4		
13	Loading lorries		1	4		
14	Onward vehicle movements		2	4		
15	General housekeeping		2	4		
Open windrow composting						
1a	Inward vehicle movements	RCV	2	4		
1b		Artic	2	4		
2a	Unloading vehicle	RCV	1	4		
2b		Artic	1	4		
3	Manual pre-sorting		2	4		
4	Loading material into shredder		1	4		
5	Loading material into truck to be taken to windrows		1	4		
6	Loading material onto windrow		1	4		
7	Monitoring compost process (temperature/visual observations)		2	4		
9	Finished product taken to stockpiles		1	4		
10	Screening material and bagging finished product		1	4		
11	Loading lorries		1	4		
12	Onward vehicle movements		2	4		
13	General housekeeping		2	4		
Incineration						
1a	Inward vehicle movements	RCV	2	4		
1b		Artic	2	4		
2a	Unloading vehicle	RCV	1	4		
2b		Artic	1	4		
4	Delivery of hazardous substances in bulk		1	4		
5	Removal of by-products		1	4		
6	Onward vehicle movements		2	4		

	Acute		Chronic	
Component	***Prob.***	***Cons.***	***Prob.***	***Cons.***
7 General housekeeping	2	4		
Landfill				
2 Reversing	2	4		
3 Tipping collection vehicle	1	4		
4 Driving compaction vehicles	1	5		
5 General housekeeping	2	4		

APPENDIX E TRIAL OF THE RISK COMPARATOR TOOL

E1 INTRODUCTION

This appendix describes the work carried out for the fifth work package. It describes the results of a limited trial with a prototype of the Risk Comparator Tool with a small sample of Local Authorities (LAs). It provides details of the trials, including the feedback gathered with regards to usability of the tool and utility of the resultant information.

The objective of the trials was to give a sample of LAs the opportunity to explore the tool, and provide feedback to HSL, with regards to usability of the tool and utility of the resultant information.

E1.1 STRUCTURE OF APPENDIX E

The remainder of this appendix is structured as follows:

- Section E2 describes the approach taken for the trials;
- Section E3 presents overall results; and
- Section E4 summarises the findings.

Findings from individual trials are presented in a number of annexes to this appendix.

E2 METHOD

Participating Local Authorities (LAs) were selected following an email request for volunteers. Efforts were made to include LAs for both rural and urban areas. Four trials were arranged, one in England, two in Scotland and one in Wales. Each LA was briefed before the trial, with HSL suggesting that information regarding housing density and waste collected (tonnage) may be useful for the trial.

Each trial was designed to last around half a day, and involve LA employees (involved in the decision making process). The trial began with introductions between the HSL researchers and the LA representatives. Although some participants were aware of the work to develop the Risk Comparator Tool, the trial began with a presentation of the background to the tool's development. (See Annex E1 for the project overview received by the LAs).

HSL then demonstrated the tool using two pre-determined scenarios: a wheeled bin collection system, and a disposable bag collection system. HSL explained the information required for inputting into the tool throughout the demonstration, answering any questions as appropriate. The two demonstration scenarios were constant throughout all trials.

The LA were then given the opportunity to apply the tool to their specific situation, utilising (their) genuine data. Throughout the trial, LA questions and feedback were recorded. An additional amount of time was made available towards the end of the trial for further questions, thoughts and feedback.

For a detailed schedule of the LA trials see Annex E2.

E3 RESULTS

E3.1 LA BACKGROUND

Of the four Local Authorities taking part in the trial, two were responsible for waste collection in both rural and urban areas, one was responsible for rural areas and one for urban areas only.

Two LAs had recently implemented a new waste collection system, whilst two LAs had not implemented a new collection system recently.

E3.1.1 Remit of areas of responsibility

One LA only had influence over household waste material collection, with the county waste disposal authority dictating the options for post-collection. The LA could decide on both the collection and post-collection methods for recyclable materials.

Three LAs were unitary authorities, with both waste collection and disposal responsibilities. In some cases disposal came under the remit of private contractors.

E3.1.2 Decision making process

Across the four trials, common aspects considered during the decision making process were:

- Economic viability;
- Environmental sustainability;
- All known industry best practice;
- Container and vehicle options available;
- Number and age of crew members required to operate the system;
- The types of roads and housing typical to the area;
- Health and safety implications of implementing a new system (e.g. increased manual handling risk);
- The compromise required between householders and waste professionals' wishes and requirements; and
- Guidance on the HSE website.

The most suitable options would be selected, and a report presented to a committee of council members to seek approval, and make the final decision. LAs will also monitor other similar councils across the area and private industry to gain knowledge of their experiences of a given system.

It was acknowledged that although consideration is given to the health and safety risks associated with systems under proposal, no *systematic* consideration is given to the health and safety risks.

E3.1.3 Current waste system

Of the four LAs involved in the trial:

- One LA currently operates a weekly, wheeled bin collection of household waste. A brown bin scheme is also in operation to collect garden refuse and is operated biweekly. The kerbside scheme currently includes a green box to collect cans, glass, and clean foil, a blue bag to collect paper and a white bag to collect textiles. The recyclable material is sorted at the kerbside. The LA operates the residual and garden waste collection schemes whilst the kerbside collection is contracted out.

- One LA currently operates a weekly general waste collection utilising 240 l wheeled bins and a fortnightly garden waste collection, also utilising 240 l bins. A fortnightly recyclables collection utilising kerbside recycling boxes for glass and cans, and bags for paper and card was also in operation.
- One LA currently operates a kerbside collection (approximately 70,000 properties), with 3 colour glass, steel, aluminium, cans, plastic bottles, newspapers and cardboard all collected.
- One LA currently operates a weekly general waste collection, with a fortnightly recyclables collection. A bar code system, which was designed to include applications such as the provision of bin damage reports (so damaged bins can be replaced more efficiently) has also been implemented.

E3.2 PERCEIVED USES OF THE RISK COMPARATOR TOOL

Across the four trials, LAs suggested the Risk Comparator Tool could be used:

- To consider the health and safety risks to LA employees, and sub-contract workers involved in waste collection, treatment, processing and disposal operations; and
- To compare different systems proposed in response to tenders (highlighting areas of increased risk, and focusing attention on the control measures adopted to reduce the risks).

E3.2.1 To aid the risk assessment process

- To use as an aide-memoir when doing risk assessments.
- To prioritise the activities or hazards that need addressing first, based on the numerical score given.
- To ‘generate ideas’, i.e. identify relevant activities or hazards not previously considered (or that may have been overlooked).
- To give an indication of the relevant risks before a detailed risk assessment is carried out.

E3.2.2 Decision making

There was a general agreement that decisions regarding waste system selection are affected by politics, with a current emphasis on environmental considerations, and less emphasis on health and safety considerations.

- LAs who had recently been through the decision-making process suggested the tool could have been applied to provide an additional system analysis input to the strategic decision-making process. From a strategic viewpoint the tool was considered to give an indicator as to which is the safer system.
- Conversely, it was suggested the tool could be used to demonstrate why the decision was made not to implement a suggested change.

E3.2.3 Other Uses

- A suggested use for the Risk Comparator Tool was to illustrate to unions the benefits (i.e. in reduced risk) of a new or proposed system or change.

E3.2.4 Improvements

- It was generally agreed that for the Risk Comparator Tool to be constructive, it would be required before changes to a system were implemented. Therefore a method for marrying the environmental considerations with the risk ratings (i.e. tool output) would encourage a LA to consider aspects of the proposed system with regard to both environmental and health and safety aspects.
- Vehicle choice was considered to be a major consideration of LAs, and it was felt that results of the tool would not reflect differences in the vehicles used. This was frequently highlighted as an improvement that could add validity to the tool outputs.

E3.2.5 Other information

LAs stated it would be useful for them to see further information on the hazards (i.e. descriptions and rationale for inclusion in the tool). One LA was in the process of rewriting their health and safety booklet, and thought the information on the hazards identified would be useful.

The Risk Comparator Tool was thought to be useful because LAs do not necessarily have a standard system, and may ‘cobble’ together bits from different systems.

E3.3 LA FEEDBACK

E3.3.1 Inputs to the tool

E3.3.1.1 Accuracy of figures and information

Some LAs raised concerns about the input of inaccurate figures. It was felt that some of the information required by the Risk Comparator Tool may not be readily available, and LAs were unsure as to the impact this would have on the validity of the results. Where the information *was* readily available, this was due to the LA already having been through the consideration and decision making process (thus perceiving that the Risk Comparator Tool would be of less use to them until the system required updating). In addition:

- LAs stated they would not necessarily know details regarding the activities occurring during the post-collection phase.
- Concerns were raised regarding how to calculate the ‘mass in containers’, ‘set-out rates’ and ‘environmental risk’. It was agreed assistance (i.e. guidance thresholds) would be useful when making this judgement, adding validity to the tool for LAs in general.

E3.3.1.2 Usability

- When highlighting the system components, on the *Components* screen of the tool, there was some confusion caused by the automatic highlighting of ‘high-rise bags’ when ‘collection receptacle’ was selected.
- Irrespectively, the Risk Comparator Tool layout was considered to be user-friendly, with no suggested improvements to the input page. LAs found there were not too many

questions to be answered, and felt that as long as the information required was known, the tool could be used fairly quickly and easily.

E3.3.1.3 Limitations

- LAs commented on the inability to select or otherwise capture differences between collection vehicles (including variation in bin-lift mechanisms, and how they are operated), waste streams, and the frequency of reversing vehicles. Although it was recognised as being difficult to capture, these features were believed to have an impact on the hazards and levels of risk.
- LAs questioned the Risk Comparator Tool's ability to make direct comparisons e.g. changing a bin collection system to a black bag collection system. It was stated that rounds are typically bigger and take longer when using bins as opposed to bags, and questioned whether this was taken into account by the tool.

E3.3.1.4 Other responses

- LAs raised the variability of weather in their vicinity (in comparison to other LAs), and questioned whether this was taken into account in the risk rating.
- LAs also questioned whether the number of times cabs are entered and exited is 'hardwired' into the tool (this will typically increase in urban, and decrease in rural areas).

E3.3.2 Presentation and utility of the results

E3.3.2.1 Interpretation of information

- Throughout the trial, the majority of LAs asked for clarity regarding interpretation of the resultant risk ratings, both overall and in the results tables. (e.g. is the number 'out of something'? and what is a 'good' or 'bad' rating?) Guidance providing explanatory bands (e.g. x represents a high risk) was suggested.
- LAs generally found the results tables to be more meaningful than the overall 'risk rating' score, with most LAs agreeing that the results tables contained useful information (e.g. organisation of the hazards by the activity they were associated with).
- The information was thought to be difficult to compare quickly. As a *comparison* tool, it was thought the differences between two systems (entered into the Risk Comparator Tool) should be more apparent. It was noted that making comparisons would be difficult via the computer screen and would require the LA to print out the results pages, before 'trawling' through them.
- As an alternative, LAs suggested a colour coding system either highlighting any differences in the risk ratings or activities between two alternatives, or simply highlighting 'significant' differences in hazards or activities.
- In addition, a suggestion was made to present a summary page of the risk rating results table, with the opportunity to access further information (e.g. exposure, probability and consequence ratings) if desired. This was considered likely to focus the user in on the relevant information only, i.e. the risk rating numbers.

E3.3.2.2 Suggested Improvements

- LAs questioned whether the Risk Comparator Tool could (at some point) be incorporated with other tools currently in use (e.g. life cycle analysis tool, which gives an environmental assessment).
- LAs also questioned the flexibility of the Risk Comparator Tool i.e. for entering details of new systems into the tool, or for the ability of the LA to adapt the 'back end' of the tool (e.g. to remove hazards or activities which are of no relevance to the individual LA).

E3.3.3 Additional Information

- LAs were surprised to find that the difference between the risk ratings for two different scenarios were not as big as would be expected.
- One LA commented on the relevance of including the activity of riding on a footplate, due to this being an illegal activity.
- LAs highlighted that the Risk Comparator Tool failed to consider the health and safety of members of the public, something which would be part of their considerations during the decision making process.
- The input box for the Risk Comparator Tool would not accept '01' in place of the value '1'.
- Once the results have been saved it is not possible to check which components were highlighted in the 'setup components' section of the Risk Comparator Tool, as the options become 'deselected'.

Overall the majority of the LAs were of the opinion that they would use the Risk Comparator Tool. Primarily this was likely to be part of the strategic decision making process, and as a consequence the Risk Comparator Tool may be used infrequently (e.g. once every 3 to 4 years). Concerns were raised as to the contemporary nature of the information captured and the level of flexibility within the Risk Comparator Tool (for including future waste collection systems). LAs perceived the tool would be most beneficial if there was provision for them to remove irrelevant hazards and activities from the back end of the tool.

For detailed information regarding each of the four trials see Annexes E3 to E6.

E4 CONCLUSIONS

E4.1 SUMMARY OF FINDINGS

LA background

The four trials were organised to include a variety of rural and urban Local Authorities from England, Scotland and Wales.

Decision making process/ remit of areas of responsibility

Across the trials, LAs suggested a number of factors that they take into consideration during the evaluation of waste and recyclables management systems and decision-making process.

Variability between the remits of different LA responsibilities meant some LAs were responsible for both collection and disposal, whilst other LAs were only responsible for collection.

Current waste system

A variety of waste systems were found across the different LAs, with some LAs recently having reviewed and implemented new systems.

Perceived uses of the Risk Comparator Tool

Across the trials, LAs suggested a variety of uses for the Risk Comparator Tool. Essentially these were:

- To help with strategic decision-making;
- An aid to the risk assessment process; and
- To increase visibility of internal/business processes (e.g. decisions between different systems proposed, or rationale behind a decision not to choose a specific option).

LA feedback

Inputs to tool:

- Concerns were raised as to the importance, and accessibility of accurate data for inputting into the front end of the Risk Comparator Tool.

Presentation and utility of results:

- The general response during the LA trials was that the Risk Comparator Tool output contained useful information, but that the information was not currently in a user-friendly format.
- Suggestions for improvements were aimed at improving the usability of the Risk Comparator Tool output, both through the provision of guidance and improved organisation of the information.

E4.2 LIMITATIONS

There were a number of limitations associated with these trials:

- Due to time and budgetary constraints, the sample used was limited in number. The opportunity sampling method employed allowed the work to be completed within the allocated timeframe, but therefore restricts the generalisability of the trial findings.
- The version of the Risk Comparator Tool utilised throughout the trials was a prototype (and still undergoing development). As a result, some of the feedback received was no longer relevant due to updates already made to the Risk Comparator Tool.

E5 ANNEX E1 – RISK COMPARATOR TOOL LA INPUT REQUIREMENTS

Exposure rating

Exposure to the hazard is calculated dynamically and is based on LA inputs and hard-wired factors. For collection systems this is calculated from:

Exposure frequency = *number of households* ×
number of collections (per defined period of time) ×
set-out rate (proportion) ×
activity specific modifier

where the *number of households, number of collections* and *set-out rate* are LA inputs and the *activity specific modifier* is a hard wired factor.

Localisation factors

The Risk Comparator Tool uses three key localisation factors: housing density, environmental risk and container weight. The LA must select how each of these is distributed:

- ***Housing density*****:** this is defined as falling into one of three density categories. The proportion of households falling in each of the three density categories is required. Therefore three values are required to be entered, and the total must sum to 1.
- ***Environmental risk factor*****:** the proportion of households falling into one of three environmental risk categories, high, medium or low. For each housing density category it is necessary to estimate the proportion falling into each risk category, and the total across the 3 categories must sum to 1. Guidance will be produced that will allow LAs to estimate overall environmental risk factors based on the road types, traffic density and terrain.
- ***Container weight*****:** the amount of material in the container of interest needs to be estimated. This has been defined as the proportion of households having containers for collection that are light, average or heavy. Again the methodology will allow for this distribution to vary across the housing types. Therefore, for each housing density the proportion of households with containers falling into each weight category needs to be estimated, and the total across the categories for each housing density must sum to 1.

The requirements for LA localisation factors input data is summarised in Table E1. It is important to stress that each group of three factors, as illustrated by the colouring, must sum to one. LA input requirements are summarised in Table E2.

Table E1 Local Authority localisation factors

Housing density		***Mass in receptacle***			***Environmental risk***		
	Proportion	Light	Average	Heavy	Low	Medium	High
Low	🟩	🟦	🟦	🟦	🟨	🟨	🟨
Medium	🟩	🟨	🟨	🟨	🟦	🟦	🟦
High	🟩	🟦	🟦	🟦	🟨	🟨	🟨

Table E2 Summary of Local Authority input requirements

Input required	***Description***
Number of households	LA to input the total number of houses they collect from. This figure should remain the same to compare different systems. Flats will have to be dealt with separately if they are operating a large bin collection.
Number of collections per household	LA to input the number of collections performed for each household in a defined period of time. E.g. if kerbside box collections occur bi-weekly, for that system the number of collections per household, per year will be 26.
Mass of waste/recyclables	LA to input the tonnage of material collected from households for the given system, e.g. residual waste collection.
Housing density	LA to estimate what proportion of the household are in a low, medium or high density bracket. Decimal numbers of up to 1 decimal place are entered and should add up to 1, e.g. 50% (0.5) of collections are from high housing density areas, 40% (0.4) are from medium areas and 10% (0.1) are from low areas.
Set-out rate	LA to input the estimated set-out rate for each of the low, medium, and high housing density categories. This allows for set-out to be indicated for each type of household.
Mass in container	LA to input for each level of housing density the estimated level of container mass proportionally split between low, medium, or high. Decimal numbers of up to 1 decimal place are entered and should add up to 1, e.g. 0.5, 0.4, 0.1 = 1
Environmental risk*	LA to input for each level of housing density the estimated level of environmental risk proportionally split between low, medium and high. Decimal numbers of up to 1 decimal place are entered and should add up to 1, e.g. 0.5, 0.4, 0.1 = 1

*Environmental Factors

Risk level	***Terrain***
Low	Flat to moderate gradients with even surfaces
Medium	Flat to moderate gradients with uneven surfaces or steep gradients with even surfaces
High	Steep gradients with uneven surfaces or frequent use of stairs

Risk level	***Road Category***
Low	Low speed (< 30mph), any traffic density
Medium	Medium speed, sparse to free flowing
High	High speed (>50 mph), sparse to free flowing

E6 ANNEX E2 – PROGRAMME FOR LA TRIALS

Anticipated visit would last ½ day.

Prior to visit need to ensure that all relevant individuals e.g. decision makers will be present. Also need to ensure relevant information e.g. housing density, tonnage, is at hand.

Introductions

LA to begin by giving HSL an overview of their current decision making process when selecting a particular system, e.g:

- What considerations inform your choice?
- Who is involved in the decision process (e.g. health and safety, waste industry contractors) and how do they decide?
- On basis of information sent to LAs prior to visit, ascertain what is their understanding so far of the Risk Comparator Tool and its purpose. (Assume that once tool is implemented similar information will be given out prior to use. Therefore, will help check this information is functional and not leading to misconceptions.)

HSL to present background to work followed by brief overview of project and associated aims. Brief overview of Risk Comparator Tool and its intended purpose.

Test of tool

Initially HSL demonstrate how to use Risk Comparator Tool using a predetermined scenario.

Details required for inputting into the Risk Comparator Tool:

1. How many households/ numbers of bin stores (i.e. collective bins for flats) are there in the defined area?
2. How many collections are there per household (in the time period stated).
3. Mass of waste (total amount, in tonnage) collected from all houses in the time period stated?
4. Housing density? (should total 1)
5. Set-out rate? (0 – 1 for each)
6. Mass in containers? (should total 1)
7. Environmental risk? (should total 1)

Use 2 to 3 predetermined scenarios to input themselves whilst being observed by HSL. Get them to talk us through what they are doing and why, and how easy/difficult they are finding the process.

Get them to do a comparison e.g. collecting same material in different receptacles (get them to choose the appropriate components for this).

Finally, allow them to use the Risk Comparator Tool using their own choice of systems in order to get a comparison between using the Risk Comparator Tool and their current method of selection.

Results

- Ask them to tell us their understanding of the results. Can they interpret the values given? E.g. for comparisons, on the basis of these outputs, can you tell us which system you would choose and why?
- How easy is it to interpret the results (do they get it right)?
- Would you or how do you think you would use this information?
- Discuss possible deterrents to use e.g. time, costs, ease of use, and ease of interpretation; do they think HSE would need to deliver training on use?

Questions regarding usability

- How did you find using the Risk Comparator Tool?
  - Calculating/ finding the data (i.e. was the information readily available?)
  - Inputting data: easy/ intuitive?
  - Easy to understand results? (in their opinion)
- Would guidance be required to effectively explain how to use the Risk Comparator Tool?
  - What aspects should be covered?
- How useful do you perceive the results to be?
  - Do the results make sense?
  - Can they be used in conjunction with other data? (e.g. budgetary information)
- How do you think you would use the data? (how would you want to use this type of data?)
  - To compare different (potential) collection systems?
  - To compare different (potential) post-collection systems?
  - To compare different elements in similar systems?
  - To compare different contractors/ bids?
- What would make the data more useful?
  - Different organisation of the results?
  - Additional information required?
  - Further explanation of the meaning/ interpretation of the results?

Finish up

½ hour to review the session, e.g. how easy/difficult they found the Risk Comparator Tool to use and interpret, and any suggestions they have for improvement.

Allow time for any questions and other comments.

E7 ANNEX E3 – LA TRIAL WRITE UP: ENGLAND

E7.1 LA BACKGROUND

People present :

- Health and safety officer
- Waste manager

The Local Authority (LA) selected for the England trial collects waste and recyclable material from approximately 35,000 households. The collection area covers a combination of rural and urban locations.

This LA currently operates a weekly, wheeled bin collection of household waste. A brown bin scheme is also in operation to collect garden refuse and is operated bi-weekly. The kerbside scheme currently includes a green box to collect cans, glass, and clean foil, a blue bag to collect paper and a white bag to collect textiles. The recyclable material is sorted at the kerbside. The LA operates the residual and garden waste collection schemes whilst the kerbside collection is contracted out.

Decision making process

In terms of the residual waste collection the LA only has influence over how the material is collected. The county waste disposal authority dictates the options for post-collection disposal. In terms of recyclable material, the LA can choose both the collection and post-collection methods.

Currently the LA bases its decision on the most economically viable and the most environmentally sustainable option. This means they would not necessarily go with the cheapest option if it did not meet their environmental requirements.

A full health and safety report is requested as part of the tender process. Whilst the health and safety report is reviewed, no systematic consideration is given to the health and safety risks associated with the different systems under proposal.

The responses to tender are judged against an evaluation model and those considered viable will be included in a report along with the LA preferred option. The report is presented to a committee of council members to seek approval to award the contract to the preferred option. The committee will make the final decision.

The LA will monitor other similar councils across the area, and private industry to gain knowledge of their experiences of a given system.

E7.2 LA FEEDBACK

Perceived uses of the tool

The LA believed that the information contained within the tool could be of use in a number of ways:

- To consider the health and safety risks to LA workers involved in waste collection, treatment, processing and disposal operations.
- To consider the health and safety risks to sub-contract workers involved in waste collection, treatment, processing and disposal operations.

- To compare different systems proposed in response to tenders. It was felt this would highlight areas where there is an increased risk and focus attention on the control measures adopted to reduce the risk.
- To use as an aide-memoir when doing risk assessments.
- As part of the risk assessment process to prioritise the activities/hazards that need addressing first, based on the numerical score given.

Inputs to the tool

There were concerns raised about the input of inaccurate figures. It was felt that some of the information was not readily available and they felt unsure as to the impact this would have on the tool's validity. They also stated that they would not necessarily know what activities occur during the post-collection phase.

Presentation and utility of the results

The LA found it useful to see the range of hazards associated with a given activity but felt that the presentation of the information could be improved, for example, colour coding hazards by risk. They felt that it would be easier to compare different scenarios with the use of colours. It was also felt that there was a lot of information to take in and in its present format it looked quite daunting.

Additional information

The LA commented on the relevance of including the activity of riding on a footplate, given that it is illegal.

E8 ANNEX E4 – LA TRIAL WRITE UP: SCOTLAND (I)

E8.1 LA BACKGROUND

People present:

- Waste manager
- Collections manager
- Health and safety officer

Decision making process/ remit of areas of responsibility

Following a reorganisation in 1996, Scotland now consists of 32 unitary authorities, with even the smaller councils having both waste collection and disposal responsibilities.

This LA had recently completed the roll-out of a new system. Review of, or changes to the systems tend to be legislative or politically driven, taking into account what they have to do, and the practicalities.

They had considered a ‘waste minimisation system’, as well as a recycling system. However it was agreed that health and safety considerations were relatively low down the list of initial considerations, but that once a system had been selected health and safety is considered. This LA also talked to other councils, and shared their risk assessments. They were also involved in discussions through the North East Waste Group regarding how and what schemes are used by others.

The assumption was that systems such as the ‘kerbside box collect’ was widely used, and so any major problems would already have been identified/minimised.

Current waste system

This LA’s current system consisted of kerbside collection (approximately 70,000 properties), 3 colour glass collection, steel, aluminium, cans, plastic bottles, newspapers and cardboard.

Perceived uses of the tool

- The tool could be used for a system analysis, and help in the strategic decision making process.
- The tool could either be used as a ‘one-off’, when something changes, or even when things are not changed (i.e. to demonstrate why they cannot implement the changes requested).
- The tool was thought to be useful due to the way LAs do not necessarily have a standard system, and may ‘cobble’ together bits from different systems.
- The tool would help with ‘measurements’ that would then be reported to the committee.
- The LA also stated it would be useful for them to see further information on the hazards (i.e. descriptions and rationale for inclusion etc). (The LA are currently in the process of rewriting their health and safety booklet, and thought the information on the hazards identified etc would be useful).
- The LA agreed that decisions regarding waste system selection are affected by politics, with a current emphasis on environmental considerations, and less emphasis on health and safety considerations. The LA agreed the tool would be required before changes to

a system were implemented, and therefore a method for marrying the environmental and risk ratings would encourage a LA to consider what they are doing, and how, with regard to both environmental and health and safety aspects.

- Vehicle choice was considered to be a major consideration for LAs, and it was felt that results of the tool would not reflect differences in the vehicles used.

E8.2 LA FEEDBACK

Inputs to the tool

- The LA raised the variability of weather in their vicinity (in comparison to a LA down south), and questioned whether this was taken into account in the risk rating.
- This LA said they would not currently know the 'mass in containers', and would need to go out and measure this for an accurate answer (although this should not be difficult to come across). It was agreed guidance would be useful on how this should be judged.
- The judgement of environmental risk was raised, with the LA asking what this should be based on (e.g. personal opinion). It was agreed guidance would be useful when making this judgement.
- Overall the inputs to the tool were not thought to be over-bearing.

Presentation and utility of the results

- Some concern was shown at the inability to amend details regarding the vehicles used (and therefore considered by the tool). This was especially relevant due to the use of vehicles requiring only a driver (and no crew) alongside a mechanically operated 'arm' (thus, reducing some risks, as the driver does not leave the cab).
- The LA questioned whether the tool could (at some point) be incorporated into other tools currently used (e.g. life cycle analysis tool, which gives an environmental assessment). It was agreed this would increase the tool's usefulness.
- The LA highlighted that, as a *comparison* tool, the differences between two systems should be more apparent. At present the tool would require either trawling through printed off tables or flicking between the onscreen tables. The LA suggested a colour coding system (highlighting 'significant' differences in hazards or activities).
- The LA questioned the flexibility of the tool (i.e. for entering details of new systems into the tool).

Additional information

The relevance of the 'stress' hazard was questioned, with an example quoted of individuals moving from a high-powered position to refuse collection, due to the lack of stress.

- LA suggested there were similarities between the tool, and a tool by Laidlock Associates HRN (Hazard Rating Number Tool).
- The LA asked whether the tool included street cleansing.
- The LA asked whether the scores are consistent with the results for the MAC tool?
- The input box for the tool would not accept '01' as '1'.
- The LA suggested that 'getting in and out of cab' should be amended to account for high and low rise cabs, left and right hand drives, side and back loading vehicles.

Physical fatigue and the hazards associated with traffic should also be taken into account for getting in and out of cabs.

- The LA's second scenario involved reusable bags. The LA were surprised that the risk rating was lower than for scenario one, as they 'thought kerbside stillage was more dangerous'.

E9 ANNEX E5 – LA TRIAL WRITE UP: SCOTLAND (II)

E9.1 LA BACKGROUND

People present:

- Waste collection and disposal manager, responsible for overseeing all household waste and recyclable collections and recyclable disposal processes.
- Operations officer, responsible for supervising city wide waste collections.
- Performance and development officer, responsible for the administrative functions of the collection systems.

Decision making process/ remit of areas of responsibility

In Scotland, collection comes under single unitary control by the LA. As a Unitary Authority, the LA visited had overall responsibility for waste collection. Disposal primarily came under the remit of private contractors. Historically, this process would have consisted of competitive tendering; generally the most financially competitive option would win. Whilst the disposal method used was essentially the responsibility of both the contractor and the LA, generally the LA would only become involved if a change were required. The current contract for disposal was a 20-year contract; however, renegotiations were currently in progress as a consequence of political changes (e.g. landfill directive).

The LA visited had not recently been through a decision-making process; the last implementation of a new collection system had occurred in 2001 when black bag collection was replaced by a fully containerised (wheeled bin) collection. The consultation process for this change was reported to have taken 2 ½ years. It consisted of a series of brainstorming sessions, involving strategy and working groups comprising the appropriate interested individuals. Attempts were made to consider health and safety aspects at every opportunity in addition to considering the most economically viable and the most environmentally sustainable option. Consideration regarding health and safety was given to:

- All known ‘industry best practice’;
- Container and vehicle options available;
- Manual handling considerations;
- Health and safety improvements that would be obtained relative to the previous system;
- Number of crew members that would be required to operate the system;
- Experiences of others in the same industry (e.g. types of injuries and problems experienced by other LAs associated with the same systems).
- Risk assessments were reviewed and where appropriate improved.

Current waste system

The system currently utilised by this LA consisted of a weekly general waste collection utilising 240 l wheeled bins and a fortnightly garden waste collection, also utilising 240 l bins. A fortnightly recyclables collection utilising kerbside recycling boxes for glass and cans and bags for paper and card was also in operation.

Perceived uses of the tool

- The tool could be used to supplement the risk assessment process, helping to focus in on relevant areas or highlight areas not previously considered (or that may be overlooked).
- The tool could be used to give a good indication of the risks applicable at the outset before going on to commence a detailed risk assessment.
- The tool could be used as a common base for people's judgement of the risks involved, as opposed to the current corporate risk assessment form, which can be just a desk-based task, and is open to individual interpretation.
- The LA could have applied this tool as an additional input to the strategic decision making process.
- From a strategic viewpoint the tool was considered to give an indicator as to which is the safer system.

E9.2 LA FEEDBACK

Inputs to the tool

- Generally, the LA found there were not too many questions to be answered, and felt that as long as the information required was known the tool could be used fairly quickly and easily.
- The tool layout was considered to be user friendly, with no suggested improvements to the input page.
- Although this LA had access to the information required for inputting into the tool (due to the recent review) it was commented upon that other LAs might not have access to this information.
- The LA commented upon the inability to select and distinguish between collection vehicles. This was believed to have a big impact on the hazards and levels of risk.
- Similarly, variation in bin-lift mechanisms and correspondingly, the way these mechanisms are operated, was noted to have been omitted from the tool. The LA considered such variation to impact upon the level of risk.
- The LA questioned whether they would be able to select and distinguish between different waste streams. It was noted that this was not possible just now and was believed to have an impact on the hazards and the level of risk (e.g. glass versus paper).
- The LA questioned how the tool could make a direct comparison between e.g. changing a collection system from a bag to bin. It was stated that rounds are typically bigger and take longer when using bins as opposed to bags.
- The activity of 'assisted lifts' was discussed and it was felt that this activity should be captured. However it was admitted that it would be difficult, as some rounds may have no assisted lifts compared to others that have a high proportion.

Presentation and utility of the results

- The LA noted that interpreting the results would require 'deciphering of the numbers at the back end'. On a positive note, it was stated that 'from a strategic point of view this would provide an indicator as to which is the safer system'.

- Concerns were raised regarding interpretation of the resultant risk rating. (E.g. 'the numbers are purely comparators, and do not mean anything'). It was suggested that the risk rating numbers should be placed in explanatory bands e.g. high risk, low risk.
- Concern was expressed about the volume of numbers presented in the results page, 'You are looking at too many numbers'. A suggestion was made that only a summary page of the risk ranking be presented first with the opportunity given to access further information, e.g. exposure, probability and consequence ratings if desired. This was considered likely to focus the user in on the relevant information only, i.e. the risk rating numbers.
- In its current format participants were of the opinion that the information was difficult to compare quickly and easily. It was noted that making comparisons would be difficult via the computer screen and would require the LA to print out the results pages.
- Overall, the results were regarded as 'far too generic' with not enough detail and therefore 'would not help with day to day stuff'.

Additional information

- The LA highlighted that the tool did not consider the health and safety of members of the public – something which would be part of their considerations during the decision making process.
- The LA suggested that the tool could be used alongside similar tools that they already use to consider environmental impacts e.g. the Sepa tool. However, it was also stated that such tools should essentially be kept apart and used to complement each other. The LA believed that there are no direct comparisons between environmental impact and health and safety considerations when choosing a waste management system.

Overall, this LA was of the opinion that they would use the tool, and that they could have the information required readily available to them. It was stated however that use of this tool was primarily likely to be as part of the strategic decision making process required when considering changing waste collection/processing systems. As a corollary it was anticipated that the tool might be used very infrequently e.g. only every 5-7 years. It must be noted that such infrequent use raises concerns about the contemporary nature of the information on waste and recyclable systems captured within the tool.

E10 ANNEX E6 – LA TRIAL WRITE UP: WALES

E10.1 LA BACKGROUND

People present:

- Collections supervisor, responsible for supervising roll-out of changes (to a single stream collection).
- Waste collection manager, responsible for seven supervisors, all collections and deliveries. Was involved in the whole process for developing the new waste collection system.
- Safety advisor, who was involved in the whole process of roll out meetings, had input to the redesign of the bin lifts, liaised with the workforce representatives (e.g. through workshops) and helped identify problem areas for improvement in the new system.

Decision making process/ remit of areas of responsibility

In Wales, collection and post-collection comes under single unitary control. As a Unitary Authority, the LA visited has responsibility for waste collection and disposal, which sit together. However this function can vary depending on the county.

The LA had recently been through the decision-making process, resulting in the implementation of a new system.

Historically, this process would have consisted of competitive tendering. However the recent process consisted of a series of brainstorming sessions, involving the appropriate interested individuals. Attempts were made to ‘build in’ health and safety aspects at every opportunity. Consideration was given to:

- The compromise required between householders and waste professionals’ wishes and requirements;
- All known ‘industry safe practice’;
- HSE website;
- The views and opinions of the HSE contact;
- Container and vehicle options;
- Age of workforce;
- Types of housing/ roads (and the associated mobility of vehicles) in the area; and
- The experiences of others in the same industry.

All risk assessments were reviewed and improved (e.g. this highlighted the need for dedicated vehicles to support the new waste collection system). The most suitable systems were then presented as options a, b, and c etc.

Current waste system

The system agreed on consisted of a weekly general waste collection, with a fortnightly recyclables collection. A bar code system, which was designed to include useful applications e.g. the provision of bin damage reports (so damaged bins can be replaced more efficiently), was also implemented.

Perceived uses of the tool

- The tool could be used to 'generate ideas' when carrying out risk assessments, helping to highlight areas not previously considered (or that may be overlooked).
- The tool could be used to highlight high 'risk figures' (areas) to focus on. Could also be used to identify 'chronic' risk areas to focus on.
- The tool could be used to illustrate to unions the benefits (i.e. in reduced risk) of a new or proposed system or change.
- The LA could have applied this tool to the eventual 3 options they suggested, as an additional input to the decision making process.

E10.2 LA FEEDBACK

Inputs to the tool

- Generally, the LA found there were not too many questions to be answered, and felt that as long as the information required was known, the tool could be used fairly quickly and easily.
- The layout was found to be okay, with no suggested improvements.
- Although this LA had access to the information required for inputting into the tool (due to the recent review) it was questioned whether other LAs would have access to this information.
- It was agreed that, for general waste, set-out was around 100%, whereas green waste set-out could be seasonal, and was also affected by the general waste/ green waste balance (i.e. more recycling results in less general waste).
- The barcode system recently implemented was identified as a way of recording set-out rates accurately (although it was recognised this would not be common across LAs in general).
- It was raised that LAs will ask how they are supposed to calculate the average mass of containers. It was suggested that guidance thresholds for the heavy, medium and light categories would add validity to the tool for LAs in general.
- The LA suggested splitting the waste collection authority and disposal authority functions (within the tool).
- The LA was unsure that the waste collection authority would know what the disposal authority does (i.e. leachate treatment etc).
- There was some confusion caused by the automatic highlighting of 'high-rise bags' when 'collection receptacle' was selected.
- The LA questioned whether they were able to select and distinguish between collection vehicles. This was believed to have a big impact on the hazards and levels of risk.

- The LA questioned whether the input information would be available if the tool was being used to calculate the risk rating for a ‘proposed new system’ (i.e. where the set-out rates and weights of containers etc were unknown).
- The LA questioned whether the number of times cabs are entered and exited is ‘hardwired’ into the tool (this will typically increase in urban, and decrease in rural areas).
- It was suggested that additional entries to cover the frequency of ‘reversing vehicles’, and collection (from rear lanes) would greatly improve the relevance of the tool, and the resultant outputs.

Presentation and utility of the results

- The LA were surprised to find that the difference between the risk ratings for two different scenarios were not as big as expected.
- The question was raised regarding interpretation of the resultant risk rating. (e.g. is the number ‘out of something’? what is a good/ bad rating?).
- The results tables were found to be more meaningful than the overall ‘risk rating’ score, and was thought to help channel energies into areas where a difference can be made.
- Tables were suggested as a more useful format, from which areas could be identified, and groups of relevant people organised for brainstorming sessions.
- Results cannot be used to compare the risk on an urban versus a rural round.
- Can the ‘back end’ of the tool be adapted (e.g. to remove hazards/ activities which are of no relevance to the individual LA)?

Additional information

- The LA suggested guidance statistics should be provided (possibly hardwired into the tool). The general consensus was that national average statistics would be useful, and there would not be much variation between LAs. The Association of Public Service Excellence was suggested as a source for useful statistical data.
- The LA highlighted that the tool did not consider the health and safety of members of the public – something which would be part of their considerations during the decision making process.

Overall, this LA would use the tool, and have the information required readily available to them. They would benefit most from using the tool, if there was provision for them to remove irrelevant hazards and activities from the back end of the tool.

APPENDIX F GOOD PRACTICE GUIDANCE

F1 INTRODUCTION

F1.1 BACKGROUND

HSE guidance material covers a range of hazards that is targeted at different industry sectors. The WISH forum has worked hard over recent months to produce material specific to the waste industry. To supplement the work already done, additional guidance has been produced to cover some areas more in-depth, as part of this project.

F1.2 AIMS AND OBJECTIVES

The aim of this section of the project was to draw out principles of good practice and produce a set of guidance material relevant to the waste management industry that did not duplicate what had already been produced.

For each topic the aim was to draw out the relevant hazards, the points in the waste management industry where they are an issue, and how they occur. Key controls and principles of good practice in managing the risk from these hazards were also to be drawn out. The guidance signposts to other published, more detailed, guidance where available.

F2 APPROACH

The guidance currently available to the waste industry was reviewed to identify areas where additional guidance would be of use. The guidance currently available looks at a number of different aspects of the waste industry such as safety at bring sites, green waste collection (health issues) or safe use of skip loaders. Most of the key risk areas within the waste industry were already covered. Therefore, it was decided, through consultation with the Project Management Board and Project Advisory Committee, to focus on some key hazards, and cover them in more detail, to improve understanding of these hazards and the kinds of controls that might be used.

The key hazards were selected by members of the project group, and were subsequently distributed to the project advisory members for feedback. Generally, the project advisory members were supportive of the chosen topics. The hazards identified from this process for which guidance has been produced are:

- Manual handling
- Slips and trips
- Microbiological

It was also decided that guidance should be produced on psychological factors – to incorporate issues such as:

- stress, fatigue and violence.

Stress, fatigue and violence all have the potential to adversely affect the health and safety of industry workers if not properly managed and controlled. There was found to be no existing guidance on these issues specific to the waste and recyclables industry. This is an industry where task and finish is prevalent. This practice may produce fast paced work and heavy workload and has the potential to contribute to stress and fatigue if not properly managed and controlled. Guidance on task and finish is currently being produced by WISH, but this does not really address the aspect of stress and fatigue brought about by this practice.

Finally it was decided to produce good practice guidance focusing on:

- Generic good practice principles.

A number of general good practice principles, for example those concerning risk assessment, communication, work practices, and behaviour, can be applied to all aspects of waste management industry work, including the hazard areas detailed above. It was considered useful to detail such principles in one overarching guidance document.

HSL has a broad range of research capabilities, and can draw on the knowledge and skills of a wide variety of health and safety professionals to address occupational health and safety problems involving human factors and psychosocial issues. The guidance produced represents current thinking of what constitutes good practice, in line with current HSE legislation, for the control of hazards in the waste industry.

F2.1 MANUAL HANDLING

It is known that manual handling activities can increase the risk of a musculoskeletal disorder (MSD), such as back plain. To reduce work related ill health caused by an MSD is one of the Health and Safety Executive's (HSE's) key target areas.

The guidance on manual handling, illustrated in Annex F1, focuses on the two areas of the waste industry where work is predominantly manual: collection and hand sorting at a Material Recycling Facility (MRF). It provides information on the factors that are known to affect the risk of injury when handling, and suggests appropriate control methods that illustrate best practice. The best practice control methods identified draw upon HSL's expertise in the area of manual handling. This expertise includes extensive research into manual handling activities in both the collection and MRF phases.

F2.2 SLIPS AND TRIPS

Slips and trips is another key target area for the HSE to reduce work related injuries. Slips and trips can be a contributing factor to injury from other hazards such as manual handling. This guidance was produced in consultation with the Pedestrian Safety Section of HSL, who have extensive experience in understanding the causes of slips and trips. The guidance draws upon previous HSL research, which looked at work that involved traversing public highways and byways on foot. This research was utilised to produce general good practice guidance illustrated in Annex F2, in line with current HSE guidance.

F2.3 MICROBIOLOGICAL

The guidance on microbiological hazards, illustrated in Annex F3, focuses on the areas of the waste industry where workers are exposed to microbiological health risks. This guidance was produced in consultation with the Health Exposures Section of HSL, utilising expertise in the field of microbiology. It provides information on the factors that are known to affect the risk of ill health. Waste material naturally has micro-organisms in it and some processes (such as composting) rely on large numbers of micro-organisms being present. Collecting and handling waste can create bioaerosols (micro organisms suspended with dust in the air); if these are breathed in when working they can cause allergy. Micro-organisms in waste can also cause infection if transferred from hands to mouth and swallowed, or if they infect cuts and grazes.

F2.4 STRESS, FATIGUE AND VIOLENCE

The guidance on stress, fatigue and violence, illustrated in Annex F4, focuses on the key psychological issues likely to impact on the waste management industry. It provides information on factors that are known to affect the risk to waste industry operatives from stress, fatigue and violence. Practical advice and methods of control are given in the guidance that represent current thinking of what constitutes best practice for dealing with such issues. Where applicable, it is in line with current HSE guidance (e.g. Stress Management Standard (SMS) approach, HSE 2004).

This guidance has been produced in consultation with the Work Psychology Section of HSL utilising HSL's expertise in the areas of work-related violence, fatigue, working hours, and stress.

F2.5 GENERIC GOOD PRACTICE

The guidance on generic good practice, illustrated in Annex F5, provides appropriate general risk reduction measures that can be used throughout the waste management industry. The guidance has been produced utilising HSL’s expertise in the areas of risk assessment/management, health and safety management, training, communication, work practices and behaviour. Where applicable it is in line with current HSE legislation (e.g. The Workplace (Health, Safety and Welfare) Regulations 1992). Details of health and safety benefits and business benefits that may be derived from the application of the good practice principles are included.

F3 CONCLUSIONS

It is recognised that the current format in which the guidance has been produced is not the same as that previously produced by HSE for the waste management industry. It is viewed that this guidance is a working document that could be taken forward by the HSE and WISH forum. The content is believed to be accurate and represents the views of experts within HSL as to what could constitute good practice for the waste management industry to minimise the risks from the range of hazards covered.

F4 ANNEX F1 – MANUAL HANDLING GUIDANCE

Reducing manual handling risks in the waste industry: Good Practice Guidance

What is this about?

This is one of a series of guidance and good practice documents from the Health and Safety Laboratory to help the waste management industry manage and control risk. This one deals with manual handling during waste collection and at the Materials Recycling Facilities (MRF). The focus is placed on these two areas, as this is where the greatest amount of handling takes place.

Who is it for?

It is written for managers, supervisors and operators working with all types of waste in the waste management and recycling industries.

Why is it needed?

This series of guidance documents aim to comment on and help reduce the health and safety risks associated with the collection, transfer, treatment and processing of waste and recyclable material. They are not intended to interpret the law, nor to be comprehensive, but to suggest good practice that may be helpful in considering what you need to do. Your risk assessment may reveal other factors that also require attention. More sources of information and help are given at the end of this document.

Is there really that much risk?

Manual handling injuries are the most frequently occurring injury within the waste industry. Heavy weights are cited as being most frequently involved in handling injuries[1]. However, the weight of the load is only one of a range of factors that affects the risk of injury. This guidance provides appropriate manual handling risk reduction measures. Whilst it refers to handling activities during collection and at the MRF, some of the risk reduction measures may apply to other areas of the industry.

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[1] *BOMEL Limited (2004). Mapping health and safety standards in the UK waste industry. (Sudbury, Suffolk: HSE Books), Report No. RR240*

How and Where the Hazard Arises

Lifting and carrying - collection

Waste/recycling materials collection using kerbside boxes or re-useable and disposable bags requires the collection worker to lift and carry the receptacle to the collection vehicle. Handling activities at the collection vehicle range from throwing material into the rear of the vehicle or sorting the contents of a kerbside box at the side of or in the body of the vehicle.

Injury examples

Typical incidents can include:

- Overexertion injuries, which can arise when having to apply too much force to lift an object; for example, attempting to lift a load that is too heavy to handle.
- A cut due to handling a sharp surface.
- Losing control of the load and overstraining the body trying to regain balance.
- Cumulative overuse, which leads to a strain when lifting a load that is well within an individual's capacity.

- **Collection worker injures lower back**
  A recycling collection worker was sorting the contents of a receptacle at the vehicle. As he removed the box from the lugs, he turned at the same time, twisting his back. He then felt pain in his lower back and as a result of his injury was absent from work for 4 weeks. An agency worker was needed to cover his absence.

Risk factors

The following factors contribute to the risk of lifting and carrying operations. Where several factors are identified, the risk will be greater.

Tasks
Do they involve:

• awkward body movements such as twisting, stretching, stooping, reaching?	Collection workers operate in restricted work space such as moving between parked cars, through narrow alleyways, and through overgrown vegetation. In general the workplace layout will influence the extent to which awkward body movements occur.
• holding or manipulating loads at a distance from the trunk of the body?	This could occur when holding sacks or boxes away from the body to negotiate obstacles.
• excessive lifting, lowering, carrying distances of loads?	If a load is handled frequently or carried for an excessive distance, physical stresses are prolonged, leading to fatigue and increased risk of injury.

• risk of sudden movement of loads?	A load that suddenly moves, or is difficult to handle can impose unpredictable stresses on the body.
• physically demanding work, especially where breaks are insufficient?	Collection work is probably the most physically demanding task within the waste industry.
• a rate of work imposed by a process?	Without proper control the work method of ‘task and finish’ is likely to encourage workers to rush, thus increase the work rate, to complete the round.

Loads
Are they:

• heavy, bulky or unwieldy?	An individual box weight usually varies between 3 to 20 kg. Individual black bag weights usually varies between 2 to 6 kg. In the case of bags, the weight handled will be greater if more than one is lifted at a time.
• difficult to grasp?	The ease with which bags can be handled may vary depending upon the material they are made from, how householders present the bags and the weather conditions. Dedicated handles like those on a kerbside box make an object easier to grasp and will require less grip strength.
• Unstable or sharp?	Workers who handle waste/recyclable material are exposed to sharp objects such as tins, glass and hypodermic needles.

Working environment
Are there:

• lifting tasks in confined spaces, on slippery floors or in poorly lit areas	Poor weather conditions, such as ice or snow will give rise to a more slippery underfoot surface. In the winter months, the reduced daylight hours may mean there are more poorly lit areas.
• variations in floor levels or work surfaces	Collection workers have to negotiate stairs, kerbs, slopes, and in some cases steps onto the collection vehicle.

Figure F1 A heavy load that is awkward to handle (left hand picture) and holding the load out to one side of the body (right hand picture) are factors that can increase the risk of injury

Pushing and Pulling - Collection

Waste/recycling materials collection using wheeled bins requires the collection worker to push or pull the receptacle to the collection vehicle. At the collection vehicle, some precision is required to position the bin onto the lifting mechanism.

When undertaking pushing and pulling activities, typical incidents can include:

- Overexertion injuries, which can arise when having to apply too much force to move a bin or when applying force with the body in an awkward, twisted position.
- Cumulative overuse, which leads to a strain when pushing or pulling a load that is well within an individual's capacity.
- Losing control of the bins when moving up, down or across a slope
- Trapping the hands between the bin and another object
- Slipping or tripping on wet, slippery or uneven ground
- Trapping the feet beneath the bins
- Trying to stop a bin from tipping over when travelling over kerbs

Injury Example

- **Collection worker injured moving a wheeled bin**
  A collection worker strained their shoulder when trying to pull a wheeled bin over a gravelled surface. As a result of the injury the worker was absent from work for 2 weeks. Following the incident, management requested the bins be moved to a more suitable location.

Risk Factors

There are a number of factors that contribute to the risk of pushing and pulling operations in collection. These can also apply to other areas of the waste/ recycling industry when handling trolleys. A suitable and sufficient risk assessment should address these common factors relating to collection work.

• Heavy or overfilled bins -	Heavy bins are more difficult to move, balance and steer. Overfilled bins may restrict collector visibility when pushing. The bin contents may also fall out when moved.
• Movement over long distances -	Where the collection vehicle cannot be parked close to the bins, moving the bins over long distances may be more demanding and/or encourage unsafe timesaving behaviours.
• Lack of equipment maintenance -	Wheels that are damaged or contaminated with debris and seldom inspected or cleaned, may not run smoothly, may be difficult to steer, and may require more effort to move the bin.
• Confined work areas -	In restricted work areas, the bins may need to be turned or placed in a location with some precision. In these cases, the forces that a collector can apply safely may be considerably less due to the use of weaker arm and shoulder muscles. Storage areas and other confined areas may lead collectors to twist and adopt awkward body positions when manoeuvring bins.
• Terrain / ground surfaces	Bin wheels roll with greater difficulty over soft and/or uneven ground such as grass, mud, broken pavement and cobblestones. It is more difficult to move bins up down and across slopes. It is also more difficult to move bins where there is unstable or insecure footing (e.g. while standing on slippery surfaces such as snow).
• Work organisation	Without proper control task and finish work practices are likely to encourage rushing and timesaving activities such as pulling too many bins at one time. This can increase the pushing and pulling forces that collectors apply when starting, stopping and changing the direction of the bin.

Figure F2 Handling two bins at once, negotiating kerbs and pushing or pulling up a steep slope are factors that can increase the risk of injury

Frequent sorting activities – MRF

At the MRF, dry recyclable material is frequently sorted by hand as it travels along a conveyor belt. The three principal sorting tasks include: pre-sorting, final-sorting and grading.

Typical incidents could include:

- A cut or puncture wound from handling sharp objects such as broken glass or hypodermic needles
- Overexertion injuries, which can occur from prolonged tissue loading caused by static posture or performance of very frequent exertions even at low force levels.

Risk factors

The following factors contribute to the risk of injury from hand sorting of recyclable material. A suitable and sufficient risk assessment should address these common factors relating to collection work.

Task related factors:

• repetitive handling of dry recyclables	Hand sorting of waste requires the same muscle groups to be used over and over again during the working day.
• working postures	Working postures can increase the risk of injury when they are awkward and / or held for prolonged periods in a static or fixed position. The physical aspects of the conveyor workstation such as work surface height and reach distance will influence the occurrence of awkward posture. Hand sorting

	in an awkward posture for long periods of the working day will increase the risk of an injury to the soft tissues.
• force	Local force can be applied to the body when leaning against the conveyor for long periods. The level of force required to handle the recyclable material depends on its size and weight. However, the items handled at the MRF are likely to need low levels of force.
• duration of exposure	Duration includes the length of time that hand sorting is undertaken in each shift, plus the number of working days it is performed. The more time spent sorting the greater the risk of injury.

Environment related factors:

• working environment	Exposure to cold can result in reduced blood flow to the hands and upper limbs, and reduced sensation and dexterity. The amount and kind of light available can influence the workers posture.
• psychosocial factors: workers have little control over their work and work method?	A work rate may be imposed on those who hand sort waste if the conveyor operates at a set speed.

Figure F3 Hand sorting of dry recyclable material at an MRF

Generic risk factors

The following factors also contribute to the risk of a manual handling injury, which apply to all aspects of handling activities:

• extremes of temperature and humidity levels	Working in extreme hot or cold conditions may affect physical capability. For example cold hands will reduce the ability to grip.
• Individual and team competence -	Lack of knowledge about the hazards on the particular collection route, or within the workplace make it more difficult for workers to manage unfamiliar or unexpected situations. Insufficient training and lack of handling experience make it more difficult for workers to manage the risks.
• Individual and team behaviour -	Unsafe working practices such as rushing, taking short cuts, or carrying two kerbside boxes at a time increase the risk of injury.
• Individual and team capability -	Those suffering with musculoskeletal or respiratory complaints may be more likely to encounter difficulties with the work. Not all people will have the required strength or physical stamina to do the work. This is especially the case for those who are new to the job, which includes agency workers. It is likely that informal self-selection will occur.

Good Practice Guidance for Manual Handling

The Manual Handling Operations Regulations (1992) require you to avoid the need for any manual handling operations at work which involve a risk to health and safety – so far as is reasonably practicable.

If it is not reasonably practicable to avoid any manual handling operations, you must carry out a manual handling risk assessment to identify how the risk is caused, so each factor can be addressed and measures taken to control the risk. Further information on manual handling risk assessment can be found in the signposting section.

Good practice that can help reduce the risk of manual handling injuries includes:

Workload – our company manages employees' workload well because:

- Collection methods are suitable for the operating environment and the range of materials collected.
- Collections are balanced to ensure that individual receptacles are not under/ overloaded
- The weight of loads and the frequency of handling by individuals are continually monitored.
- Workers are encouraged to take rest breaks before the onset of discomfort or fatigue.
- In periods of increased workload such as Christmas, and bank holidays, additional controls are used to ease the individual workload.
- Collection is from the kerbside and not from gardens or the rear of premises, which reduces the handling distance.
- The workload is scheduled to allow for some slack in the system so that should an unforeseen problem occur, workers will not have to unduly rush to catch up.

Work method – our company encourages sensible work methods such as:

- Parking the collection vehicle as close to the collection point as possible.
- Finding new methods to retrieve waste from difficult locations; for example, to retrieve waste from a basement a vehicle could be fitted with a lifting jib to lift the material out, thus reducing the need to handle the waste[2]. Or supply a bulk container.
- Collectors lifting and carrying only one kerbside box at a time. This not only reduces the weight of the load but will ensure that the line of sight is not blocked.
- Collectors clearing a suitable path (e.g. open doors and gates, remove large ground debris) between the bin and the collection vehicle.
- Collectors working in teams to assist each other in awkward environments. For example, one collector may hold gates and doors open for the others.
- Testing the weight of a bin/ bag or box before trying to move it.
- Collectors moving one bin at a time using two hands to tilt, push and pull the bin.
- Avoiding moving bins up kerbs and steps wherever possible.

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[2] *Gibson, C., Barnsley, P., (no date).* Don't bin your back: The report of the SITA/GMB back in work project.

- When moving bins down kerbs or steps, roll both wheels off the edge of the kerb simultaneously and in a controlled manner so that the bins do not tip over.
- Collectors seeking assistance when they experience difficulties moving a bin, particularly if moving a bin up or down a steep slope.
- Where possible two people at a time handle Euro bins and Paladins.
- Collectors inspect the Euro bins and Paladins before moving them to check the alignment of the wheels and whether there are any ground debris or obstructions that may make their movement more difficult.
- Moving Euro bins and Paladins across dropped kerbs wherever possible and particularly when they are returned to the pavement level after emptying.
- If possible avoiding the use of paladins where they have to be moved over uneven surfaces, up or down kerbs or on steep slopes. The small wheels on a paladin get stuck more easily and therefore require greater force to move them.
- Where possible, providing enough light adequate for the task.
- Providing drinking water in hot conditions.

Equipment Design – good equipment designs include:

Collection Vehicle:

- Using anthropometric measurements to compare vehicle dimensions with body measurements to keep rave heights of the vehicles below shoulder height.
- Eliminating space constraints that could lead to awkward body movements such twisting.
- Where applicable, designed to meet British Standards.[3]
- Adequate lighting for the task.

Receptacle:

- Box receptacles that are not too deep, which reduces the need for a collector to have to hold the box higher /further away from the body.
- Handholds that allow a power grip to reduce the grip strength required to hold the receptacle.
- An easy to grab handhold on re-useable bags.
- Wheeled bins, including Euro bins and paladins designed to meet British Standards.[4]

MRF Conveyor belt:

- A work surface height appropriate to the task performed i.e. where precision tasks are performed on smaller objects a higher work surface will be required than when heavier tasks are performed on larger objects.
- Adjustable work surface height. In the absence of being able to adjust the work surface height a more straightforward solution is to have a higher work surface so taller people don’t have to stoop. Smaller operators could then be provided with adjustable platforms to stand on.
- A work surface height that is comfortable to work at. The preferred work surface height for most tasks is set below elbow height.
- Adequate thigh clearance beneath the conveyor belt when in a seated posture.

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[3] *BSI (1998 & 2005). Refuse collection vehicles and their associated lifting devices – General requirements and safety requirements – Part 1: Rear-end loaded refuse collection vehicles BS1501-1:1998 and Part 2: Side loaded refuse collection vehicles BS1501-2:2005*

[4] *BSI (2004).* Mobile waste containers – Part 6: Safety and health requirements. *BS840-6:2004*

- Adequate leg clearance for either a standing or seated posture to enable the operator to stand closer to the objects on the belt.
- Easy to reach objects. Deflection strips and belt width is used to keep the material within the comfortable reach distance of workers.
- Reducing the height of sills at workstations sites to help reduce localised compression of the soft tissues. Rounded-over edges will make occasional leaning against the conveyor to relieve the legs more comfortable.
- Where possible giving the worker the option to slow the speed of the conveyor to allow them to control the rate of sorting.

Management – our company's successful management policies includes:

- Reviewing accident and ill health reports to identify patterns of injury, and possible improvements to manual handling controls.
- Auditing workers on a regular basis. Supervisory staff carry out regular audits for activities to ensure what should happen, does happen in practice.
- Absence management to diagnose and treat an injured worker, returning them to work as soon as practicable, where possible. Consulting the workforce prior to the introduction of new manual handling aids or controls to obtain feedback on their suitability.

Communications in our company are good because:

- Collectors are able to report problems using a hazard reporting system. The kinds of problems reported include:
    - Frequently overfilled bins/boxes;
    - The collection vehicle cannot be parked close to the collection point;
    - Bins/boxes which are damaged or defective;
    - Confined spaces, obstacles and uneven terrain that restrict movement

  The system enables collectors to follow the progress of a report and be informed of actions taken.
- There is frequent dialogue from management about safety to reinforce the messages and information given during formal manual handling training.
- Incident reporting systems are straightforward and do not provide a barrier to the reporting of incidents.
- Management works with local residents and traders to make them aware of hazards on their property and how this makes collection work difficult. These customers might be asked to improve access to bins and other waste storage areas. Management discusses with customers the reasons for bins/boxes to be regularly overfilled and works with them to find a solution.
- Local residents are made aware of how they can position receptacle to assist collection work.
- Management regularly communicates with Local Authorities and the Highways Agency to improve vehicle and collector access and address existing hazards in the environment that increase the risk of injury during handling.
- Management regularly communicates with Local Authorities and the Highways Agency to ensure that the hazards associated with waste/recycling collection are considered in any new developments or building projects.

Training and Competence – good manual handling training covers:

- Basic information about the back and the key risk factors relating to the load, task, environment and individual capability.
- How to avoid manual handling and reduce the risk factors.
- Basic principles of safe moving and handling in the workplace to equip workers with the skills to review and deal with unfamiliar tasks.
- Information on the importance of adopting a good working posture.

Individual Factors – particular consideration should be given to:

- Agency workers, those who are young and new starters, as they may not have the same degree of fitness and strength as the regular crew, so are more at risk of injury. Ensure they are given suitable training and instruction prior to starting work to encourage safer working practices such as taking regular rest breaks.
- Those with an existing musculoskeletal health problem who are more at risk of an injury.

Personal Protective Equipment – workers are supplied with:

- Appropriate footwear and protective clothing for the work they do, particularly for adverse weather conditions.
- Appropriate equipment for working out of doors in extreme weather.
- Suitable gloves and cut resistant clothing to reduce the risk of injury from handling sharp objects.

Signposting

Relevant Legislation

- **Health and Safety at Work Act (1974)**
  Places a duty on employers to ensure the health and safety of employees and others who may be affected by their work activities.

- Management of health and safety at work:
  Management of Health and Safety at Work Regulations 1999. Approved code of practice, L21. HSE Books, 2000 ISBN 0 7176 2488 9
  Builds on the HSAW Act and includes duties for people in control of workplaces to assess risks.

- Workplace health, safety and welfare.
  Workplace (Health, Safety and Welfare) Regulations 1992 (as amended by the **Quarries Miscellaneous Health and Safety Provisions Regulations 1995**), L24. HSE Books 1996. ISBN 0 7176 0413 6
  Provides guidance on the Regulations which implement a European directive No. 89/654/EECincluding temperature, lighting; workstations and seating.

- **Personal Protective Equipment at work Regulations 1992** (as amended), L25. HSE Books 2005 ISBN 0 7176 6139 3
  This new version reflects the latest developments in most personal protective equipment (PPE).

- Manual handling:
  Manual Handling Operations Regulations 1992 (as amended): Guidance on Regulations, L23, 3rd Edition. HSE Books, 2004 ISBN 0 7176 2823 X.

Further guidance

- **Manual handling: Solutions you can handle** HSG115 HSE Books 1994 ISBN 0 7176 06937
  Provides guidance to help employers to avoid manual handling or reduce the risk of injury in areas where assessment shows there is a risk. Each solution is illustrated with a photograph or diagram with a short explanatory paragraph.

- **Work-related upper limb disorders: A guide to prevention** HSG60 HSE Books 2002 ISBN 0 7176 1978 8
  This revised guidance is aimed at managers with responsibility for workers who may be at risk of developing limb disorders. It aims to help the reader understand the hazards and risks and how to control them.

- **A pain in your workplace? Ergonomic problems and solutions.** HSE Books 1994 ISBN 0717 6066 86
  Aimed at all employers who might be putting their employees' muscles and joints at risk of damage.

- **Caring for cleaners: Guidance and case studies on how to prevent musculoskeletal disorders.** HSG234, HSE Books 2003 ISBN 0717 6268 22
  This publication provides guidance on recognising and controlling manual handling and upper limb risks faced by cleaners at work.

- **Managing sickness absence and return to work: An employers and managers guide.** HSG249 HSE Books 2004 ISBN 0 7176 2882 5
  This guide shows best practice and also offers simple, practical advice and suggests steps you can take to help employees following injury, ill health or the onset of disability.

HSE free booklets and leaflets

- Manual handling assessment chart (MAC tool). INDG383 HSE Books 2003
- Are you making the best use of lifting and handling aids? INDG398 HSE Books 2004
- Getting to grips with manual handling: A short guide for employers INDG143(rev2) HSE Books 2006.
- Waste industry safety and health: reducing the risks, INDG359 HSE Books 2002
- Handling needles in the waste and recycling industry. Best practice guidance produced by WISH: http://www.hse.gov.uk/waste/needles.htm
- Ergonomic considerations for designing and selecting conveyor belt systems. Best practice guidance produced by WISH*:* http://www.hse.gov.uk/waste/conveyorbelt.pdf
- Health and safety training: guidelines for the waste management sector, 2006 Best practice guidance produced by WISH

Websites

- Information can also be found on the HSE musculoskeletal disorder website www.hse.gov.uk/msd/index.htm
- The Waste Industry Safety and Health (WISH) Forum can be found at www.hse.gov.uk/waste/wish.htm.

Research

- Pinder, A.D.J. and Milnes, E. (2002). Manual handling in refuse collection. (Sheffield: Health and Safety Laboraratory), HSL/2002/21 http://www.hse.gov.uk/research/hsl_pdf/2002/hsl02-21.pdf
- Pinder, A.D.J. Oxley, L. and Cope, M. (2006) Manual handling in kerbside collection and sorting of recyclables HSL/2006/25 http://www.hse.gov.uk/research/hsl_pdf/2006/hsl0625.pdf
- BOMEL Ltd. (2004) Mapping health and safety standards in the UK waste industry HSE Research report, CRR 240 ttp://www.hse.gov.uk/RESEARCH/rrpdf/rr240.pdf
- Hu-Tech Associates Ltd (2006) The costs and benefits of active case management rehabilitation for musculoskeletal disorders, HSE Research report 493 www.hse.gov.uk/RESEARCH/rrhtm/rr493.htm

F5 ANNEX F2 – SLIPS AND TRIPS GUIDANCE

Reducing Slips and Trips in the Waste Management Industry: Good Practice Guidance

What is this about?

This is one of a series of guidance and good practice documents from the Health and Safety Laboratory to help the waste management industry manage and control risk. This one deals with slips and trips.

Who is it for?

It is written for managers, supervisors and operators working with all types of waste in the waste management and recycling industries.

Why is it needed?

This series of guidance documents aim to comment on and help reduce the health and safety risks associated with the collection, transfer, treatment and processing of waste and recyclable material. They are not intended to interpret the law, nor to be comprehensive, but to suggest good practice that may be helpful in considering what you need to do. Your risk assessment may need to take other factors into consideration. More sources of information and help are given at the end of this document.

Slips and trips result in a large number of injuries and lost working days within the UK Waste Management industry. 30% of accidents are due to slips, trips and falls[5]. A sprained ankle can result in 3 weeks off work; a fracture could mean 3 months off work.

Is there really that much of a risk?

The large numbers of accidents and injuries caused by slips and trips are not inevitable however. Effective solutions are often simple, cheap and can lead to better, easier working conditions and improved work effectiveness. This guidance provides appropriate slip and trip risk reduction measures that can be used throughout the industry.

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[5] *Source: Bomel 2003 RIDDOR data*

How and Where the Hazard Arises

KERBSIDE COLLECTION

Collection workers walk around 6 ¼ miles (10km) per day. That is over 10000 steps, which means over 10000 opportunities for a slip or trip. Common causes of slip incidents in collection work are slippery surfaces due to ice, snow, mud, grass and wetness. Common causes of trip incidents in collection work are uneven ground, kerbs and holes.

There are a number of factors that can contribute to the risk of a slip or trip:

Weather	Weather conditions such as rain, ice, snow and fog.
Light	The amount of daylight available is dependent upon the time of year and the shift start time, coupled with the weather. In winter collection workers spend one third of their time working in the dark.
Individual behaviour	Unsafe working practices such as rushing and taking short cuts.
Work organisation	Task and finish work practices could encourage rushing and time saving activities.
Manual Handling	One third of slips occur during manual handling activities.
Lack of maintenance	Uneven paving, and housekeeping practices of residents plus their choice of floor material such as gravel or paving stones.
Environment	Permanent obstacles such as kerbstones, steps, stairs and walls (see Figure F1).
Distraction	Caused by another occurrence such as a dog attack.

Figure F4 Walking on grass and up and down flights of stairs are potential slip and trip hazards

HIGH-RISE COLLECTION

Collection from high-rise flats is likely to require frequent stair use. A fall on stairs tends to result in falling forwards. Stair descent results in more fall injuries than stair climbing because the distance of the fall is likely to be greater, than during stair ascent[6].

Factors that can contribute to an increased number of stair falls include:

Stair design	Narrow goings* and tall riser** [7]heights and poorly contrasted stairs.
Stair maintenance	Poor condition of the treads and slippery floor surfaces.
Environment	Inadequate lighting.
User	Unfamiliarity of environment - likely to affect new starters, and temporary employees.
Behaviour	Rushing to finish.
Carrying	Carrying items can obstruct the view of the stairway and decrease the chance of recovering from a loss of balance.

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[6] *Templer, J., Archea, J. & Cohen, H.H. (1985) Study of factors associated with risk of work-related stairway falls.* Journal of Safety Research*. 16: 183-196*

[7] * Going: the horizontal distance between two consecutive nosings. The nosing is defined as the part of the tread that overlaps the tread below.

** Rise(r): the vertical distance between two consecutive treads, or between a tread and a landing.

Injury examples

Examples of serious injuries caused by a slip or trip incident include:

- **Collection worker slips on wet grass**
  A collection worker walked across wet grass to retrieve a kerbside box. In doing so, he slipped on the grass and fell. To save himself he put his hand out and bent his wrist back, which resulted in a fracture to the wrist. It took the recycling collection worker 43 days to recover from the injury and return to work. A temporary member of staff was used to cover his absence.

- **Collection worker trips on a piece of cable**
  A collection worker sprained their knee when he tripped over a piece of cable that had been left on the ground. The accident happened during collection whilst the worker was running with his attention focused on looking for the wagon in amongst the surrounding traffic. A temporary member of staff was used to cover his period of absence, which lasted 79 days.

POST COLLECTION

Workers (both collection workers tipping material and site workers) are exposed to a range of slip and trip risks at waste management sites. Common causes of slip incidents are stray items of waste/recyclable/compostable material, wetness, dust and mud. Common causes of trip incidents are stray items of waste/recyclable/compostable material, uneven ground in tipping areas and obstacles.

A number of factors can contribute to the risk of a slip or trip including:

• Weather	Rain, ice, snow and fog can increase risk at outdoor areas/sites.
• Contamination	Anything that ends up on a floor/ground e.g. stray items of waste, recyclable or compostable material, rainwater, mud, oil, grease, or dust (see Figure F2). By-products from treatment and processing such as condensation, water, leachate and ash.
• Obstacles	Potential for stray items to cause an obstacle. Bad housekeeping e.g. unsecured storage of waste/recyclable materials and equipment. Composting practices requiring operatives to walk on compostable material - risk of tripping/slippingon items such as plastic bags.
• Trailing leads, cables and pipes	Housekeeping at many sites requires the use of pressure hoses etc, posing a trip hazard from cables, leads and pipes.

• Light	Too little light or light that causes glare can stop people from seeing hazards.
• Individual behaviour	Unsafe working practices such as ignoring risks, rushing and taking short cuts.
• Work Organisation	Poorly organised work at sites can result in unsafe practices e.g. poor housekeeping, walking on mounds of waste.
• Lack of maintenance	Uneven and poorly maintained floor/ground surfaces.
• Building environment	If rainwater gets onto smooth surfaces inside or outside of a building, it may create a slip hazard. Permanent obstacles at sites such as steps, stairs and machinery.
• Distraction	Such as a loud or unfamiliar noise

Figure F5 Wet paper left on a floor where people might walk creates a slip and trip hazard

Injury examples

Examples of serious injuries caused by a slip or trip incident post collection include:

- **Transfer station operative slips on dusty floor**
  A transfer station operative walked across a contaminated tipping hall to retrieve a broom. In doing so, he slipped on a dusty floor. He received torn wrist ligaments after putting out his hand to steady himself as he fell. He needed hospital treatment for his injuries and 20 days to recover from the injury and return to work. A temporary member of staff was required to cover his absence.

- **Incinerator station operative trips on obstacle**
  An incinerator station operative tripped over a pile of waste that had accumulated in the tipping hall as he was walking to his shovel loader vehicle after taking a break. He suffered a serious hip injury, needed hospital admission and took 2 months to return to work. A temporary member of staff was required to cover his absence.

Good practice principles

A number of good practice principles are given below:

General Good Practice Principles

There are a number of general good practice principles that can be applied to all apects of the waste management industry. Examples of good practice case studies from varying UK industries can be found in HSE Slips and Trips guidance (See signposting). This document also highlights the Business and Health and Safety benefits of implementing good practice

Outdoor areas

Good practice that can help reduce the risk of slips and trips in outdoor areas includes:

- Ensure collection workers are familiar with the hazards on their routes.
- Consider using maps with the location of hazards indicated on them.
- Where hazards are on customers property, communication with the Local Authorities or Highways Agency should be established to address these issues.
- Working practices in severe weather might include:
    - The identification of high-risk routes particularly affected by severe weather such as those in exposed rural areas and on steep slopes.
    - Postponing collections until conditions improve.
    - Altering the route so that the worst affected areas are left until last.
- Post collection, prevent the use of rough ground where possible. Consider moving some activities to suitable concreted areas.
- Keep rough ground as level as possible. In some cases regular levelling may be needed to remove ramps, areas of subsidence, deep vehicle wheel ruts etc.
- Pedestrian routes over rough ground should be suitably marked and maintained.
- Composting staff should be made aware of the risk of slipping/tripping when walking over compost mounds to conduct tasks e.g screening, inserting temperature probes.
- Make staff at sites aware of the unusual tripping hazards e.g. from leachate wells.
- Improve drainage to remove standing water, consider laying chippings to provide drainage.
- Treat pedestrian areas in frosty and icy weather conditions.
- Ensure adequate lighting.

Flooring

Given the variety of sites used employers must ensure that:

- The floor is suitable for the type of work that will be taking place on it.
- Where floors cannot be kept dry, they should have sufficient roughness so that people can walk on the floor without fear of a slip. See Signposting for more information on surface roughness.
- Floors must be cleaned correctly to ensure that they do not become slippery and keep their slip resistance properties (if a non slip floor).

- The floor must be fitted correctly,
    - to ensure that there are no trip hazards,
    - to ensure that non slip coatings are correctly applied.
- The floor must be maintained in good order to ensure that there are no trip hazards e.g. holes, uneven surfaces.
- Ramps, raised platforms and other changes of level should be avoided; if they cannot they must be highlighted.

Contamination

Most floors only become slippery once contaminated. First think about whether you can stop contamination, e.g.

- Fit canopies to external entranceways to stop rainwater from entering a building.
- Change the system of work if necessary to reduce the possibility of contamination.

If you cannot stop contamination you will need to ensure that floors are cleaned effectively and quickly. If you are relying on the floor to cope with contamination and still be non-slip, remember, the thicker the contamination, the rougher a floor needs to be to avoid slips.

Regular and effective cleaning to remove contamination will help reduce slip/trip accidents.

- Use the right amount of the correct cleaning product.
- Detergent needs time to work on greasy floors.
- Cleaning equipment will only be effective if it is well maintained.
- A dry mop or squeegee will reduce floor-drying time but whilst the floor is damp there will be a slip risk.
- A well-wrung mop will leave a thin film of water sufficient enough to create a slip risk on a smooth floor.
- Spot clean where possible.

Housekeeping

Many slip/trip accidents are caused by bad housekeeping. Good practice points to consider include:

- All equipment must be stored in designated areas and returned to this area following use.
- Spillages must be cleaned up immediately. Absorbent granules should be provided for liquid/oil spills.
- Ensure that there is a suitable walkway through the workplace, kept clear, with no obstructions at all times.
- Keep tipping areas tidy, with waste/recyclables stored in suitable bays.
- Ensure bays are emptied regularly and not allowed to overspill.
- When carrying out work with power tools or hoses, all efforts should be made to keep walkways clear, such as routing cables/pipes over or under walkways.

Good housekeeping does not cost money; it just takes a little personal effort. Do all staff at your workplace (workers, managers, cleaners, maintenance technicians etc.) have a see it, sort it attitude? Encourage operatives to take responsibility and deal with any obstacles.

Footwear

Footwear can play an important part in preventing slips and trips. In public areas or work situations where floors cannot always be kept dry or clean the right footwear will be especially important. A slip resistant shoe may be required.

Do not select footwear on the basis of brochure descriptions alone. Footwear that claims ‘slip-resistance’ may not perform well in your particular work environment.

So how can you make the best choice?

- Be aware that footwear can perform differently in different situations. Consider where the wearer will be.
- A good tread pattern is essential on fluid-contaminated surfaces.
- Sole tread patterns should not become clogged with any waste or debris.
- Take account of factors such as comfort, durability and additional safety features required, such as steel mid-sole. The final choice may have to be a compromise.
- Adopt an approach that will maximise the wearing of issued footwear:
    - Conduct user trials to establish field performance and comfort;
    - Monitor the effectiveness of the footwear with regards to wear.

Further information on the selection of appropriate footwear and relevant regulations are given in Signposting.

Signposting

Relevant Legislation

- **Health and Safety at Work Act (1974)**
  Places a duty on employers to ensure the health and safety of employees and others who may be affected by their work activities.

- Management of health and safety at work:
  Management of Health and Safety at Work Regulations 1999. Approved code of practice, L21. HSE Books, 2000 ISBN 0 7176 2488 9
  Builds on the HSAW Act and includes duties for people in control of workplaces to assess risks.

- Workplace health, safety and welfare.
  Workplace (Health, Safety and Welfare) Regulations 1992 (as amended by the **Quarries Miscellaneous Health and Safety Provisions Regulations 1995**), L24. HSE Books 1996. ISBN 0 7176 0413 6
  Provides guidance on the Regulations, which implement a European directive No. 89/654/EECincluding temperature, lighting; workstations and seating.

- **The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR)**
  Employers must notify their enforcing authority in the event of an accident at work to any employee resulting in death, major injury or incapacity for normal work for three or more consecutive days.

- **Personal Protective Equipment at work Regulations 1992** (as amended), L25. HSE Books 2005 ISBN 0 7176 6139 3
  This new version reflects the latest developments in most personal protective equipment (PPE).

Further Guidance

- **Five steps to successful health and safety management**. INDGI32 (1992). HSE Free leaflet.

- **5 steps to risk assessment**. INDGI63 (rev 2). (2006). HSE Free leaflet.

- **Waste Industry Safety and Health Reducing the Risk** HSE/WISH (2002). HSE Books ISBN 07176 25141

- **Preventing slips and trips at work.** HSE INDG 225 (rev1)
  http://www.hse.gov.uk/pubns/indg225.pdf

- **Safer surfaces to walk on – Reducing the risk of slipping**
  This guide is produced by CIRIA (Construction Industry Research Information Association) in conjunction with HSE and Arup
  www.hse.gov.uk/slips/safersurface.htm

- **Slips and Trips: Guidance for employers on identifying hazards and controlling risks.** HSG 155 (1996) ISBN 0717611450
  http://www.hsebooks.com/books/product/bookmark.asppub=0717611450

- **Slips Assessment Tool** – freely downloadable computer software package that allows an operator to assess the slip potential of pedestrian walkway surfaces.
  http://www.hsesat.info

- **Slips and trips speakers pack** HSE has prepared a Slips and Trips "Speaker's Pack" on the control of slips and trips at work. The purpose is to make it easy for talks to be given to employers, employees, trade associations, trade unions etc on this topic, by using this Powerpoint presentation. Each slide is supported by speaker's notes. The presentation is downloadable onto a PC or laptop for use at health and safety meetings or events.

- **The assessment of pedestrian slip risk**
  HSE guidance downloadable from internet.
  http://www.hse.gov.uk/pubns/web/slips01.pdf

- **British Standards**
  http://www.bsi-global.com/

F6 ANNEX F3 – MICROBIOLOGICAL HAZARDS GUIDANCE

Microbiological Hazards in the Waste Industry: Good Practice Guidance

What is this about?

One of a series of guidance and good practice documents from the Health and Safety Laboratory to help the waste management industry manage and control risk. This one deals with microbiological hazards.

Who is it for?

Managers, supervisors and operators working with all types of waste in the waste management and recycling industries. Some parts of the guidance suggest the sort of controls that managers should be providing. Some parts suggest what actions operators should be taking. If you are a supervisor, you could use this guidance when discussing risk controls with your staff. If you are an operator reading this and you don't think risks are well enough controlled, use this guidance when discussing with your supervisor.

Why is it needed?

This series of guidance documents aim to comment on and help reduce the health risks associated with the collection, transfer, treatment and processing of waste and recyclable material. They are not intended to interpret the law, nor to be comprehensive, but to suggest good practice that may be helpful in considering what you need to do. Each situation may be different though, and your risk assessment may need to take other factors into consideration. More sources of information and help are given at the end of this document.

What are microbiological hazards?

We come into contact with micro-organisms (bacteria, moulds and viruses) all the time and mostly they do us no harm. But sometimes they can cause allergies or infections if they are breathed in, swallowed or enter the body through cuts or grazes. Some people get asthma from breathing in mould spores, and we all from time to time get food poisoning or an infected cut. But sometimes the workplace can increase the risk of some of these hazards.

Which of these microbiological hazards are present in waste?

Waste material naturally has micro-organisms in it and some processes such as composting rely on large numbers of micro-organisms being present. Collecting and handling waste can exposure workers to bioaerosols (micro-organisms suspended with dust in the air) and if these are breathed in when working there is a risk of ill health from allergies.

Some of the micro-organisms in waste can cause ill health from infections if you transfer them from dirty hands to your mouth and swallow them, or if they infect cuts and grazes. Other infections (referred to as zoonoses) can be caused by animal detritus in waste.

INFOBOX - SOME NAMES OF MICRO-ORGANISMS THAT YOU MAY FIND IN WASTE

Penicillium – a common mould everywhere, the sort that grows on mouldy fruit. Can trigger allergy if inhaled in large numbers.
Cladosporium - a common mould everywhere, the sort that causes black spots on bathroom window frames. As above.
Aspergillus, including **Aspergillus fumigatus** - a common mould everywhere, grows on rotting vegetation. In particular this may be present in large numbers in compost and can trigger allergy or in some rare circumstances infection if inhaled in large numbers.
Escherichia coli (E coli) – food poisoning bacteria usually associated with faecal contamination.
Salmonella – as above, food poisoning bacteria usually associated with faecal contamination.
Clostridium tetani – the bacteria that cause tetanus. May be present in any soil and cause infections through cuts.
Leptospira – bacteria that cause Weil's disease. They grow in rats and may cause an infection through cuts or damaged skin in humans in contact with contaminated rat urine.
Pasteurella multocida – bacteria present in animal saliva. Can cause infection through dog bites.
Toxoplasma & Toxocara – parasites that may be present in dog and cat faeces and cause infection through hand to mouth contamination.
Blood borne viruses – viruses such as Hepatitis and HIV could be present as a result of clinical waste or contaminated needles from drug users.

Is there really that much risk?

Illness and disease from microbiological hazards are not inevitable. Effective solutions are often simple, cheap and can lead to better, easier working conditions and improved work effectiveness. This guidance provides appropriate risk reduction measures that can be used throughout the waste industry.

How and Where the Hazards Arises

KERBSIDE COLLECTION

Because collection workers undertake a variety of tasks that may put them at risk of inhaling bioaerosols, of contaminating their hands, of sustaining cuts and grazes or of coming into contact with vermin and domestic pets and their detritus.

Influencing Factors Are

- The waste collection round and the material being handled – Anything capable of microbiological deterioration, for instance organic material such as food waste, will increase potential exposure to micro-organisms. Therefore the waste from food shops and restaurants may have more micro-organisms in it than waste from other retail areas.
- The quantities handled and how they are handled - For example, emptying big wheeled bins is likely to generate more dust and aerosols than emptying normal wheeled bins; compaction may burst bags generating aerosols.
- The weather - organic waste may deteriorate faster in warmer weather.
- Collection rota - Increased time between collections gives more time for deterioration.
- Work organisation – Working close to operating vehicle machinery, e.g., during compaction of waste and emptying collection vehicle, can increase the chance of inhaling contaminated dust..
- Requirements for manual handling/sorting – Any contamination on hands could potentially be transferred into the mouth. Manual handling could also lead to cuts & grazes. There is likely to be broken glass and sharp metal in the waste which could cause cuts and this could lead to infection. In addition, there could be clinical waste which has entered the waste stream by accident or contaminated needles left in waste by drug users (for further guidance see at the end of this document).
- Facilities - Lack of hand hygiene facilities on mobile units.
- Environment - Potential presence of vermin in waste holding areas (increasing risk of Weil's disease).
- Contact with uncontrolled dogs

POST COLLECTION HANDLING

At waste transfer stations, landfill sites, incinerators, material recycling facilities (MRFs), compost facilities.

Influencing Factors Are

All of the above plus:

- The composting process promotes microbial activity to break down degradable waste, so there may be more micro-organisms in dust from compost. Co-composting with wastewater or sewage sludge can increase possible exposure to faecal bacteria; composting of animal by-products can increase possible exposure to food poisoning bacteria.

- Quantities handled and how handled, i.e., tipping from vehicles and use of compaction vehicles in tipping halls and at landfill will create aerosols.

- Scale of operation – large numbers of vehicles congregating to empty waste, may be done in enclosed facilities e.g. tipping halls, which could increase airborne dust levels.

- Manual Handling - Requirements for manual handling of waste/containers can lead to cuts & grazes. Large amounts of manual sorting e.g. at MRFs may create aerosols. Soiling of hands can lead to hand to mouth contamination.
- Mechanical Handling - Mechanical handling of waste such as loading compactors or conveyor belts. Shredding, turning and screening, a necessary part of the composting process, generates aerosols. The need to monitor the process may lead to exposure.
- Storage - Additional storage time of bulk material between collection and delivery to landfill (if via transfer stations) can increase any microbial deterioration already in progress.
- Housekeeping - Sweeping up during housekeeping may generate aerosols. Repairing and maintaining machinery could increase the likelihood of exposure to aerosols, to soiling of the hands or cuts and grazes.
- Environment - Potential presence of vermin in waste holding areas (increasing risk of Weil’s disease). Also affected by source material (animal by products more likely to attract vermin).

Generic Good Practice Principles

There are a number of generic good practice principles e.g. for risk assessment, communication, work practices, behaviour etc that are applicable to all aspects of the waste management industry and that also apply to reducing microbiological risks. (See signposting). These include practical methods such as training and communication principles.

Good practice principles for kerbside collection

Systems of work

The following systems of work, used where reasonably practicable, can help:

- Avoiding working methods that involve double tipping (e.g. emptying bags into bins which are then tipped into the vehicle).
- Avoiding using sacks and bins that are designed to be shoulder carried (e.g. ‘skeps’, ‘skips’ and other wide mouthed shoulder carried bins). These can create dust clouds when emptying.
- Avoiding working methods that encourage tipping from unnecessarily high heights (e.g. hand-loading waste into bin lift equipped vehicles).
- Separation of waste may reduce the amount potentially undergoing deterioration

To minimise dust and bioaerosols entering the lungs, employees should try to:

- Avoid opening sacks and containers. As far as possible, keep bags closed while carrying them, and open them only prior to tipping.
- Avoid leaning over bags and bins that are being tipped. As far as possible, face away from the tipping point.
- Avoid ‘loitering’ at the back of the vehicle after unloading bags and bins.

Good practice principles to avoid hand to mouth cross contamination and infection via skin include:

- Avoid eating or touching mouth after handling waste.
- Provide appropriate hand hygiene facilities on mobile units.
- Employees should be encouraged to use these facilities regularly and prior to eating.
- Clean up any wounds quickly and apply antiseptic.
- Cover any existing cuts and grazes.
- Avoid contact with uncontrolled dogs where possible.

Protection from exposure

- Separate the operator from the waste – for example where possible provide the ability to operate machinery remotely (e.g., design of vehicle to have compactor controls away from compactor).
- Fit and maintain rubber/plastic strip curtains to larger container chambers. These can help to contain any dust clouds created during tipping.
- Supply personal protective equipment – especially gloves to protect hands from cuts and soiling, but also safety boots, respiratory protection, goggles. Such

equipment should always be available to employees wishing to use it. It should be worn correctly in accordance with the manufacturer's instructions, and be kept clean and well maintained.

Good practice principles for post collection

<u>All of the above plus</u>

- Engineering control – e.g. exhaust ventilation dust removal over tipping bays and conveyors.
- Damping sprays to minimise dust.
- Operate machinery remotely, for example working from vehicle cabs with integral air filtration units, or siting grab crane cabins at incinerators well above the waste hoppers.
- Minimise the amount of manual sorting wherever possible.
- Identify higher risk activities such as maintenance and repair – this may lead to greater potential exposure and need additional protection.

To minimise dust and bioaerosols entering the lungs:

- In addition to working within vehicles that have cabs with a filtered air supply, make sure that staff keep their cab doors and windows closed.
- Where no other controls are practicable, use suitable and well fitted respiratory protection.

Good practice principles to avoid hand to mouth cross contamination and infection via skin include:

- Wear gloves and even after taking them off avoid eating or touching mouth before washing hands.
- Make use of hand wash facilities (water, soap/cleansers and towels) provided, especially before eating.
- Clean up any wounds quickly and apply antiseptic.
- Cover any existing cuts and grazes.
-

Try not to transfer dust and dirt to yourself or your clothes when taking off dirty coveralls.

Training and communication

Using this guidance as a starting point, managers and supervisors could have discussions with operators to:

- Identify what are the main areas of concern
- Identify specific activities that might increase exposure to microbiological hazards
- Decide whether the controls are adequate
- Discuss what reasonably practical measures could be used to improve controls.

This can be used to supplement training on safe use of machinery and wearing of protective equipment.

A written record of the above, with notes of what actions to take, is the starting point to your formal risk assessment.

Signposting

- **Generic Good Practice Principles for the Waste Management Industry**. HSL Draft (2006).

- **Green Waste Collection –Health Issues.** This document is available only on HSE's website at www.hse.gov.uk/pubns/web10.pdf

- **Handling needles in the waste and recycling industry.** HSE guidance at http://www.hse.gov.uk/waste/needles.htm

- **Infection at work – controlling the risks.** HSE guidance at http://www.hse.gov.uk/pubns/infection.pdf

- **Leptospirosis. INDG84. HSE Books (2006).** Also available on the web at www.hse.gov.uk/pubns/indg84.htm

- **Blood-borne viruses in the workplace –** Guidance for employers and employees. INDG342. HSE Books (2001). http://www.hse.gov.uk/pubns/indg342.pdf

F7 ANNEX F4 – STRESS FATIGUE AND VIOLENCE GUIDANCE

Stress, Fatigue and Violence in the Waste Management Industry: Good Practice Guidance

What is this about?

One of a series of guidance and good practice documents from the Health and Safety Laboratory to help the waste management industry manage and control risk. This one deals with psychological issues (stress, fatigue and violence).

Who is it for?

Managers, supervisors and operators working with all types of waste in the waste management and recycling industries.

Why is it needed?

This series of guidance documents aim to comment on and help reduce the health and safety risks associated with the collection, transfer, treatment and processing of waste and recyclable material. They are not intended to interpret the law, nor to be comprehensive, but to suggest good practice that may be helpful in considering what you need to do. Each situation may be different though, and your risk assessment may need to take other factors into consideration. More sources of information and help are given at the end of this document.

What are the issues?

Work-related stress, fatigue and work-related violence are important issues within the Waste Management industry. All have the potential to affect the health and safety of industry workers if not properly managed and controlled. Work-related stress for example, accounts for over a third of all new incidences of ill health throughout the UK. Each case of stress-related ill health leads to an average of 30.9 working days lost. A total of 12.8 million working days were lost to stress, depression and anxiety in 2004/5[8]

Is there really that much risk?

Illness, injury and time lost from work due to stress, fatigue and violence are not inevitable however. Effective solutions are often simple, cheap and can lead to better, easier working conditions and improved work effectiveness. This guidance provides appropriate good practice guidance that can be used throughout the waste management industry.

How and Where the Hazard Arises

The Health and Safety Executive defines:

Stress as: *'The adverse reaction people have to excessive pressure or other types of demands place on them'.*

Work-related Violence as: *'Any incident in which a person is abused, threatened or assaulted in circumstances relating to their work'.*
Verbal abuse and threats are the most common types of incident. Physical attacks are comparatively rare.

Fatigue as a concept is harder to define, it can be short or long-term and may be mental (e.g. feeling tired, lack of attention) or physical (e.g. muscle fatigue). All types can affect performance, and may affect health and well being in the long-term.

There are a number of factors that can increase the likelihood of an individual experiencing work-related stress, fatigue and violence. These are identified below:

• Individual behaviour	Unsafe working practices such as not taking appropriate or sufficient breaks. Task and finish work practices are likely to encourage rushing/ time saving activities that can lead to stress and fatigue.
• Work organisation The following areas of work design are associated with poor health and well-being, if not properly managed:	Demands – workload, work patterns and the work environment. Control – how much say workers have in the way they do their work. Support – the encouragement, sponsorship and resources provided by the organisation, line

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[8] *Source: HSE Stress website (Dec 2006). http://www.hse.gov.uk/stress/index.htm*

not properly managed:	management and colleagues. Relationships – e.g. promoting positive working to avoid conflict and dealing with unacceptable behaviour. Role – whether people understand their role within the organisation and whether the organisation ensures that they do not have conflicting roles. Change – how organisational change (large or small) is managed and communicated in the organisation.
• Fast-paced, physically/mentally demanding, tasks	Physical fatigue e.g. muscular fatigue resulting from fast paced, prolonged physical work such as collection duties. The impact of mental fatigue may be greater for jobs that require attention, such as driving. A large fatigue dose can result from work that is too intensive with not enough chance to rest.
• Boring tasks	Mental fatigue can result from too little stimulation at work e.g. picking operations at MRFs, long hours spent in vehicle cabs. Lack of opportunity for different work tasks.
• Repetitive tasks	Work involving movements repeated over and over is physically tiring. Workers cannot fully recover in the short periods of time between movements. When the work activity continues in spite of the fatigue, injuries can occur.
• General public	Employees whose job requires them to deal with the public can be at risk from verbal abuse and occasionally physical violence. Most at risk are those engaged in giving a service e.g. collection tasks. Road rage' incidents due to collection vehicles causing an obstruction.

Consequences

Work-related stress produces a range of symptoms and negative outcomes for both individuals and organisations. For the individual, symptoms can include coronary heart disease, mental illness, and poor health behaviours such as drinking, smoking and lack of exercise. Stress can also lead to accidents, and careless or unsafe behaviours at work. For the organisation, symptoms can include high labour turnover, high sickness absence rates, industrial relations difficulties, and high rates of absenteeism.

Fatigue can produce a general deterioration in mood and motivation and may affect health and well being in the long term. Physical fatigue can lead to muscular skeletal disorders and mental fatigue may have an impact on individual safety and an increased likelihood of work-related accidents. This is thought to result from the fact that fatigue may affect such things as maintenance of attention and risk taking.

For employers, violence can lead to poor morale and a poor image for the organisation, making it difficult to recruit and keep staff. It can also mean extra
costs, with absenteeism, higher insurance premiums and compensation payments. For employees, violence can cause pain, distress and in severe examples, even disability or death. Physical attacks are obviously dangerous but serious or persistent verbal abuse or threats can also damage employees' health through anxiety or stress.

Good practice principles

A number of general good practice principles, for example those concerning risk assessment, communication, work practices, and behaviour, can be applied to all aspects of Waste Management industry work, including the areas of stress, fatigue and violence (See Generic Good Practice Guidance for the Waste Management Industry). This document also highlights the Business and Health and Safety benefits of implementing good practice.

A number of specific good practice principles for managing the risk of stress, fatigue and violence are given below:

STRESS
Good practice that can help reduce stress to employees includes:

Managers:

- Carry out a risk assessment for work-related stress, in conjunction with your employees. HSE's Management Standards approach can help (www.hse.gov.uk/stress/standards).
- Implement recommendations from risks assessments, and check they are working.
- Ensure good communication between management and staff, particularly where there are changes to the organisation or procedures.
- Ensure workers feel able to express their honest opinions. Consider involving someone else in the process so that workers are not afraid to say what they think.
- Record what workers say, this will help you prioritise, and give you a record to check back on.
- Continue to use existing methods to talk to employees about issues that affect them at work, e.g. regular staff meetings, toolbox talks, or performance reviews.
- As far as possible allow workers to control the pace of their work and when they take breaks.
- If operating Task and Finish consider the use of Group T & F rather than Individual Team T & F[9]. Group T&F operations can promote good team and company spirit and are less likely to lead to stress as there is perceived to be less personal gain from rushing.
- Ensure staff are fully trained to conduct their duties and their skills and abilities are matched to their job.
- Provide staff with meaningful development opportunities.
- Monitor workloads to ensure that people are not overloaded. Work demands must be achievable in relation to the hours of work.
- Monitor working hours and overtime to ensure that staff are not overworking.
- Increase staff numbers during predicted busy periods e.g. post Xmas.
- Monitor holidays to ensure staff are taking their full entitlement.
- Ensure that bullying and harassment is not tolerated.

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[9] Individual team T&F - working day is over for the team members (typically a single collection crew) when it has completed its individual task. Group T&F -working day is over when all working teams from the depot have completed all the tasks (e.g. all of the days collection activities are complete).

- Be vigilant; offer additional support if a member of staff is experiencing stress outside work e.g. bereavement or separation.

Occupational Health and Safety Staff:

- Support individuals who have been off sick with stress and advise them and their managers on a planned return to work.
- Refer to workplace counsellors or specialist agencies as required.
- Monitor and review the effectiveness of any measures to reduce stress.

Employees:

Many employees are reluctant to talk about stress at work, due to the stigma attached to it. They fear they will be seen as weak. But stress is not a weakness, and can happen to anyone.

It is important to take action at a personal level. Things you should consider doing include:

- Avoid rushing or hurrying. If operating Task and Finish be reaslistic about how long it will take you to do your job.
- Make sure that you do not miss breaks, even if you feel under pressure from your co-workers to do so.
- Avoid eating on the run, or in a disorganised manner
- Make sure that when away from work you make time for exercise and relaxation.
- If you feel stressed, try to identify the causes and what you can do to make things better.
- Ideally, tell your line manager, safety representative or occupational health department at an early stage. If your stress is work-related, this will give them the chance to help and prevent the situation getting worse.
- Even if it isn't work-related, they may be able to do something to reduce some of your pressure.
- Accept opportunities for counselling if recommended.

FATIGUE

Good practice that can help reduce the risk of fatigue to employees could include, for example:

Managers:

- Carry out a risk assessment for fatigue. Recognise that Task and Finish practices may contribute to a heavy, fast paced workload and the potential for both physical and mental fatigue.
- Consider the use of Group T & F rather than Individual Team T & F (see Stress).
- Introduce company policies that cover overtime, second jobs and exchange of shifts. Review the extent and distribution of any overtime.
- Recognise that there is a link between available resources, workload and fatigue; particularly during times of changing staffing levels or when there are higher workloads (e.g. summer holidays).

- Set minimum staffing levels that consider foreseeable planned abnormal conditions (such as busy times after Christmas).
- Ensure there are systems for monitoring day-to-day fitness for work.
- Have sufficient cover so that meal and rest breaks can be taken and encourage staff to take these breaks.
- Review the possible impact of fatigue on any incidents that occur.
- From time to time review whether fatigue levels are considered to be a problem by the workforce - do this informally through managers, supervisors and safety representatives or use a short questionnaire.
- Consider the travelling time of the workforce.

Employees

- Avoid trying to conduct physically demanding tasks quickly. If operating Task and Finish, be reaslistic about how long it will take you to do your job. Make sure that you do not miss breaks.
- Be aware that people may not be aware of their own fatigue, look out for fatigue in your colleagues.
- If your work involves driving a vehicle for long periods (e.g RCV, Shovel loader) make sure that you take regular short breaks.
- If your job involves standing still for long periods (e.g. picking at an MRF) regularly change your position to avoid muscle fatigue.
- Take regular short breaks from any task that involves repetitive movements to avoid muscle/joint fatigue and long term injury.

VIOLENCE

Good practice that can help reduce the risk of violence to employees includes:

Managers:

First, find out if you have a problem. You may think violence is not a problem at your workplace; however, your workers may have a different view.

- Ask your staff - do this informally through managers, supervisors and safety representatives or use a short questionnaire to find out if your employees ever feel threatened.
- Try to predict what might happen, do not restrict assessment to incidents that have already occurred. There may be a known pattern of violence linked to certain work situations (e.g. traffic hot-spots).

It is a good idea to record incidents, including verbal abuse and threats. You may find it useful to record the following information:

- An account of what happened;
- Details of the victim(s), the assailant(s) and any witnesses.
- Outcome, including working time lost.
- Details of the location of the incident.

Having found out that violence could be a problem for your employees you must decide what needs to be done.

- Identify which employees are at risk - those who have face-to-face contact with the public are normally the most vulnerable (e.g. collection workers).
- Check existing arrangements. Are the precautions already in place adequate or should more be done?
- Usually a combination of factors gives rise to violence. Things you can influence include the level of training and information provided and the design of the work (e.g. ensuring no lone-working in known areas of risk).
- Train your workers so that they can spot early signs of aggression, e.g. body language and how to either avoid it or cope with it.
- Provide employees with any information they might need to identify clients with a history of violence or to anticipate things that may make violence more likely (e.g. residents angered by a change to collection rotas).
- Consider physical security measures such as personal attack alarms.
- As far as practicable avoid lone working situations.
- Write your policy for dealing with violence into your health and safety policy so that all employees are aware of it.

If a violent incident does occur you need to respond quickly to avoid long-term distress. Plan how you are going to provide support, before any incident. You may want to consider the following:

- Debriefing - victims may want to talk through their experience as soon as possible. Remember that verbal abuse can be just as upsetting as a physical attack.
- Individuals will be different and may need differing amounts of time off work to recover. Counselling may also be required.
- Legal help may be appropriate for serious cases.
- Other employees may need guidance and/or training to help them react appropriately.

Employees

- As far as possible avoid situations where you think you may be in danger (e.g. lone working).
- Share information about potential problem areas with your colleagues.
- Trust your instincts; leave any situation that makes you feel threatened or uncomfortable.
- If faced with aggression, keep calm;
    - Do not respond to threats or provocation.
    - Approach people with a friendly and relaxed expression.
    - Give people the opportunity to move away without further confrontation (allow them to ‘save face’).
    - In a verbal exchange, stand sideways to appear less threatening.
    - Position yourself so you have an escape route; seek assistance immediately if you think you may need it.

Signposting

Relevant Legislation

- **Health and Safety at Work Act (1974)**

  Places a duty on employers to ensure the health and safety of employees and others who may be affected by their work activities.

- Management of health and safety at work:
  Management of Health and Safety at Work Regulations 1999. Approved code of practice, L21. HSE Books, 2000 ISBN 0 7176 2488 9
  Builds on the HSAW Act and includes duties for people in control of workplaces to assess risks.

- Workplace health, safety and welfare.
  Workplace (Health, Safety and Welfare) Regulations 1992 (as amended by the **Quarries Miscellaneous Health and Safety Provisions Regulations 1995**), L24. HSE Books 1996. ISBN 0 7176 0413 6
  Provides guidance on the Regulations which implement a European directive No. 89/654/EECincluding temperature, lighting; workstations and seating.

  Requires floors to be suitable, in good condition and free of obstructions. Traffic routes should be organsied so that people can circulate safely.

- **The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR)**
  Employers must notify their enforcing authority in the event of an accident at work to any employee resulting in death, major injury or incapacity for normal work for three or more consecutive days.

- **Safety Representatives and Safety Committees Regulations 1977 (a)** and **The Health and Safety (Consultation with Employees) Regulations 1996 (b)**
  Employers must inform, and consult with, employees in good time on matters relating to their health and safety. Employee representatives, either appointed by recognised trade unions under (a) or elected under (b) may make representations to their employer on matters affecting the health and safety of those they represent**.**

Further Guidance

- HSE Stress website contains detailed information, case studies, and guidance, including leaflets, information on workshops and events, and detailed references/links to other organisations that provide support and guidance.
  http://www.hse.gov.uk/stress/index.htm

- HSE Work Related Violence website contains detailed information and guidance, including leaflets, information on events, and detailed references for other organisations that provide support and guidance. http://www.hse.gov.uk/violence/index.htm

- **Real Solutions, Real People** (ISBN 0 7176 2767 5).
  A comprehensive pack designed to help employers identify risks associated with work-related stress and develop locally applicable solutions in partnership with workers.
  Tackling work-related stress. (HSG218) Only available in the Real Solutions, Real People pack.

- **Tackling stress: The Management Standards Approach** (INDG406)

- **Working together to reduce stress at work: A guide for employees**.
  The International Stress Management Association has produced this leaflet showing how employees can work with their employers to tackle work-related stress using the Management Standards approach.
  HSE Free Leaflet MISC686.

- **Violence at work: A guide for employers**.
  HSE Free Leaflet. INDG69*(rev), revised 10/96*

- **Managing and preventing violence to lone workers**: Case studies Health and Safety Laboratory/Report WIS/03/05. (A shorter version of the case studies is also available on the HSE website at www.hse.gov.uk/violence/loneworkers.htm)

- The Development of a Fatigue / Risk Index for Shiftworkers. HSE Research Report 446 (2006). HSE Books.
  www.hse.gov.uk/research/rrhtm/rr446.htm

The Waste Industry Safety and Health (WISH) Forum can be found at www.hse.gov.uk/waste/wish.htm.

This leaflet contains notes on good practice which are not compulsory but which you may find helpful in considering what you need to do.

F8 ANNEX F5 – GENERIC GOOD PRACTICE GUIDANCE

Generic Good Practice Principles for the Waste Management Industry

What is this about?

One of a series of guidance and good practice documents from the Health and Safety Laboratory to help the waste management industry manage and control risk. This one deals with general good practice principles (e.g. training and communication).

Who is it for?

Managers, supervisors and operators working with all types of waste in the waste management and recycling industries.

Why is it needed?

This series of guidance documents aim to comment on and help reduce the health and safety risks associated with the collection, transfer, treatment and processing of waste and recyclable material. They are not intended to interpret the law, nor to be comprehensive, but to suggest good practice that may be helpful in considering what you need to do. Each situation may be different though, and your risk assessment may need to take other factors into consideration. More sources of information and help are given at the end of this document.

What are the hazards?

There are various hazards in the waste management industry, ranging from slips and trips to workplace transport. The overall accident rate within the industry is very high in comparison with the national average. A recent analysis of accident statistics for HSE (BOMEL Ltd, 2004) estimated the overall accident rate for the Waste Management Industry to be around four times the national average (2,500 accidents per 100,000 workers in 2001/02), and the fatal injury accident rate to be around ten times the national average (10 per 100,000 workers in 2001/02).

Is there really that much risk?

The large numbers of accidents and injuries in the Waste Management industry are not inevitable however. Effective solutions are often simple, cheap and can lead to better, easier working conditions and improved work effectiveness. This guidance provides appropriate general risk reduction measures that can be used throughout the industry.

Risk Assessment/Management

What you have to do to manage health and safety effectively is:

- Know about the risks in your work.
- Control the risks that need it.
- Make sure the risks stay controlled.

Know about the risks in your work

Risk is a part of everday life. You are not expected to eliminate all risk. What you must do is make sure you know about the main risks that affect you, and what you need to do to manage them resoponsibly. Thinking this through is called ‘risk assessment’. The management of risks should be the same for all hazards. All employers are required to assess risks to employees and others who may me affected by their work. There are not fixed rules about conducting a risk assessment but there are general principles that should be followed. A tried and tested method is described in the HSE leaflet Five steps to successful health and safety management (see Signposting).

Poor application of risk assessment and management controls can increase the risk of accidents and injuries. Proper health and safety management in the Waste Management industry should incorporate:

- Planning,
- Organisation,
- Control,
- Monitoring and Review.

This will help you to analyse problems, decide what to do, put decisions into practice and check that actions have been effective.

Training

Barriers to the correction of risk taking problems include:

- People not taking the risks seriously.
- Little understanding of the causes of accidents.
- Thinking that accidents are inevitable.

These barriers may be overcome with appropriate training. Training should include, but should not be limited to:

- Basic information and key risk factors for accidents and injuries.
- How to avoid accidents including appropriate use of PPE, ensuring employees clear up after any work activity, how to appropriately conduct specific work activities, etc.
  - Practical work to allow the trainer to identify and put right anything the trainee is not doing safely.
  - Any task/site-specific elements that must be considered.
  - Introduce workplace coaches for new recruits that are trained to demonstrate best practice and provide explanations of why unsafe practices should not be used.
  - Make sure that supervisors and managers receive sufficient training to effectively conduct risk assessments, and check competency.
  - Use real case studies to demonstrate the types of remedial actions that managers can implement following an incident.

Communications

Actions to take should include, but not be limited to:

- Introduce a hazard reporting system whereby workers can follow the progress of actions and timescales in relation to existing hazards.
- Ensure employees are familiar with the hazards in their job. Consider using laminated sheets or cards with the key hazards indicated on them.
- Safety briefings should be held on a regular basis and address relevant issues.
- Frequent dialogue from management and fellow employees in relation to safety should reinforce the messages given in formal training sessions.
- Communicate the potential severity of injuries highlighting the human cost aspects, such as effects on family relations, personal injury and potential loss in earnings that can result from accidents to raise awareness.

Work practices

Considerations should include, but not be limited to:

- Accident reporting systems should be simple and should not provide a barrier to the reporting of accidents.
- Consider conducting safety observation tours. The observers should be respected, trusted and credible. Openly discuss with employees the outcome of the safety tours. Work with employees to encourage their participation in dealing with the hazards.

- Where hazards are on the property of customers, communication with the Local Authorities or Highways Agency should be established to address these issues. Communication with these parties should become a routine matter.
- Working practices should be flexible where possible to accommodate variation in weather e.g. postponing collections until conditions improve.
- Introduce safety committees owned and run by the workers but involving management. Allow sufficient time for members to carry out their role, such as updating risk assessments and providing solutions for safety issues.
- Provide induction training to temporary staff that includes a breakdown of the hazards in the work, safe working practices and the risk controls used. Encourage permanent crewmembers to highlight hazards to new members throughout the working day.
- Consider the introduction of a health and safety suggestion box that gives a reward to those suggestions put into practice.
- Give clear messages about expected behaviour
- Good supervisory control is important to correct poor working practices while encouraging good ones.

Behaviour

Behaviours are an important part of good practice and accident prevention and need to be considered equally alongside any relevant ergonomic and environmental changes. Considerations should include, but not be limited to:

- Do not assume workers are to blame for poor work practices and behaviours. The problem may be to do with how health and safety is managed.
- Identify improvements that can be made in the way health and safety is managed, and the controls that are put in place first, before you try and change the workers' behaviour.
- When trying to identify improvements, talk to and listen to your workers. They are usually in the best position to know what will and will not work.
- Knowing about risks is not enough to motivate people to change their behaviour and work more safely. To motivate staff you need to explain why it is a risk and what the consequences can be, in terms of their health, well being, and ability to work.
- Make sure that your workers know how to work more safely. Do this by providing training, covering hazard awareness and showing them how to carry out a task safely. Ensure supervisors set a good example.
- Do not let workers fall into the trap of thinking, “nothing bad has happened yet”. Avoid this by making them think whether what they are doing could be harming colleagues or their family in the long run, by affecting their earning power. Use examples, which make people think, “That could have been me”.
- From time to time check that your workers are doing things in a safe way. If they are, praise them, tell them well done. If they are not, show them how they can improve. Keep it constructive by sticking to the facts.
- Consider the use of an audit scheme to monitor employee behaviour and promote a good safety culture. Such schemes would enable you to identify trends in unsafe behaviour and take actions to rectify them.

Health and Safety Benefits

- Some health and safety benefits that can be obtained from the application of good practice principles include:
- A focus on the control of risks and not just the implementation of preventative measures once an accident has occurred.
- A confident workforce able to assess risks and implement safe systems of work.
- A change in behaviour in relation to risks.
- A move towards a positive health and safety culture.

Business Benefits

Potential business benefits from the application of good practice principles include:

- Improved company profile that is of benefit when tendering for work.
- Improved efficiency through a reduction in loss time caused by accidental injuries.
- Higher staff morale and improved motivation through involvement in health and safety implementation.
- Reduced costs caused by accidents and ill health

Signposting

Relevant Legislation

- **Health and Safety at Work Act (1974)**
  Places a duty on employers to ensure the health and safety of employees and others who may be affected by their work activities.

- Management of health and safety at work:
  Management of Health and Safety at Work Regulations 1999. Approved code of practice, L21. HSE Books, 2000 ISBN 0 7176 2488 9
  Builds on the HSAW Act and includes duties for people in control of workplaces to assess risks.

- Workplace health, safety and welfare.
  Workplace (Health, Safety and Welfare) Regulations 1992 (as amended by the **Quarries Miscellaneous Health and Safety Provisions Regulations 1995**), L24. HSE Books 1996. ISBN 0 7176 0413 6
  Provides guidance on the Regulations, which implement a European directive No. 89/654/EEC including temperature, lighting; workstations and seating.

Further Guidance

- **Five steps to successful health and safety management**. HSE Free leaflet (1992). INDGI32.

- **Five steps to risk assessment.** HSE Free leaflet (2006). INDGI63 (rev 2).

- **Health and safety training: What you need to know.** HSE Free Leaflet. INDG345.

- **Health and Safety training: Guidelines for the waste management sector. (2006).** WISH guidance document (currently draft, pending publication on HSE website).

- **Waste Industry Safety and Health Reducing the Risk.** HSE/WISH (2002). HSE Books ISBN 07176 25141.

- **Health and safety law: What you should know (rev1).** HSE Books (1999). ISBN 0 7176 1702 5.

- **Workplace health, safety and welfare: A short guide for managers**. HSE Books (1997). INDG244.

- **Basic advice on first aid at work.** HSE Books (2002). INDG347.

- **A Guide to the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 L73 (Second edition).** HSE Books (1999). ISBN 0 7176 2431 5.

- **Essentials of health and safety at work (Third edition) guidance**. HSE Books (1994). ISBN 0 7176 0716.

9 REFERENCES

1 DEFRA (2006) 'Report of the market development group' *Viewed online 05th April 2006 at http://www.defra.gov.uk/environment/waste/strategy/mdg/report/4.htm*

2 Waste Strategy (2000) 'The waste strategy for England and Wales – part 1'

3 Waste Online (2004) 'Waste disposal and collection information sheet' *Viewed online 1st March 2006 at http://www.wasteonline.org.uk/resources/InformationSheets/WasteDisposal.htm*

4 BOMEL Ltd. (2004) 'Mapping health and safety standards in the UK waste industry' *HSE Research Report, CRR 240*

5 Waste Watch (1999) 'Jobs from waste: employment opportunities in recycling' *Viewed online 3rd April 2006 at http://www.wastewatch.org.uk*

6 Environment Agency (2006) 'What does a waste collection authority do?' *Viewed online 20th March 2006 at http://www.environment-agency.gov.uk /subjects/waste/1029679/1029771 /?version=1&lang=_e*

7 Chartered Institution of Wastes Management (2004) 'Kerbside collection of recyclables and compostable waste'

8 Chartered Institution of Wastes Management (2003) 'Energy from Waste: A good practice guide'

9 Pinder, A.D.J. and Milnes, E. (2002) 'Manual handling in refuse collection' *HSL Report, ERG/02/07*

10 Oxley, L., Pinder, A.D.J., Cope, M. (2006) 'Manual handling in kerbside collection and sorting of recyclables' *HSL Report, ERG/06/01*

11 Chartered Institution of Water and Environmental Management (2005) 'Incineration fact sheet' *Viewed online 22nd March 2006 at http://www.ciwem.org/policy/factsheets*

12. Animal By-Products Regulations (2003) Statutory Instrument 2003 No. 1482

13 National Household Hazardous Waste Forum (2006) 'Definitions of household hazardous waste' *Viewed online 1st April 2006 at http://www.nhhwf.org.uk/pages/about.htm*

14 Waste Watch (2005) 'Schemes for collection of household hazardous waste' *Viewed online 3rd April 2006 at http://www.wastewatch.org.uk/hhw.htm*

15 Waste Watch (2004) 'Recycling from flats - case studies of recycling schemes for housing estates, high-rise blocks and other areas of high-density housing' *Viewed online 2nd April 2006 at http://www.wasteonline.org.uk/resources/WasteWatch/RecyclingFromFlats_files/page1.html*

16 S^3 Environmental Solutions Ltd (2003) 'Best practice guide: maximising diversion at household waste recycling centres'

17 McLanaghan, S.R.B. (2002) 'Delivering the landfill directive: the role of new and emerging technologies' *Associates in Industrial Ecology*

18 Residua (1998) 'Materials Recovery Facility information sheet' *Viewed online 28th March at www.env.leeds.ac.uk/envi2063/WB58-IS_(MRFs).pdf*

19 Ferreira, J. (2003) 'Musculoskeletal disorder risks at Exeter City Council materials recycling facility' *HSL Report, JS2003319*

20 DEFRA (2004) 'Introductory guide: options for the diversion of biodegradable municipal waste from landfill'

21 DEFRA (2001) 'Municipal waste management survey 1999/2000' *DEFRA, July 2001*

22 Confederation of Paper Industries (2005) 'Fact sheet: recovery and recycling of paper and board' *Viewed online 27th March 2006 at http://www.paper.org.uk/paperchain/recycling.htm*

23 Severnside (2006) 'Paper recycling loop' *Viewed online 06th April 2006 at http://www.severnside.com/home.htm*

24 Waste Online (2006) 'Paper recycling information sheet' *Viewed online 24th March 2006 at http://www.wasteonline.org.uk/resources/InformationSheets/paper.htm*

25 The British Glass Manufacturers Confederation (2006) 'The glass recycling cycle' *Viewed online 24th March 2006 at http://www.wasteonline.org.uk/resources/InformationSheets/paper.htm*

26 Newport Wastesavers (2006) 'Kerbside collection: Where it goes' *Viewed online 09th March 2006 at www.wastesavers.co.uk/kerbside-where.html*

27 RECOUP (2005) 'Useful statistics' *Viewed online 06th April 2006 at http://www.recoup.org/business/current_useful.asp*

28 Hooper, R. (2000) 'Household waste plastics – a future for recovery' *IWM Scientific and technical Review, November, 37 - 40*

29 RECOUP (2006) 'Fact sheet: automatic bottle sorting equipment' *Viewed online 06th April 2006 at http://www.recoup.org/shop/product_documents/23.pdf*

30 RECOUP (2002) 'Fact sheet: feedstock recycling of mixed polymers' *Viewed online 06th April 2006 at http://www.recoup.org/shop/product_documents/26.pdf*

31 Betsinger, G., Brosseau, L.M and Golden, J. (2000) 'Occupational health and safety in household hazardous waste management facilities' *American Industrial Hygiene Association Journal, 61, 575-583*

32 Waste Online (2004b) 'Compost information sheet' *Viewed online 30th March 2006 at http://www.wasteonline.org.uk/resources/Information Sheets/Compost.htm*

33 Robinson, J. and Stentiford, E. (1993) ‘Composting of organic material from Leeds City Councils source-separated household waste collection scheme’ *Environmental Policy and Practice, 3(1), pp51-60*

34 U.S Environmental Protection Agency (2006) ‘Aerated (turned) windrow composting’ *Viewed online 30th March2006 at http://www.epa.gov/compost/windrow.htm*

35 SITA (2006) ‘In-vessel composting’ *Viewed online 29th March 2006 at http://www.sita.co.uk/in-vessel*

36 Environment Agency (2002) ‘Environmental facts and figures: waste incineration’ *Viewed online 23rd March 2006 at http://www.environment-agency.gov.uk/incineraiton.htm*

37 ETSU (1998) ‘An introduction to household waste management’ *ETSU, Harwell, Didcot, Oxfordshire*

38 Integra (1998) ‘Fact sheet: anaerobic digestion’ *Viewed online 07th April 2006 at http://www.integra.org.uk/facts/extrafacts/anaerobic.html*

39 Friends of the Earth (2004) ‘Anaerobic digestion briefing’ *Viewed online 3rd April 2006 at http://www.foe.co.uk/resource/briefings/anaerobic_digestion.pdf*

40 Office of the Deputy Prime Minister (2004) ‘Planning for waste management facilities: A research study’ *HMSO, Norwich*

41 SITA (2004) ‘Landfill position paper’ *Viewed online 27th March 2006 at http://www.sita.co.uk /assets/PPLandfill.pdf*

42 SITA (2004) ‘Composting position paper’ *Viewed online 27th March 2006 at http://www.sita.co.uk/assets/PPComposting.pdf*

43 Chartered Institution of Wastes Management (2006) ‘Waste treatment and processing options’

44 HSE (2001) ‘Reducing Risks Protecting People - HSE’s decision making process’ *HSE 12/01, ISBN 0 7176 2151 0*

45 HSE (2005) ‘COSHH: A brief guide to the Regulations; What you need to know about the Control of Substances Hazardous to Health Regulations 2002 (COSHH)’, INDG136(rev 3) 04/05. www.hse.gov.uk/pubns/indg136.pdf

46 HSE ‘The Work at Height Regulations 2005 (as amended); A brief guideWorking at height regs’, INDG401(rev 1) 04/07. http://www.hse.gov.uk/pubns/indg401.pdf

47 HSE heat stress web pages, http://www.hse.gov.uk/temperature/information/heatstress.htm

48 HSE temperature web pages, http://www.hse.gov.uk/temperature/index.htm

49 HSE, Manual handling. Manual Handling Operations Regulations 1992 (as amended), L23, 071762823X

50 HSE waste website – manual handling, http://www.hse.gov.uk/waste/issues.htm#5.

51 HSE 'Noise at work Guidance for employers on the Control of Noise at Work Regulations 2005', INDG362(rev 1) 11/06. http://www.hse.gov.uk/pubns/indg362.pdf

52 Shanks, E (2007), Glass recycling: noise exposure from simulated roadside collection of recyclable glass noise report – lining of hoppers, HSL report, NV/07/01.

53 HSE 'Control the risks from hand-arm vibration Advice for employers on the Control of Vibration at Work Regulations 2005', INDG175(rev2) 06/05.
http://www.hse.gov.uk/pubns/indg175.pdf

54 HSE 'Control back-pain risks from whole-body vibration Advice for employers on the Control of Vibration at Work Regulations 2005Whole body vibration', INDG242(rev 1) 06/05.
http://www.hse.gov.uk/pubns/indg242.pdf

55 HSE violence web pages, http://www.hse.gov.uk/violence/index.htm.

56 HSE/WISH 'Waste and recycling vehicles in street collection', WEB 14, 06/06.
http://www.hse.gov.uk/pubns/web14.pdf

57 HSE/WISH 'Safe transport in waste management and recycling facilities',
http://www.hse.gov.uk/pubns/web/wastetransport.pdf

10 GLOSSARY OF ABBREVIATIONS

ALARP	As low as reasonably practicable
ATT	Advanced thermal treatment
CCTV	Closed-circuit television
CIWM	Chartered Institution of Wastes Management
COSHH	Control of Substances Hazardous to Health
cRDF	Coarse refuse derived fuel
CRN	Community Recycling Network
DEFRA	Department for Environment, Food and Rural Affairs
dRDF	Densified refuse derived fuel
ECT	Ealing Community Transport
FRN	Furniture reuse network
HHW	Hazardous household waste
HSE	Health and Safety Executive
HSL	Health and Safety Laboratory
HWRC	Household waste recycling centre
LA	Local Authority
MBT	Mechanical microbiological treatment
MRF	Material recycling facility
MSD	Musculoskeletal disorder
OCC	Oil care campaign
PCV	Pedestrian controlled vehicle
PPE	Personal protective equipment
RCT	Risk Comparator Tool
RCV	Refuse collection vehicle
RDF	Refuse derived fuel
RIDDOR	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations
SFAIRP	So far as is reasonably practicable
THCRC	Tower Hamlets Community Recycling Consortium
WCA	Waste collection authority
WDA	Waste disposal authority
WEEE	Waste electrical and electronic equipment
WISH	Waste Industry Safety and Health (WISH) forum
WRAP	Waste and Resources Action Programme

Published by the Health and Safety Executive 01/08

HSE

Health and Safety Executive

Collecting, transfer, treatment and processing household waste and recyclables

Assessment of the occupational health and safety risks of systems to provide HSE, local authorities, waste/recycling companies and others with data that will assist in the selection of the most appropriate system whilst meeting environmental targets

Given the potential increase in the number of employees working in the waste and recycling industry, it is reasonable to anticipate that there will be greater exposure to health and safety related hazards, particularly in collecting and sorting waste where human involvement is essential. In order to reduce the high accident rate within the waste and recycling industry, it is essential to ensure that considerations of health and safety are included in the decision-making process regarding which systems to operate. The Health and Safety Executive (HSE) has identified that the provision of appropriate guidance or tools could present a useful means of assisting Local Authorities, or organisations (including community organisations) that are responsible for delivering waste management services, to select the most appropriate systems to ensure environmental targets are met with the least possible health and safety risk.

As a means of obtaining this information, the Health and Safety Laboratory (HSL) were jointly commissioned by HSE, the Department for Environment, Food and Rural Affairs (Defra), the Scottish Government (SG), and the Welsh Assembly Government (WAG) to undertake an assessment of the occupational health and safety risks of systems for collection, transfer, treatment and processing of household waste and recyclables.

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